QNX® Neutrino® Realtime Operating System

Library Reference

For QNX® Neutrino® 6.3

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About This Reference

The *Library Reference* describes the C functions, data types, and protocols that are included as part of the QNX Neutrino RTOS.

The *Library Reference* also contains:

- Summary listings of the library, including a description of what you'll find in a function description
- Summary of safety information:
  - functions that are cancellation points
  - functions that you can safely call from an interrupt handler
  - functions that you can safely call from a signal handler
  - functions that you *can't* safely call from a multithreaded program.
- descriptions of manifests
- SOCKS — A Basic Firewall
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What's new in QNX Neutrino 6.3.0

New content

fopen64()	Large-file support for *fopen()*.
freopen64()	Large-file support for *freopen()*.
ftw64()	Large-file support for *ftw()*.
getnameinfo()	Perform address-to-nodename translation.
inet6_option_*()	Manipulate IPv6 hop-by-hop and destination options.
inet6_rthdr_*()	manipulate IPv6 Router header options.

ipsec_dump_policy()
: Generate a readable string from an IPsec policy specification.

ipsec_get_policylen()
: Get the length of the IPsec policy.

ipsec_set_policy()
: Generate an IPsec policy specification structure from a readable string.

nftw(), nftw64()
: Walk a file tree and its large-file support.

poll()
: Input/output multiplexing.

resmgr_handle_tune()
: Tune aspects of client *fd*-to-OCB mapping

sctp_bindx()
: Add or remove one or more addresses from a given association.

sctp_connectx()
: Help associate an endpoint that is multi-homed.

sctp_freeladdrs()
: Free all resources allocated by *sctp_getladdrs()*.

sctp_freepaddrs()
: Free all resources allocated by *sctp_getpaddrs()*.

sctp_getladdrs()
: Return all locally bound addresses on a socket.

sctp_getpaddrs()
: Return all peer addresses in an association.

sctp_peeloff()
: Branch off an association into a seperate socket.

SCTP
: Stream Control Transmission Protocol.

sctp_recvmsg()
: Receive message using advanced SCTP features.

sctp_sendmag()
: Send message using advanced SCTP features.

tmpfile64()
: Large-file support for *tmpfile()*.

Changed content

Errata

What's new in QNX Neutrino 6.2.1

New content

dispatch_unblock()

Unblock all of the threads that are blocked on a dispatch handle

errno Each thread in a multi-threaded program has its own error value in its thread local storage. No matter which thread you're in, you can simply refer to *errno* — it's defined in such a way that it refers to the correct variable for the thread. For more information, see "Local storage for private data" in the documentation for *ThreadCreate()*.

pthread_attr_setschedpolicy().

Sporadic scheduling (SCHED_SPORADIC) is a new feature of QNX Neutrino 6.2.0.

`sched_param`

Structure of scheduling parameters

va_copy() Make a copy of a variable argument list

Changed content

bind(), bindresvport()

These functions aren't cancellation points any more, because this conflicted with POSIX.

htonl(), htons(), inet_ntop(), inet_pton(), isfdtype(), ntohl(), ntohs()

These functions have been moved from **`libsocket`** to **`libc`**.

Errata

alphasort() This function compares two directory entries; it doesn't sort an array of entries.

execlpe(), execvpe()

You can now execute a shell script.

fgetc(), fgetchar(), fgets(), fgetwc(), fgetws(), getc(), getc_unlocked(), getchar(), getchar_unlocked(), gets(), getw(), getwc(), getwchar()

Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

fstat(), fstat64() These functions return -1 if an error occurs.

iofunc_mmap(), iofunc_mmap_default()

These functions return a nonpositive value on success.

InterruptAttach(), InterruptAttachEvent()

You should always set _NTO_INTR_FLAGS_TRK_MSK.

mq_getattr(), mq_setattr()

The *mq_flags* member of the **`mq_attr`** structure applies to the message-queue description (i.e. locally), not to the queue as a whole.

mq_open() Corrected the interpretation of the *name* argument.

MsgError(), MsgError_r()

If the *error* argument is EOK, the *MsgSend*()* call returns EOK; if *error* is any other value, the *MsgSend*()* call returns -1.

MsgSendPulse(), MsgSendPulse_r()

You can now send pulses across the network.

	You can send a pulse to any process — not just to a process in the same process group — if your process has the appropriate permission.
name_open()	This function returns a nonnegative integer representing a side-channel connection ID, or -1 if an error occurred.
printf()	The exponent produced for the **e** and **E** formats is at least two digits long. Clarified what happens if the format string includes invalid multibyte characters.
pthread_mutex_timedlock(), pthread_rwlock_timedrdlock(), pthread_rwlock_timedwrlock()	The timeout is based on the CLOCK_REALTIME clock.
_resmgr_ocb()	Corrected the name.
select()	This function and the associated macros are now defined in **<sys/select.h>**, instead of **<sys/time.h>** (which includes **<sys/select.h>**).
sem_open()	Corrected the interpretation of the *sem_name* argument.
sem_timedwait()	The timeout is based on the CLOCK_REALTIME clock.
send()	The list of errors now includes EPIPE.
shm_open()	Corrected the interpretation of the *name* argument.
sigaction()	Corrected the example (it isn't safe to call *printf()* in a signal handler).
spawn(), spawnl(), spawnle(), spawnlp(), spawnlpe(), spawnp(), spawnv(), spawnve(), spawnvp(), spawnvpe()	You can now execute a shell script.

	The child process's *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* are now calculated.
timer_create()	Don't use SIGEV_INTR or SIGEV_UNBLOCK for the event type.
vsnprintf()	Corrected the returned values.

What's new in QNX Neutrino 6.2

Significant changes:

- New content
- Deprecated content
- Errata

New Content

addrinfo	TCP/IP address information
dircntl()	Control an open directory
freeaddrinfo()	Free an address information structure
freeifaddrs()	Free an address information structure
gai_strerror()	Return the *getaddrinfo()* error code
getaddrinfo()	Get address information
getdomainname()	Get the domain name of the current host
gethostbyname2()	Get a network host entry, given a name
getifaddrs()	Get a network interface address
hwi_find_item()	Find an item in the **hwi_item** structure

hwi_find_tag()	Find a tag in the **hwi_item** structure
hwi_off2tag()	Return a pointer to the start of a tag in the *hwinfo* area of the system page
hwi_tag2off()	Return the offset from the start of the *hwinfo* area of the system page
ICMP6	Internet Control Message Protocol for IPv6
if_freenameindex()	Free dynamic memory allocated by *if_nameindex()*
if_indextoname()	Map an interface index to its name
if_nameindex()	Return a list of interfaces
if_nametoindex()	Map an interface name to its index
ifaddrs()	Structure that describes an Internet host
INET6	Internet Protocol version 6 family
inet_net_ntop()	Convert an Internet network number to CIDR format
inet_net_pton()	Convert an Internet network number from CIDR format to network format
IPv6	Internet Protocol version 6
IPsec	Internet security protocol
mallinfo()	Get memory allocation information
mallopt()	Control the memory allocation
mcheck()	Enable memory allocation routine consistency checks
memalign()	Allocate aligned memory
mprobe()	Perform consistency check on memory

posix_memalign()
: Allocate aligned memory

procmgr_session()
: Provide process manager session support

_resmgr_handle_grow()
: Expand the capacity of the device manager database

_resmgr_io_func()
: Retrieve an I/O function from an I/O function table

resmgr_iofuncs()
: Extract the I/O function pointers associated with c connection

_resmgr_ocb()
: Retrieve an Open Control Block

sched_get_priority_adjust()
: Calculate the allowable priority for the scheduling policy

seekdir()
: Set the position for the next read of the directory stream

_sleepon_broadcast()
: Wake up multiple threads

_sleepon_destroy()
: Destroy a sleepon

_sleepon_init()
: Initialize a sleepon

_sleepon_lock()
: Lock a sleepon

_sleepon_signal()
: Wake up a single thread

_sleepon_unlock()
: Unlock a sleepon

_sleepon_wait()	Wait on a sleepon
tcsetsid()	Make a terminal device a controlling device
strtoimax(), strtoumax()	Convert a string to an integer type
telldir()	Get the location associated with the directory stream
valloc()	Allocate a heap block aligned on a page boundary
wcstoimax(), wcstoumax()	Convert a wide-character string to an integer type

Deprecated Content

- *getpriority()* — use *getprio()* or *SchedGet()* instead.
- *setpriority()* — use *setprio()* or *SchedSet()* instead.

Errata

snprintf()	Corrected the Returns section and Classifications

What's new in the QNX Neutrino 6.1.0 docs

Significant changes:

- New content
- Deprecated content

New content

The following functions have been added:

Wide-character functions	Wide-character versions of many functions

InterruptHookTrace()

Attach the pseudo interrupt handler that's used by the instrumented module

iofdinfo() Retrieve server attributes

iofunc_fdinfo() Handle an _IO_FDINFO message

iofunc_fdinfo_default()

Default handler for _IO_FDINFO messages

MsgVerifyEvent(), MsgVerifyEvent_r()

Check the validity of a receive ID and an event configuration

resmgr_unbind()

Remove an OCB

straddstr() Concatenate one string on to the end of another

SyncCtl(), SyncCtl_r()

Perform an operation on a synchronization object

SyncMutexEvent(), SyncMutexEvent_r()

Attach an event to a mutex

SyncMutexRevive(), SyncMutexRevive_r()

Revive a mutex

thread_pool_control()

Control the thread pool behavior

thread_pool_limits()

Wrapper function for *thread_pool_control()*

TraceEvent() Trace kernel events

Deprecated content

The following function has been deprecated:

matherr()	Handle errors in math library functions

Summary of Functions

Summary of function categories

We've organized the functions in the C library into the following categories:

Asynchronous I/O functions
: Asynchronous read, write, and other I/O operations.

Atomic functions
: Thread-safe integer manipulation functions.

Character manipulation functions
: Single-character functions for upper/lowercase conversions.

Conversion functions
: Convert values from one representation to another (e.g. numeric values to strings).

Directory functions
: Directory services (change, open, close, etc.).

Dispatch interface functions
: Handle different event types, including messages, pulse codes, and signals.

File manipulation functions
: File operations (change permissions, delete, rename, etc.)

IPC functions
: Traditional InterProcess Communication functions.

Hardware functions
: These functions work with PCI and other devices.

Math functions
: Perform computations such as the common trigonometric calculations. These functions operate with floating-point values.

Memory allocation functions

: Allocate and deallocate memory.

Memory manipulation functions

: Manipulate blocks of memory.

Message queue functions

: Nonblocking message-passing facilities.

Multibyte character functions

: ANSI C functions for processing multibyte and wide characters.

QNX Neutrino-specific IPC functions

: Native message-passing and related functions.

Operating system I/O functions

: POSIX functions for performing I/O at a lower level than the C Language stream I/O functions (e.g. *fopen()*, *fread()*, *fwrite()*, and *fclose()*).

PC Card functions

: Native PC Card functions.

Platform-specific functions

: Invoke Intel 80x86 and other processor-related functions directly from a program.

Process environment functions

: For process identification, user identification, process groups, system identification, system time and process time, environment variables, terminal identification, and configurable system variables.

Process manipulation functions

: For process creation, execution, and termination; signal handling; and timer operations.

Realtime timer functions

Rich set of “inexpensive” timer functions that are quick to create and manipulate.

Resource manager functions

These functions help you create resource managers.

Searching and sorting functions

Perform various search and sort operations (do a binary search on a sorted array, find one string inside another, etc.).

Shared-memory functions

Create and manipulate shared-memory regions.

Signal functions Rich set of functions for handling and sending signals.

Stream I/O functions

The “standard” functions to read and write files. Data can be transmitted under format control or as characters, strings, or blocks of memory.

String manipulation functions

Manipulate a character string, i.e. an array of zero or more adjacent characters followed by a NUL character (\0) that marks the end of the string.

System database functions

Allow an application to access group and user database information.

System message log functions

This set of functions controls the system log.

TCP/IP functions

Handle TCP/IP network communications and the TCP/IP database files.

Terminal control functions
: Set and control terminal attributes (baud rate, flow control, etc.).

Thread functions
: Operate on threads and the objects used to synchronize threads.

Time functions
: Obtain and manipulate times and dates.

Variable-length argument list functions
: Process a variable number of arguments to a function.

Wide-character functions
: Wide-character versions of functions from other function summary categories.

The following subsections describe these function categories in more detail. Each function is noted with a brief description of its purpose.

Asynchronous I/O functions

These functions perform *asynchronous* read, write, and other I/O operations.

Asynchronous I/O operations aren't currently supported.

The following functions are defined:

aio_cancel()
: Cancel an asynchronous I/O operation

aio_error()
: Get the error status for an asynchronous I/O operation

aio_fsync()
: Asynchronously synchronize a file

aio_read()
: Asynchronously read from a file

aio_return()	Get the return status for an asynchronous I/O operation
aio_suspend()	Wait for asynchronous I/O operations to complete
aio_write()	Asynchronously write to a file

Atomic functions

These functions manipulate an integer in a thread-safe way. On a multiprocessor system, even a simple:

```
/*
 Assuming x is an unsigned variable shared between two
 or more threads or a thread and an interrupt handler.
*/

x ^= 0xdeadbeef;
```

may cause *x* to be in an undefined state if multiple threads running simultaneously on multiple processors execute this code at the same time.

Use the *atomic*()* functions to ensure that your integer operations are carried out properly:

```
atomic_toggle( &x, 0xdeadbeef );
```

atomic_add()	Safely add to a variable
atomic_add_value()	Safely add to a variable, returning the previous value
atomic_clr()	Safely clear a variable
atomic_clr_value()	Safely clear a variable, returning the previous value
atomic_set()	Safely set bits in a variable

atomic_set_value()
: Safely set bits in a variable, returning the previous value

atomic_sub()
: Safely subtract from a variable

atomic_sub_value()
: Safely subtract from a variable, returning the previous value

atomic_toggle()
: Safely toggle a variable

atomic_toggle_value()
: Safely toggle a variable, returning the previous value

Character manipulation functions

These functions operate on single characters of type **`char`**. The functions test characters in various ways and convert them between upper and lowercase. (Some of these functions have wide-character versions in the “Wide-character functions” section of the function summary.)

isalnum()
: Test a character to see if it’s alphanumeric

isalpha()
: Test to see if a character is a letter

isascii()
: Test for a character in the range 0 to 127

iscntrl()
: Test a character to see if it’s a control character

isdigit()
: Test for any decimal digit

isgraph()
: Test for any printable character except space

islower()
: Test for any lowercase letter

isprint()
: Test for any printable character, including space

ispunct()	Test for any punctuation character
isspace()	Test for a whitespace character
isupper()	Test for any uppercase letter
isxdigit()	Test for any hexadecimal digit
tolower()	Convert a character to lowercase
toupper()	Convert a character to uppercase

Conversion functions

These functions perform conversions between objects of various types and strings:

atof()	Convert a string into a **`double`**
atoh()	Convert a string containing a hexadecimal number into an unsigned number
atoi()	Convert a string into an integer
atol(), atoll()	Convert a string into a long integer
ENDIAN_BE16()	Return a big-endian 16-bit value in native format
ENDIAN_BE32()	Return a big-endian 32-bit value in native format
ENDIAN_BE64()	Return a big-endian 64-bit value in native format
ENDIAN_LE16()	Return a little-endian 16-bit value in native format
ENDIAN_LE32()	Return a little-endian 32-bit value in native format

ENDIAN_LE64()

Return a little-endian 64-bit value in native format

ENDIAN_RET16()

Return an endian-swapped 16-bit value

ENDIAN_RET32()

Return an endian-swapped 32-bit value

ENDIAN_RET64()

Return an endian-swapped 64-bit value

ENDIAN_SWAP16()

Endian-swap a 16-bit value in place

ENDIAN_SWAP32()

Endian-swap a 32-bit value in place

ENDIAN_SWAP64()

Endian-swap a 64-bit value in place

htonl()	Convert a 32-bit value from host-byte order to network-byte order
htons()	Convert a 16-bit value from host-byte order to network-byte order
itoa()	Convert an integer into a string, using a given base
ltoa(), *lltoa()*	Convert a long integer value into a string, using a given base

nsec2timespec()

Convert nanoseconds to a **`timespec`** structure

ntohl()	Convert network-byte order value
ntohs()	Convert network-byte order value
strtod()	Convert a string into a **`double`**

strtoimax(), strtoumax()
: Convert a string into an integer

strtol(), strtoll()
: Convert a string into a long integer

strtoul(), strtoull()
: Convert a string into an unsigned long integer

`timespec`
: Time-specification structure

timespec2nsec()
: Convert a timespec structure to nanoseconds

ultoa(), ulltoa()
: Convert an unsigned long integer into a string, using a given base

UNALIGNED_PUT16()
: Write a misaligned 16-bit value safely

UNALIGNED_PUT32()
: Write a misaligned 32-bit value safely

UNALIGNED_PUT64()
: Write a misaligned 64-bit value safely

UNALIGNED_RET16()
: Access a misaligned 16-bit value safely

UNALIGNED_RET32()
: Access a misaligned 32-bit value safely

UNALIGNED_RET64()
: Access a misaligned 64-bit value safely

utoa()
: Convert an unsigned integer into a string, using a given base

wordexp()
: Perform word expansions

wordfree()	Free a word expansion buffer

See also the following functions, which convert the cases of characters and strings:

- *strlwr()*
- *strupr()*
- *tolower()*
- *toupper()*

Directory functions

These functions pertain to directory manipulation:

alphasort()	Compare two directory entries
chdir()	Change the current working directory
chroot()	Change the root directory
closedir()	Close a directory
dircntl()	Control an open directory
dirname()	Report the parent directory name of a file pathname
getcwd()	Get the name of the current working directory
getwd()	Get current working directory pathname
glob()	Find paths matching a pattern
globfree()	Free storage allocated by a call to *glob()*
mkdir()	Create a subdirectory
mount()	Mount a filesystem
mount_parse_generic_args()	Strip off common mount arguments

opendir() Open a directory file

pathfind(), pathfind_r()
Search for a file in a list of directories

readdir() Get information about the next matching filename

readdir_r() Get information about the next matching filename

realpath() Resolve a pathname

rewinddir() Reset the position of a directory stream to the start of the directory

rmdir() Delete an empty directory

scandir() Scan a directory

seekdir() Set the position for the next read of the directory stream

telldir() Get the location associated with the directory stream

umount() Unmount a filesystem

Dispatch interface functions

These functions make up the dispatch interface where you can handle different event types including messages, pulse codes, and signals. The functions cover dispatch contexts, attaching events, attaching pathnames and file descriptors to dispatch contexts, thread pools, etc. For an overview of these functions, see “Components of a resource manager” in the Writing a Resource Manager chapter of the QNX Neutrino *Programmer’s Guide*.

dispatch_block() Block while waiting for an event

dispatch_context_alloc()
Return a dispatch context

dispatch_context_free()

Free a dispatch context

dispatch_create()

Allocate a dispatch handle

dispatch_destroy()

Destroy a dispatch handle

dispatch_handler()

Handle events received by *dispatch_block()*

dispatch_timeout()

Set a timeout

dispatch_unblock()

Unblock all of the threads that are blocked on a dispatch handle

message_attach()

Attach a message range

message_connect()

Create a connection to a channel

message_detach()

Detach a message range

name_attach() Register a name in the namespace and create a channel

name_detach() Remove a name from the namespace and destroy the channel

`_pulse` Structure that describes a pulse

pulse_attach() Attach a handler function to a pulse code

pulse_detach() Detach a handler function from a pulse code

resmgr_attach() Attach a path to a pathname space

resmgr_block() Block while waiting for a message

resmgr_connect_funcs_t
Table of POSIX-level connect functions

resmgr_context_alloc()
Allocate a resource-manager context

resmgr_context_free()
Free a resource-manager context

resmgr_context_t
Context information that's passed between resource-manager functions

resmgr_detach() Remove a pathname from the pathname space

resmgr_devino() Get the device and inode number

_resmgr_handle_grow()
Expand the capacity of the device manager database

resmgr_handler()
Handle resource manager messages

_resmgr_io_func()
Retrieve an I/O function from an I/O function table

resmgr_io_funcs_t
Table of POSIX-level I/O functions

resmgr_iofuncs() Extract the I/O function pointers associated with client connections

resmgr_msgread()
Read a message from a client

resmgr_msgreadv()

Read a message from a client

resmgr_msgwrite()

Write a message to a client

resmgr_msgwritev()

Write a message to a client

_RESMGR_NPARTS()

Get a given number of parts from the *ctp->iov* structure

_resmgr_ocb() Retrieve an Open Control Block

resmgr_open_bind()

Associate an OCB with an open request

resmgr_pathname()

Return the pathname associated with an ID

_RESMGR_PTR()

Get one part from the *ctp->iov* structure and fill in its fields

_RESMGR_STATUS()

Set the status member of a resource-manager context

resmgr_unbind() Remove an OCB

select_attach() Attach a file descriptor to a dispatch handle

select_detach() Detach a file descriptor from a dispatch handle

select_query() Decode the last select event

thread_pool_create()

Create a thread pool handle

thread_pool_control()

Control the thread pool behavior

thread_pool_destroy()

Free the memory allocated to a thread pool

thread_pool_limits()

Wrapper function for *thread_pool_control()*

thread_pool_start()

Start a thread pool

File manipulation functions

These functions operate directly with files. The following functions are defined:

access()	Check to see if a file or directory can be accessed
chmod()	Change the permissions for a file
chown()	Change the user ID and group ID of a file
eaccess()	Check to see if a file or directory can be accessed (extended version)
glob()	Find paths matching a pattern
globfree()	Free storage allocated by a call to *glob()*
fchmod()	Change the permissions for a file
fchown()	Change the user ID and group ID of a file
fpathconf()	Return the value of a configurable limit associated with a file or directory

ftruncate(), ftruncate64()

Truncate a file

futime()	Record the modification time for a file

lchown()	Change the user ID and group ID of a file or symbolic link
lstat(), lstat64()	Get information about a file or directory
ltrunc()	Truncate a file at a given position
mkfifo()	Create a FIFO special file
mkstemp()	Make a unique temporary filename, and open the file
mktemp()	Make a unique temporary filename
pathconf()	Return the value of a configurable limit
pclose()	Close a pipe
pwrite(), pwrite64()	Write into a file without changing the file pointer
remove()	Remove a link to a file
rename()	Rename a file
stat(), stat64()	Get information about a file or directory, given a path
statvfs(), statvfs64()	Get filesystem information, given a path
sync()	Synchronize filesystem updates
tempnam()	Create a name for a temporary file
truncate()	Truncate a file to a specified length
tmpnam()	Generate a unique string for use as a filename
unlink()	Remove a link to a file
utime()	Record the modification time for a file or directory
utimes()	Set a file's access and modification times

IPC functions

These functions deal with InterProcess Communications.

flock()	Apply or remove an advisory lock on an open file
lockf()	Record locking on files
mlock()	Lock a buffer in physical memory
mlockall()	Lock a process's address space
mmap(), mmap64()	Map a memory region into a process address space
mprotect()	Change memory protection
msync()	Synchronize memory with physical storage
munlock()	Unlock a buffer
munlockall()	Unlock a process's address space
munmap()	Unmap previously mapped addresses
pthread_barrier_destroy()	Destroy a barrier object
pthread_barrier_init()	Initialize a barrier object
pthread_barrier_wait()	Synchronize at a barrier
pthread_barrierattr_destroy()	Destroy a barrier attributes object
pthread_barrierattr_getpshared()	Get the process-shared attribute of a barrier attributes object

pthread_barrierattr_init()

Initialize a barrier attributes object

pthread_barrierattr_setpshared()

Set the process-shared attribute of a barrier attributes object

pthread_cond_broadcast()

Unblock threads waiting on a condition

pthread_cond_destroy()

Destroy a condition variable

pthread_cond_init()

Initialize a condition variable

pthread_cond_signal()

Unblock the thread waiting on a condition variable

pthread_cond_timedwait()

Wait on a condition variable, with a time limit

pthread_cond_wait()

Wait on a condition variable

pthread_condattr_destroy()

Destroy a condition variable attribute object

pthread_condattr_getclock()

Get the clock attribute from a condition-variable attribute object

pthread_condattr_getpshared()

Get the process-shared attribute from a condition variable attribute object

pthread_condattr_init()

Initialize a condition variable attribute object

pthread_condattr_setclock()

Set the clock attribute in a condition-variable attribute object

pthread_condattr_setpshared()

Set the process-shared attribute in a condition-variable attribute object

pthread_mutex_destroy()

Destroy a mutex

pthread_mutex_getprioceiling()

Get a mutex's priority ceiling

pthread_mutex_init()

Initialize a mutex

pthread_mutex_lock()

Lock a mutex

pthread_mutex_setprioceiling()

Set a mutex's priority ceiling

pthread_mutex_timedlock()

Lock a mutex

pthread_mutex_trylock()

Attempt to lock a mutex

pthread_mutex_unlock()

Unlock a mutex

pthread_mutexattr_destroy()

Destroy a mutex attribute object

pthread_mutexattr_getprioceiling()

Get the priority ceiling of a mutex attribute object

pthread_mutexattr_getprotocol()

Get a mutex's scheduling protocol

pthread_mutexattr_getpshared()

Get the process-shared attribute from a mutex attribute object

pthread_mutexattr_getrecursive()

Get the recursive attribute from a mutex attribute object

pthread_mutexattr_gettype()

Get a mutex type

pthread_mutexattr_init()

Initialize the mutex attribute object

pthread_mutexattr_setprioceiling()

Set the priority ceiling of a mutex attribute object

pthread_mutexattr_setprotocol()

Set a mutex's scheduling protocol

pthread_mutexattr_setpshared()

Set the process-shared attribute in mutex attribute object

pthread_mutexattr_setrecursive()

Set the recursive attribute in mutex attribute object

pthread_mutexattr_settype()

Set a mutex type

pthread_once() Dynamic package initialization

pthread_rwlock_destroy()

Destroy a read/write lock

pthread_rwlock_init()

Initialize a read/write lock

pthread_rwlock_rdlock()

Acquire a shared read lock on a read/write lock

pthread_rwlock_timedrdlock()

Lock a read-write lock for writing

pthread_rwlock_timedwrlock()

Attempt to acquire an exclusive write lock on a read/write lock

pthread_rwlock_tryrdlock()

Attempt to acquire a shared read lock on a read/write lock

pthread_rwlock_trywrlock()

Attempt to acquire an exclusive write lock on a read/write lock

pthread_rwlock_unlock()

Unlock a read/write lock

pthread_rwlock_wrlock()

Acquire an exclusive write lock on a read/write lock

pthread_rwlockattr_destroy()

Destroy a read-write lock attribute object

pthread_rwlockattr_getpshared()

Get the process-shared attribute of a read-write lock attribute object

pthread_rwlockattr_init()

Create a read-write lock attribute object

pthread_rwlockattr_setpshared()
: Set the process-shared attribute of a read-write lock attribute object

pthread_spin_destroy()
: Destroy a thread spinlock

pthread_spin_init()
: Initialize a thread spinlock

pthread_spin_lock()
: Lock a thread spinlock

pthread_spin_trylock()
: Try locking a thread spinlock

pthread_spin_unlock()
: Unlock a thread spinlock

readcond() Read data from a terminal device

sem_close() Close a named semaphore

sem_destroy() Destroy a semaphore

sem_getvalue() Get the value of a semaphore (named or unnamed)

sem_init() Initialize a semaphore

sem_open() Create or access a named semaphore

sem_post() Increment a semaphore

sem_timedwait() Wait on a semaphore, with a timeout

sem_trywait() Wait on a semaphore, but don’t block

sem_unlink() Destroy a named semaphore

sem_wait() Wait on a semaphore

sync() Synchronize filesystem updates

Hardware functions

These functions work with PCI and other devices for operations such as determining whether or not a PCI BIOS is present, attaching a driver to a PCI device, and so on.

The following functions are defined:

pci_attach() Connect to the PCI server

pci_attach_device()
Attach a driver to a PCI device

pci_detach() Disconnect from the PCI server

pci_detach_device()
Detach a driver from a PCI device

pci_find_class() Find devices that have a specific Class Code

pci_find_device() Find the PCI device with a given device ID and vendor ID

pci_irq_routing_options()
Retrieve PCI IRQ routing information

pci_map_irq() Map an interrupt pin to an IRQ

pci_present() Determine whether or not PCI BIOS is present

pci_read_config()
Read from the configuration space of a PCI device

pci_read_config8()
Read a byte from the configuration space of a device

pci_read_config16()
Read 16-bit values from the configuration space of a device

pci_read_config32()

Read 32-bit values from the configuration space of a device

pci_rescan_bus() Rescan the PCI bus for added or removed devices

pci_write_config()

Write to the configuration space of a PCI device

pci_write_config8()

Write bytes to the configuration space of a PCI device

pci_write_config16()

Write 16-bit values to the configuration space of a device

pci_write_config32()

Write 32-bit values to the configuration space of a device

hwi_find_item() Find an item in the **hwi_item** structure

hwi_find_tag() Find a tag in the **hwi_item** structure

hwi_off2tag() Return a pointer to the start of a tag in the *hwinfo* area of the system page

hwi_tag2off() Return the offset from the start of the *hwinfo* area of the system page

Math functions

The math functions are arranged in the following categories:

- Absolute values
- Bessel functions
- Divisions, remainders, and modular arithmetic

- Floating-point settings
- Gamma functions
- Logarithms and exponentials
- Miscellaneous
- Pseudo-random numbers
- Roots and powers
- Rounding
- Trigonometric and hyperbolic functions

Absolute values

abs()	Return the absolute value of an integer
cabs(), cabsf()	Compute the absolute value of a complex number
fabs(), fabsf()	Compute the absolute value of a double number
labs()	Calculate the absolute value of a long integer

Bessel functions

j0(), j0f()	Compute a Bessel function of the first kind
j1(), j1f()	Compute a Bessel function of the first kind
jn(), jnf()	Compute a Bessel function of the first kind
y0(), y0f()	Compute a Bessel function of the second kind
y1(), y1f()	Compute a Bessel function of the second kind
yn(), ynf()	Compute a Bessel function of the second kind

Division, remainders, and modular arithmetic

div() Calculate the quotient and remainder of a division operation

drem(), dremf()
Compute the remainder of two numbers

fmod(), fmodf()
Compute a residue, using floating-point modular arithmetic

ldiv() Perform division on long integers

modf(), modff()
Break a number into integral and fractional parts

remainder(), remainderf()
Compute the floating point remainder

Floating-point settings

These functions set or get attributes of floating-point operations:

fp_exception_mask()
Get or set the current exception mask

fp_exception_value()
Get the value of the current exception registers

fp_precision() Set or get the current precision

fp_rounding() Set or get the current rounding

Gamma functions

gamma(), gamma_r(), gammaf(), gammaf_r()
Log gamma function

lgamma(), lgamma_r(), lgammaf(), lgammaf_r()
Log gamma function

Logarithms and exponentials

The following routines calculate logarithms and exponentials:

exp(), expf()	Compute the exponential function of a number
expm1(), expm1f()	Compute the exponential of a number, then subtract 1
frexp(), frexpf()	Break a floating-point number into a normalized fraction and an integral power of 2
ilogb(), ilogbf()	Compute the integral part of a logarithm
ldexp(), ldexpf()	Multiply a floating-point number by an integral power of 2
log(), logf()	Compute the natural logarithm of a number
log10(), log10f()	Compute the logarithm (base 10) of a number
log1p(), log1pf()	Compute log(1+x)
logb(), logbf()	Compute the radix-independent exponent
scalb(), scalbf()	Load the exponent of a radix-independent floating-point number
scalbn(), scalbnf()	Compute the exponent of a radix-independent floating-point number
significand(), significandf()	Compute the “significant bits” of a floating-point number

Miscellaneous

copysign(), copysignf()
: Copy the sign bit from one number to another

erf(), erff()
: Compute the error function of a number

erfc(), erfcf()
: Complementary error function

finite(), finitef()
: Determine if a number is finite

hypot(), hypotf()
: Calculate the length of the hypotenuse for a right-angled triangle

isinf(), isinff()
: Test for infinity

isnan(), isnanf()
: Test for not-a-number (NAN)

max()
: Return the greater of two numbers

min()
: Return the lesser of two numbers

nextafter(), nextafterf()
: Compute the next representable double-precision floating-point number

Pseudo-random numbers

The math library includes several sets of functions that you can use to generate pseudo-random numbers.

The simplest family consists of:

rand()
: Compute a sequence of pseudo-random integers

rand_r()
: Compute a sequence of pseudo-random integers in a thread-safe manner

srand()
: Start a new sequence of pseudo-random integers for *rand()*

This set of functions uses a nonlinear additive feedback random-number generator, using a state array:

initstate()	Initialize a pseudo-random number generator
random()	Generate a pseudo-random number from the default state
setstate()	Reset the state of a pseudo-random number generator
srandom()	Set the seed for a pseudo-random number generator

This set of functions uses 48-bit arithmetic to produce pseudo-random numbers of various types:

drand48()	Generate a pseudo-random **`double`**
erand48()	Generate a pseudo-random **`double`** in a thread-safe manner
jrand48()	Generate a pseudo-random signed **`long`** integer in a thread-safe manner
lcong48()	Initialize a sequence of pseudo-random numbers
lrand48()	Generate a pseudo-random nonnegative **`long`** integer
mrand48()	Generate a pseudo-random signed **`long`** integer
nrand48()	Generate a pseudo-random nonnegative **`long`** integer in a thread-safe manner
seed48()	Initialize a sequence of pseudo-random numbers
srand48()	Initialize a sequence of pseudo-random numbers

Roots and powers

cbrt(), cbrtf()	Compute the cube root of a number
pow(), powf()	Raise a number to a given power
sqrt(), sqrtf()	Calculate the nonnegative square root of a number

Rounding

ceil(), ceilf()	Round up a value to the next integer
floor(), floorf()	Round down a value to the next integer
rint(), rintf()	Round to the nearest integral value

Trigonometric and hyperbolic functions

acos(), acosf()	Compute the arccosine of an angle
acosh(), acoshf()	Compute the inverse hyperbolic cosine
asin(), asinf()	Compute the arcsine of an angle
asinh(), asinhf()	Compute the inverse hyperbolic sine
atan(), atanf()	Compute the arctangent of an angle
atanh(), atanhf()	Compute the inverse hyperbolic tangent
atan2(), atan2f()	Compute the arctangent, determining the quadrant
cos(), cosf()	Compute the cosine of an angle
cosh(), coshf()	Compute the hyperbolic cosine
sin(), sinf()	Calculate the sine of an angle
sinh(), sinhf()	Compute the hyperbolic sine
tan(), tanf()	Calculate the tangent of an angle
tanh(), tanhf()	Calculate the hyperbolic tangent

Memory allocation functions

These functions allocate and deallocate blocks of memory:

alloca()	Allocate automatic space from the stack
_amblksiz	The increment for the break pointer
_btext	The beginning of the text segment
calloc()	Allocate space for an array
cfree()	Free allocated memory
_edata	The end of the data segment, excluding BSS data
_end	The end of the data segment, including BSS data
_etext	The end of the text segment
free()	Deallocate a block of memory
ftw()	Walk a file tree
longjmp()	Restore the environment saved by *setjmp()*
mallinfo()	Get memory allocation information
malloc()	Allocate memory
mallopt()	Control the memory allocation
mcheck()	Enable memory allocation routine consistency checks
memalign()	Allocate aligned memory
mprobe()	Perform consistency check on memory
posix_memalign()	Allocate aligned memory
realloc()	Allocate, reallocate or free a block of memory

sbrk()	Set the allocation break value for a program
_scalloc()	Allocate space for an array
setjmp()	Save the calling environment, for use by *longjmp()*
siglongjmp()	Restore the signal mask for a process, if one was saved
sigsetjmp()	Save the environment, including the signal mask
_sfree()	Deallocate a block of memory
_smalloc()	Allocate memory in blocks
_srealloc()	Allocate, reallocate or free a block of memory
valloc()	Allocate a heap block aligned on a page boundary

Memory manipulation functions

These functions manipulate blocks of memory. In each case, the address of the memory block and its size is passed to the function.(Some of these functions have wide-character versions in the "Wide-character functions" section of the function summary.)

brk()	Change the amount of space allocated for the calling process's data segment
bzero()	Set the first part of an object to null bytes
ffs()	Find the first bit set in a bit string
index()	Find a character in a string
memccpy()	Copy bytes until a given character is found
memchr()	Find the first occurrence of a character in a buffer
memcmp()	Compare a given number of characters in two objects

memcpy() Copy a number of characters from one buffer to another

memcpyv() Copy a given number of structures

memicmp() Compare a given number of characters of two objects, without case sensitivity

mem_offset(), mem_offset64()
Find offset of a mapped typed memory block

memmove() Copy bytes from one buffer to another, handling overlapping memory correctly

memset() Set the first part of an object to a given value

mlock() Lock a buffer in physical memory

mlockall() Lock a process's address space

mmap(), mmap64()
Map a memory region into a process address space

mmap_device_io()
Gain access to a device's registers

mmap_device_memory()
Map a device's physical memory into a process's address space

msync() Synchronize memory with physical storage

munlock() Unlock a buffer

munlockall() Unlock a process's address space

munmap_device_io()
Free access to a device's registers

munmap_device_memory()
Unmap previously mapped addresses

posix_mem_offset(), posix_mem_offset64()
: Find offset and length of a mapped typed memory block

rindex()
: Find the last occurrence of a character in a string

shm_ctl()
: Give special attributes to a shared memory object

swab()
: Endian-swap a given number of bytes

See the section “String manipulation functions” for descriptions of functions that manipulate strings of data.

Message queue functions

These functions deal with message queues:

mq_close()
: Close a message queue

mq_getattr()
: Get a message queues attributes

mq_notify()
: Ask to be notified when there’s a message in the queue

mq_open()
: Open a message queue

mq_receive()
: Receive a message from a queue

mq_send()
: Send a message to a queue

mq_setattr()
: Set a queue’s attributes

mq_timedreceive()
: Receive a message from a message queue

mq_timedsend()
: Send a message to a message queue

mq_unlink()
: Remove a queue

Multibyte character functions

These ANSI C functions provide capabilities for processing multibyte characters. (Some of these functions have wide-character versions in the "Wide-character functions" section of the function summary.)

mblen()	Count the bytes in a multibyte character
mbrlen()	Count the bytes in a multibyte character (restartable)
mbrtowc()	Convert a multibyte character into a wide character (restartable)
mbsinit()	Determine the status of the conversion object used for restartable *mb*()* functions
mbsrtowcs()	Convert a multibyte-character string into a wide-character string (restartable)
mbstowcs()	Convert a multibyte-character string into a wide-character string
mbtowc()	Convert a multibyte character into a wide character

QNX Neutrino-specific IPC functions

The following functions are defined:

ChannelCreate(), ChannelCreate_r()
: Create a communications channel

ChannelDestroy(), ChannelDestroy_r()
: Destroy a communications channel

_msg_info
: Information about a message

MsgDeliverEvent(), MsgDeliverEvent_r()
: Deliver an event through a channel

MsgError(), MsgError_r()
: Unblock a client and set its *errno*

MsgInfo(), MsgInfo_r()

Get additional information about a message

MsgKeyData(), MsgKeyData_r()

Pass data through a common client

MsgRead(), MsgRead_r()

Read data from a message

MsgReadv(), MsgReadv_r()

Read data from a message

MsgReceive(), MsgReceive_r()

Wait for a message or pulse on a channel

MsgReceivePulse(), MsgReceivePulse_r()

Receive a pulse on a channel

MsgReceivePulsev(), MsgReceivePulsev_r()

Receive a pulse on a channel

MsgReceivev(), MsgReceivev_r()

Wait for a message or pulse on a channel

MsgReply(), MsgReply_r()

Reply with a message

MsgReplyv(), MsgReplyv_r()

Reply with a message

MsgSend(), MsgSend_r()

Send a message to a channel

MsgSendnc(), MsgSendnc_r()

Send a message to a channel (non-cancellation point)

MsgSendPulse(), MsgSendPulse_r()

Send a pulse to a channel

MsgSendsv(), MsgSendsv_r()

Send a message to a channel

MsgSendsvnc(), MsgSendsvnc_r()

Send a message to a channel (non-cancellation point)

MsgSendv(), MsgSendv_r()

Send a message to a channel

MsgSendvnc(), MsgSendvnc_r()

Send a message to a channel (non-cancellation point)

MsgSendvs(), MsgSendvs_r()

Send a message to a channel

MsgSendvsnc(), MsgSendvsnc_r()

Send a message to a channel (non-cancellation point)

MsgVerifyEvent(), MsgVerifyEvent_r()

Check the validity of a receive ID and an event configuration

MsgWrite(), MsgWrite_r()

Write a reply

MsgWritev(), MsgWritev_r()

Write a reply

name_close() Close the file descriptor returned by *name_open()*

name_open() Open a name for a server connection

`sigevent` Structure that describes an event

SyncTypeCreate(), SyncTypeCreate_r()

Create a synchronization object

Operating system I/O functions

These functions operate at the operating-system level, and are included for compatibility with other C implementations. For new programs, we recommended that you use the functions in the section "File manipulation functions", functions are defined portably and are part of the ANSI standard for the C language.

The functions in this section reference opened files and devices using a *file descriptor* that's returned when the file is opened. The file descriptor is passed to the other functions.

The following functions are defined:

chsize()	Change the size of a file
cfgopen()	Open a configuration file
close()	Close a file at the operating system level
_cmdfd()	Return a file descriptor for the executable file
_cmdname()	Find the path used to invoke the current process
creat(), creat64()	Create and open a file at the operating system level
devctl()	Control a device
dup()	Duplicate a file descriptor
dup2()	Duplicate a file descriptor, specifying the new descriptor
eof()	Determine if the end-of-file has been reached
fcfgopen()	Open a configuration file
fcntl()	Provide control over an open file
fdatasync()	Write queued file data to disk

fileno()	Return the number of the file descriptor for a stream
flink()	Assign a pathname to a file descriptor
flockfile()	Acquire ownership of a file
fstat(), fstat64()	Obtain information about an open file, given a file descriptor
fstatvfs(), fstatvfs64()	Get filesystem information, given a file descriptor
fsync()	Write queued file and filesystem data to disk
ftrylockfile()	Acquire ownership of a file, without blocking
funlockfile()	Release ownership of a file
GETIOVBASE()	Get the base member of an **`iov_t`** structure
GETIOVLEN()	Get the length member of an **`iov_t`** structure
getdtablesize()	Get the size of the file descriptor table
getrusage()	Get information about resource utilization
in8()	Read an 8-bit value from a port
in8s()	Read 8-bit values from a port
in16(), inbe16(), inle16()	Read a 16-bit value from a port
in16s()	Read 16-bit values from a port
in32(), inbe32(), inle32()	Read a 32-bit value from a port
in32s()	Read 32-bit values from a port
ioctl()	Control device

link()	Create a link to an existing file
lseek(), lseek64()	Set the current file position at the OS level
lio_listio()	Initiate a list of I/O requests
mknod()	Make a new filesystem entry point
modem_open()	Open a serial port
modem_read()	Read bytes from a file descriptor
modem_script()	Run a script on a device
modem_write()	Write a string to a device
name_close()	Close the file descriptor obtained with *name_open()*
name_open()	Open a name for a server connection
open(), open64()	Open a file
openfd()	Open for private access a file associated with a given descriptor
out8()	Write an 8-bit value to a port
out8s()	Write 8-bit values to a port
out16(), outbe16(), outle16()	Write a 16-bit value to a port
out16s()	Write 16-bit values to a port
out32(), outbe32(), outle32()	Write a 32-bit value to a port
out32s()	Write 32-bit values to a port

pathmgr_symlink()
: Create a symlink in the process manager

pathmgr_unlink()
: Remove the link created by *pathmgr_symlink()*

pipe()
: Create a pipe

popen()
: Execute a command, creating a pipe to it

pread(), pread64()
: Read from a file without moving the file pointer

rdchk()
: Check to see if a read is likely to succeed

read()
: Read bytes from a file

readblock()
: Read blocks of data from a file

readcond()
: Read data from a terminal device

readlink()
: Place the contents of a symbolic link into a buffer

readv()
: Read bytes from a file

select()
: Check for files that are ready for reading or writing

SETIOV()
: Fill in the fields of an **`iov_t`** structure

sopen()
: Open a file for shared access

sopenfd()
: Open for shared access a file associated with a given descriptor

symlink()
: Create a symbolic link to a path

tcischars()
: Determine the number of characters waiting to be read

tell(), tell64()
: Determine the current file position

umask()
: Set the file mode creation mask for the process

uname()	Get information about the operating system
unlink()	Delete a file
write()	Write bytes to a file
writeblock()	Write blocks of data to a file
writev()	Write bytes to a file

PC Card functions

The following functions are defined:

pccard_arm()	Arm the **devp-pccard** server
pccard_attach()	Attach to the **devp-pccard** server
pccard_detach()	Detach from the **devp-pccard** server
pccard_info()	Obtain socket information from the **devp-pccard** server
pccard_lock()	Lock the window of the card in the selected socket
pccard_raw_read()	Read the raw CIS data from the PC Card
pccard_unlock()	Unlock the window of the card in the selected socket

Platform-specific functions

These functions are for invoking Intel 80x86 and other processor-related functions directly from a program. Functions that apply to the Intel 8086 CPU apply to that family including the 80286, 80386, 80486 and Pentium processors.

You'll also find endian-related functions listed here.

The following functions are defined:

ENDIAN_BE16()

Return a big-endian 16-bit value in native format

ENDIAN_BE32()

Return a big-endian 32-bit value in native format

ENDIAN_BE64()

Return a big-endian 64-bit value in native format

ENDIAN_LE16()

Return a little-endian 16-bit value in native format

ENDIAN_LE32()

Return a little-endian 32-bit value in native format

ENDIAN_LE64()

Return a little-endian 64-bit value in native format

ENDIAN_RET16()

Return an endian-swapped 16-bit value

ENDIAN_RET32()

Return an endian-swapped 32-bit value

ENDIAN_RET64()

Return an endian-swapped 64-bit value

ENDIAN_SWAP16()

Endian-swap a 16-bit value in place

ENDIAN_SWAP32()

Endian-swap a 32-bit value in place

ENDIAN_SWAP64()

Endian-swap a 64-bit value in place

_intr_v86() Execute a real-mode software interrupt

offsetof() Return the offset of an element within a structure

sysmgr_reboot()

Reboot a QNX Neutrino system

Process environment functions

These functions deal with process identification, user identification, process groups, system identification, system time and process time, environment variables, terminal identification, and configurable system variables:

_argc	The number of arguments passed to *main()*
_argv	A pointer to the vector of arguments passed to *main()*
_auxv	A pointer to a vector of auxiliary arguments to *main()*
clearenv()	Clear the process environment area
confstr()	Get configuration-defined string values
ctermid()	Generate the pathname of the current controlling terminal
endutent()	Close the current user-information file
environ	Pointer to the process's environment variables
err(), errx()	Display a formatted error message, and then exit
errno	Global error variable
getegid()	Get the effective group ID
getenv()	Get the value of an environment variable
geteuid()	Get the effective user ID
getgid()	Get the group ID
getgrouplist()	Determine the group access list for a user

getgroups()	Get the supplementary group IDs of the calling process
getlogin()	Get the user name associated with the calling process
getlogin_r()	Get the user name associated with the calling process
getopt()	Parse options from a command line
getpgid()	Get a process's group ID
getpgrp()	Get the process group
getpid()	Get the process ID
getppid()	Get the parent process ID
getsid()	Get the session ID of a process
getuid()	Get the user ID
getutent()	Read the next entry from the user-information file
getutid()	Search for an entry in the user-information file
getutline()	Get an entry from the user-information file
initgroups()	Initialize the supplementary group access list
isatty()	Test to see if a file descriptor is associated with a terminal
login_tty()	Prepare for a login in a tty
main()	The function where program execution begins
ND_NODE_CMP()	Compare two node descriptor IDs
netmgr_ndtostr()	Convert a node descriptor into a string

netmgr_remote_nd()	Get a node descriptor that's relative to a remote node
netmgr_strtond()	Convert a string into a node descriptor
__progname	The basename of the program being executed
putenv()	Add, change, or delete an environment variable
pututline()	Write an entry in the user-information file
searchenv()	Search the directories listed in an environment variable
setegid()	Set the effective group ID for a process
setenv()	Set one or more environment variables
seteuid()	Set the effective user ID
setgid()	Set the real, effective and saved group IDs
setgroups()	Set supplementary group IDs
setlocale()	Set a program's locale.
setpgid()	Join or create a process group
setpgrp()	Set the process group
setregid()	Set real and effective group IDs
setreuid()	Set real and effect user IDs
setsid()	Create a new session
setuid()	Set the real, effective and saved user IDs
setutent()	Return to the beginning of the user-information file
strerror()	Convert an error number into an error message

sysconf()	Return the value of a configurable system limit
ttyname()	Get a fully qualified pathname for a file
ttyname_r()	Get a fully qualified pathname for a file
unsetenv()	Remove an environment variable
utmp	Entry in a user-information file
utmpname()	Change the name of the user-information file
verr(), verrx()	Display a formatted error message, and then exit (varargs)
vwarn(), vwarnx()	Formatted error message (varargs)
warn(), warnx()	Formatted error message

Process manipulation functions

These functions deal with: process creation, execution, and termination; signal handling; and timer operations.

When you start a new process, it replaces the existing process if:

- You specify P_OVERLAY when calling one of the *spawn** functions.
- You call one of the *exec** routines.

The existing process may be suspended while the new process executes (control continues at the point following the place where the new process was started) in the following situations:

- You specify P_WAIT when calling one of the *spawn** functions.
- You call *system()*.

The following functions are defined:

abort()	Raise the SIGABRT signal to terminate program execution
alarm()	Schedule an alarm
assert()	Print a diagnostic message and optionally terminate the program
atexit()	Register functions to be called when the program terminates normally
ConnectAttach(), ConnectAttach_r()	Establish a connection between a process and a channel
ConnectClientInfo(), ConnectClientInfo_r()	Store information about a client connection
ConnectDetach(), ConnectDetach_r()	Break a connection between a process and a channel
ConnectFlags(), ConnectFlags_r()	Modify the flags associated with a connection
ConnectServerInfo(), ConnectServerInfo_r()	Store information about a connection
daemon()	Run a program in the background
DebugBreak()	Enter the process debugger
DebugKDBreak()	Enter the kernel debugger
DebugKDOutput()	Print text with the kernel debugger
delay()	Suspend a process for a given length of time
dladdr()	Translate an address to symbolic information

dlclose()	Close a shared object
dlerror()	Get dynamic loading diagnostic information
dlopen()	Gain access to an executable object file
dlsym()	Get the address of a symbol in a shared object
execl()	Execute a file
execle()	Execute a file
execlp()	Execute a file
execlpe()	Execute a file
execv()	Execute a file
execve()	Execute a file
execvp()	Execute a file
execvpe()	Execute a file
_exit()	Terminate the program
exit()	Terminate the program
fork()	Create a new process
forkpty()	Create a new process operating in a pseudo-tty
getrlimit(), getrlimit64()	Get the limit on a system resource
getprio()	Get the priority of a given process
InterruptAttach(), InterruptAttach_r()	Attach an interrupt handler to an interrupt source
InterruptAttachEvent(), InterruptAttachEvent_r()	Attach an event to an interrupt source

InterruptDetach(), InterruptDetach_r()
: Detach an interrupt handler by ID

InterruptDisable()
: Disable hardware interrupts

InterruptEnable()
: Enable hardware interrupts

InterruptHookIdle()
: Attach an “idle” interrupt handler

InterruptHookTrace()
: Attach the pseudo interrupt handler that the instrumented module uses

InterruptLock() Protect critical sections of an interrupt handler

InterruptMask() Disable a hardware interrupt

InterruptUnlock()
: Release a critical section locked with *InterruptLock()*

InterruptUnmask()
: Enable a hardware interrupt

InterruptWait(), InterruptWait_r()
: Wait for a hardware interrupt

_intr_v86() Execute a real-mode software interrupt

kill() Send a signal to a process or a group of processes

killpg() Send a signal to a process group

nap() Sleep for a given number of milliseconds

napms() Sleep for a given number of milliseconds

nice() Change the priority of a process

openpty() Find an available pseudo-tty

pause() Suspend the process until delivery of a signal

procmgr_daemon()
Run a process in the background

procmgr_event_notify()
Ask to be notified of system-wide events

procmgr_event_trigger()
Trigger a global system event

procmgr_guardian()
Let a daemon process takeover as parent = guardian

procmgr_session()
Provide process manager session support

raise() Signal an exceptional condition

SchedGet(), SchedGet_r()
Get the scheduling policy for a thread

SchedInfo(), SchedInfo_r()
Get scheduler information

SchedSet(), SchedSet_r()
Set the scheduling policy for a thread

SchedYield(), SchedYield_r()
Yield to other threads

setitimer() Set the value of an interval timer

setprio() Set the priority of a process

setrlimit(), setrlimit64()
Set the limit on a system resource

sigaction()	Examine or specify the action associated with a signal
sigaddset()	Add a signal to a set
sigblock()	Add to the mask of signals to block
sigdelset()	Delete a signal from a set
sigemptyset()	Initialize a set to contain no signals
sigfillset()	Initialize a set to contain all signals
sigismember()	See if a given signal is in a given set
sigmask()	Construct a mask for a signal number
signal()	Set handling for exceptional conditions
SignalAction(), SignalAction_r()	Examine and/or specify actions for signals
SignalKill(), SignalKill_r()	Send a signal to a process group, process or thread
SignalProcmask(), SignalProcmask_r()	Modify or examine the signal blocked mask of a thread
SignalSuspend(), SignalSuspend_r()	Suspend a process until a signal is received
SignalWaitinfo(), SignalWaitinfo_r()	Select a pending signal
sigpause()	Wait for a signal
sigpending()	Examine the set of pending, masked signals for a process
sigprocmask()	Examine or change the signal mask for a process

sigqueue()	Queue a signal to a process
sigsetmask()	Set the mask of signals to block
sigsuspend()	Replace the signal mask, and then suspend the process
sigtimedwait()	Wait for a signal or a timeout
sigunblock()	Unblock signals
sigwait()	Wait for a pending signal
sigwaitinfo()	Wait for a pending signal and get its information
sleep()	Suspend a process for a given length of time
spawn()	Create and execute a new child process
spawnl()	Create and execute a new child process
spawnle()	Create and execute a new child process
spawnlp()	Create and execute a new child process
spawnlpe()	Create and execute a new child process
spawnp()	Create and execute a new child process
spawnv()	Create and execute a new child process
spawnve()	Create and execute a new child process
spawnvp()	Create and execute a new child process
spawnvpe()	Create and execute a new child process
SyncCondvarSignal(), SyncCondvarSignal_r()	Wake up any threads that are blocked on a synchronization object
SyncCondvarWait(), SyncCondvarWait_r()	Block a thread on a synchronization object

SyncCtl(), SyncCtl_r()
: Perform an operation on a synchronization object

SyncDestroy(), SyncDestroy_r()
: Destroy a synchronization object

SyncMutexEvent(), SyncMutexEvent_r()
: Attach an event to a mutex

SyncMutexLock(), SyncMutexLock_r()
: Lock a mutex synchronization object

SyncMutexUnlock(), SyncMutexUnlock_r()
: Unlock a mutex synchronization object

SyncMutexRevive(), SyncMutexRevive_r()
: Revive a mutex that's in the DEAD state

SyncSemPost(), SyncSemPost_r()
: Increment a semaphore

SyncSemWait(), SyncSemWait_r()
: Wait on a semaphore

system()
: Execute a system command

SYSPAGE_CPU_ENTRY()
: Return a CPU-specific entry from the system page

SYSPAGE_ENTRY()
: Return an entry from the system page

_syspage_ptr
: A pointer to the system page

ThreadCancel(), ThreadCancel_r()
: Cancel a thread

ThreadCreate(), ThreadCreate_r()
: Create a new thread

ThreadCtl(), ThreadCtl_r()
: Control a thread

ThreadDestroy(), ThreadDestroy_r()
: Destroy a thread immediately

ThreadDetach(), ThreadDetach_r()
: Detach a thread from a process

ThreadJoin(), ThreadJoin_r()
: Block until a thread terminates

TraceEvent()
: Trace kernel events

ualarm()
: Schedule an alarm

usleep()
: Suspend a thread for a given number of microseconds

vfork()
: Spawn a new process and block the parent

wait()
: Wait for the status of a terminated child process

wait3()
: Wait for a child process to change state

wait4()
: Wait for a child process to terminate or stop

waitid()
: Wait for a child process to change state

waitpid()
: Suspend the calling process

There are eight *spawn*()* and *exec*()* functions each. The `*` is one to three letters, where:

- `l` or `v` (one is required) indicates the way the process parameters are passed
- `p` (optional) indicates that the **PATH** environment variable is searched to locate the program for the process
- `e` (optional) indicates that the environment variables are being passed

Realtime timer functions

These functions provide realtime timer capabilities:

clock_getres() Get the resolution of the clock

clock_gettime() Get the current time of a clock

clock_nanosleep()
High resolution sleep with specifiable clock

clock_settime() Set a clock

getitimer() Get the value of an interval timer

nanosleep() Suspend process until a timeout or signal occurs

nanospin() Busy-wait without thread blocking for a period of time

nanospin_calibrate()
Calibrate before calling *nanospin*()*

nanospin_count()
Busy-wait without blocking for a number of iterations

nanospin_ns() Busy-wait without blocking for a period of time

nanospin_ns_to_count()
Convert a time in nanoseconds into a number of iterations

sched_getparam()
Get the current priority of a process

sched_get_priority_adjust()
Calculate the allowable priority for the scheduling policy

sched_get_priority_max()

Get the maximum value for the scheduling policy

sched_get_priority_min()

Get the minimum value for the scheduling policy

sched_getscheduler()

Get the current scheduling policy for a process

sched_param Structure that describes scheduling parameters

sched_rr_get_interval()

Get the execution time limit of a process

sched_setparam()

Change the priority of a process

sched_setscheduler()

Change the priority and scheduling policy of a process

sched_yield() Yield to other READY processes at the same priority

timer_create() Create a timer

timer_delete() Delete a timer

timer_getexpstatus()

Get the expiry status of a timer

timer_getoverrun()

Return the number of timer overruns

timer_gettime() Get the amount of time left on a timer

timer_settime() Set the expiration time for a timer

Resource manager functions

These functions help you create resource managers. For an overview of these functions, see "Components of a resource manager" in the Writing a Resource Manager chapter of the QNX Neutrino *Programmer's Guide*.

`_io_connect` Structure of a resource manager's connect message

`_io_connect_ftype_reply`
Structure of a connect message giving a status and a file type

`_io_connect_link_reply`
Structure of a connect message that redirects a client to another resource

iofdinfo() Retrieve server attributes

iofunc_attr_init()
Initialize the default attribute structure

iofunc_attr_lock()
Lock the attribute structure

`iofunc_attr_t`
Attribute structure

iofunc_attr_trylock()
Try to lock the attribute structure

iofunc_attr_unlock()
Unlock the attribute structure

iofunc_check_access()
Check access permissions

iofunc_chmod() Handle an _IO_CHMOD message

iofunc_chmod_default()
Default handler for _IO_CHMOD messages

iofunc_chown() Handle an _IO_CHOWN message

iofunc_chown_default()
Default handler for _IO_CHOWN messages

iofunc_client_info()
Return information about a client connection

iofunc_close_dup()
Frees all locks allocated for the client process

iofunc_close_dup_default()
Default handler for _IO_CLOSE messages

iofunc_close_ocb()
Return the memory allocated for an OCB

iofunc_close_ocb_default()
Return the memory allocated for an OCB

iofunc_devctl() Handle an _IO_DEVCTL message

iofunc_devctl_default()
Default handler for _IO_DEVCTL messages

iofunc_fdinfo() Handle an _IO_FDINFO message

iofunc_fdinfo_default()
Default handler for _IO_FDINFO messages

iofunc_func_init()
Initialize the default POSIX-layer function tables

iofunc_link() Link two directories

iofunc_lock() Lock a resource

iofunc_lock_calloc()

Allocate memory to lock structures

iofunc_lock_default()

Default handler for _IO_LOCK messages

iofunc_lock_free()

Return memory allocated for lock structures

iofunc_lock_ocb_default()

Default handler for the *lock_ocb* callout

iofunc_lseek() Handle an _IO_LSEEK message

iofunc_lseek_default()

Default handler for _IO_LSEEK message

iofunc_mknod() Verify a client's ability to make a new filesystem entry point

iofunc_mmap() Handle an IO_MMAP message

iofunc_mmap_default()

Default handler for IO_MMAP messages

iofunc_notify() Install, poll, or remove a notification handler

iofunc_notify_remove()

Remove notification entries from list

iofunc_notify_trigger()

Send notifications to queued clients

iofunc_ocb_attach()

Initialize an Open Control Block

iofunc_ocb_calloc()

Allocate an iofunc OCB

iofunc_ocb_detach()
: Release OCB resources

iofunc_ocb_free()
: Deallocate an iofunc OCBs memory

iofunc_ocb_t
: Open Control Block structure

iofunc_open()
: Verify a client's ability to open a resource

iofunc_open_default()
: Default handler for _IO_CONNECT messages

iofunc_openfd()
: Increment count and locking flags

iofunc_openfd_default()
: Default handler for _IO_OPENFD messages

iofunc_pathconf()
: Support *pathconf()* requests

iofunc_pathconf_default()
: Default handler for _IO_PATHCONF messages

iofunc_read_default()
: Default handler for _IO_READ messages

iofunc_readlink()
: Verify a client's ability to read a symbolic link

iofunc_read_verify()
: Verify a client's read access to a resource

iofunc_rename()
: Do permission checks for a _IO_CONNECT_RENAME message

iofunc_space_verify()
: Do permission checks for _IO_SPACE message

iofunc_stat()
: Populate a **stat** structure

iofunc_stat_default()
: Default handler for _IO_STAT messages

iofunc_sync()
: Indicate if synchronization is needed

iofunc_sync_default()
: Default handler for _IO_SYNC messages

iofunc_sync_verify()
: Verify permissions to sync

iofunc_time_update()
: Update time stamps

iofunc_unblock()
: Unblock OCBs

iofunc_unblock_default()
: Default unblock handler

iofunc_unlink()
: Verify that an entry can be unlinked

iofunc_unlock_ocb_default()
: Default handler for the *unlock_ocb* callout

iofunc_utime()
: Update time stamps

iofunc_utime_default()
: Default handler for _IO_UTIME messages

iofunc_write_default()
: Default handler for _IO_WRITE messages

iofunc_write_verify()
: Verify a client's write access to a resource

ionotify()
: Arm a resource manager

mount()
: Mount a filesystem

mount_parse_generic_args()
: Strip off common mount arguments

resmgr_devino()
: Get the device and inode number

resmgr_open_bind()
: Associate an OCB with a process

rsrcdbmgr_attach()
: Reserve a system resource for a process

rsrcdbmgr_create()
: Create a system resource

rsrcdbmgr_destroy()
: Destroy a system resource

rsrcdbmgr_detach()
: Return a system resource to the resource database

rsrcdbmgr_devno_attach()
: Get a major and minor number

rsrcdbmgr_devno_detach()
: Detach a major and minor number

rsrcdbmgr_query()
: Query the resource database

umount()
: Unmount a filesystem

Searching and sorting functions

These functions provide searching and sorting capabilities (Some of these functions have wide-character versions in the “Wide-character functions” section of the function summary.):

alphasort()
: Compare two directory entries

bsearch()	Perform a binary search on a sorted array
ffs()	Find the first bit set in a bit string
hcreate()	Create a hash search table
hdestroy()	Destroy the hash search table
hsearch()	Search the hash search table
index()	Find a character in a string
lfind()	Find entry in a linear search table
lsearch()	Linear search and update
pathfind(), pathfind_r()	Search for a file in a list of directories
qsort()	Sort an array, using a modified Quicksort algorithm
re_comp()	Compile a regular expression
re_exec()	Execute a regular expression
regcomp()	Compile a regular expression
regerror()	Explain a regular expression error code
regexec()	Compare a string with a compiled regular expression
regfree()	Release memory allocated for a regular expression
rindex()	Find a character in a string
strcspn()	Count the characters at the beginning of a string that aren't in a character set
strstr()	Find one string inside another

Shared memory functions

These functions provide memory mapping capabilities:

mmap(), mmap64()
: Map a memory region into a process address space

mprotect()
: Change memory protection

munmap()
: Unmap previously mapped addresses

shm_ctl()
: Give special attributes to a shared memory object

shm_open()
: Open a shared memory object

shm_unlink()
: Remove a shared memory object

Signal functions

These functions deal with handling and sending signals.

DebugBreak()
: Enter the process debugger

DebugKDBreak()
: Enter the kernel debugger

DebugKDOutput()
: Print text with the kernel debugger

kill()
: Send a signal to a process or a group of processes

killpg()
: Send a signal to a process group

pause()
: Suspend the process until delivery of a signal

raise()
: Signal an exceptional condition

sigaction()
: Examine or specify the action associated with a signal

sigaddset()
: Add a signal to a set

sigdelset()	Delete a signal from a set
sigemptyset()	Initialize a set to contain no signals
sigfillset()	Initialize a set to contain all signals
sigismember()	See if a given signal is in a given set
signal()	Set handling for exceptional conditions
SignalAction(), SignalAction_r()	Examine and/or specify actions for signals
SignalKill(), SignalKill_r()	Send a signal to a process group, process, or thread
SignalProcmask(), SignalProcmask_r()	Modify or examine the signal blocked mask of a thread
SignalSuspend(), SignalSuspend_r()	Suspend a process until a signal is received
SignalWaitinfo(), SignalWaitinfo_r()	Select a pending signal
sigpending()	Examine the set of pending, masked signals for a process
sigprocmask()	Examine or change the signal mask for a process
sigqueue()	Queue a signal to a process
sigsuspend()	Replace the signal mask, and then suspend the process
sigtimedwait()	Wait for a signal or a timeout
sigwait()	Wait for a pending signal
sigwaitinfo()	Wait for a pending signal and get its information
strsignal()	Return the description of a signal

Stream I/O functions

A *stream* is the name given to a file or device that has been opened for data transmission. When a stream is opened, a pointer to a **FILE** structure is returned. This pointer is used to reference the stream when other functions are subsequently invoked.

When a program begins execution, a number of streams are already open for use:

stderr	Standard Error: output to the console (used for error messages)
stdin	Standard Input: input from the console
stdout	Standard Output: output to the console

You can redirect these standard streams by calling *freopen()*.

See also the section “File manipulation functions” for other functions that operate on files.

The functions in the section “Operating system I/O functions” may also be invoked (use the *fileno()* function to get the file descriptor). Since the stream functions may buffer input and output, use these functions with caution to avoid unexpected results.

(Some of these functions have wide-character versions in the “Wide-character functions” section of the function summary.)

clearerr()	Clear the end-of-file and error indicators for a stream
fclose()	Close a stream
fcloseall()	Close all open stream files, except *stdin*, *stdout* and *stderr*
fdopen()	Associate a stream with a file descriptor
feof()	Test the end-of-file indicator

ferror()	Test the error indicator for a stream
fflush()	Flush the input or output buffer for a stream
fgetc()	Get the next character from a file stream
fgetchar()	Get a character from *stdin*
fgetpos()	Store the current position of a stream
fgets()	Get a string of characters from a stream
flushall()	Clear all input buffers and write all output buffers
fopen()	Open a stream
fprintf()	Write output to a stream
fputc()	Write a character to an output stream
fputchar()	Write a character to *stdout*
fputs()	Write a character string to an output stream
fread()	Read elements of a given size from a stream
freopen()	Reopen a stream
fscanf()	Scan input from a stream
fseek(), *fseeko()*	Change the read/write position of a stream
fsetpos()	Set the current stream position
ftell(), *ftello()*	Return the current read/write position of a stream
fwrite()	Write a number of elements into a stream
getc()	Get the next character from a stream
getchar()	Get a character from *stdin*
getchar_unlocked()	Get a character from *stdin*

getc_unlocked()	Get the next character from a stream
gets()	Get a string of characters from a stream
getw()	Get a word from a stream
perror()	Print, in *stderr*, the message associated with the value of *errno*
printf()	Write formatted output to *stdout*
putc()	Write a character to an output stream
putchar()	Write a character to *stdout*
putchar_unlocked()	Write a character to *stdout*
putc_unlocked()	Write a character to an output stream
puts()	Write a string to *stdout*
putw()	Put a word on a stream
rewind()	Set the file position indicator to the beginning of the stream
scanf()	Scan formatted input from a stream
setbuf()	Associate a buffer with a stream
setbuffer()	Assign block buffering to a stream
setlinebuf()	Assign line buffering to a stream
setvbuf()	Associate a buffer with a stream
snprintf()	Write formatted output to a character array, up to a given max number of characters
tmpfile()	Create a temporary binary file
ungetc()	Push a character back onto an input stream

vfprintf()	Write formatted output to a file stream (varargs)
vfscanf()	Scan input from a file stream (varargs)
vprintf()	Write formatted output to standard output (varargs)
vscanf()	Scan input from standard input (varargs)

See the section “Directory functions” for functions that are related to directories.

String manipulation functions

A *string* is an array of characters (with type **`char`**) that’s terminated with an extra null character (\0). Functions are passed only the address of the string, since the size can be determined by searching for the terminating character. (Some of these functions have wide-character versions in the “Wide-character functions” section of the function summary.)

basename()	Find the part of a string after the last slash (`/`)
bcmp()	Compare a given number of characters in two strings
bcopy()	Copy a number of characters in one string to another
fnmatch()	Check to see if a file or path name matches a pattern
getsubopt()	Parse suboptions from a string
index()	Find a character in a string
input_line()	Get a string of characters from a file
localeconv()	Set numeric formatting according to the current locale
re_comp()	Compile a regular expression

re_exec()	Execute a regular expression
regcomp()	Compile a regular expression
regerror()	Explain a regular expression error code
regexec()	Compare a string with a compiled regular expression
regfree()	Release memory allocated for a regular expression
rindex()	Find a character in a string
sprintf()	Print formatted output into a string
sscanf()	Scan input from a character string
straddstr()	Concatenate one string on to the end of another
strcasecmp()	Compare two strings, ignoring case
strcat()	Concatenate two strings
strchr()	Find the first occurrence of a character in a string
strcmp()	Compare two strings
strcmpi()	Compare two strings, ignoring case
strcoll()	Compare two strings, using the locale's collating sequence
strcpy()	Copy a string
strcspn()	Count the characters at the beginning of a string that aren't in a given character set
strdup()	Create a duplicate of a string
strerror()	Map an error number to an error message
stricmp()	Compare two strings, ignoring case
strlen()	Compute the length of a string

strlwr()	Convert a string to lowercase
strncasecmp()	Compare two strings, ignoring case, up to a given length
strncat()	Concatenate two strings, up to a maximum length
strncmp()	Compare two strings, up to a given length
strncpy()	Copy a string, to a maximum length
strnicmp()	Compare two strings up to a given length, ignoring case
strnset()	Fill a string with a given character, to a given length
strpbrk()	Find the first character in a string that's in a given character set
strrchr()	Find the last occurrence of a character in a string
strrev()	Reverse a string
strsep()	Separate a string into pieces marked by given delimiters
strset()	Fill a string with a given character
strspn()	Count the characters at the beginning of a string that are in a given character set
strstr()	Find one string inside another
strtok()	Break a string into tokens
strtok_r()	Break a string into tokens (reentrant)
strupr()	Convert a string to uppercase
strxfrm()	Transform one string into another, to a given length
vsprintf()	Write formatted output to a buffer (varargs)

vsnprintf()	Write formatted output to a character array, up to a given max number of characters (varargs)
vsscanf()	Scan input from a string (varargs)

For related functions see these sections:

- "Conversion functions" — conversions to and from strings
- "Time functions" — formatting of dates and times
- "Memory manipulation functions" — operating on arrays without a terminating NUL character.

System database functions

The following functions are defined:

crypt()	Encrypt a password
encrypt()	Encrypt a string
endgrent()	Close the group database file
endpwent()	Close the password database file
endspent()	Close the shadow password database file
fgetspent()	Get an entry from the shadow password database
getgrent()	Return an entry from the group database
getgrgid()	Get information about the group with a given ID
getgrgid_r()	Get information about the group with a given ID
getgrnam()	Get information about the group with a given name
getgrnam_r()	Get information about the group with a given name
getpass()	Prompt for and read a password
getpwent()	Get an entry from the password database

getpwnam()	Get information about the user with a given name
getpwnam_r()	Get information about the user with a given name
getpwuid()	Get information about the user with a given ID
getpwuid_r()	Get information about the user with a given ID
getspent(), getspent_r()	Get an entry from the shadow password database
getspnam(), getspnam_r()	Get information about a user with a given name
putspent()	Put an entry into the shadow password database
qnx_crypt()	Encrypt a password (QNX 4)
setkey()	Set the key used in encryption
setgrent()	Rewind to the start of the group database file
setpwent()	Rewind the password database file
setspent()	Rewind the shadow password database file

System message log functions

The following functions are defined:

closelog()	Close the system log
openlog()	Open the system log
setlogmask()	Set the system log priority mask
slogb()	Send a message to the system logger
slogf()	Send a formatted message to the system logger
slogi()	Send a message to the system logger
syslog()	Write a message to the system log

vslogf()	Send a formatted message to the system logger (varargs)
vsyslog()	Control system log (varargs)

TCP/IP functions

These functions, prototypes and structures deal with TCP/IP network communications, database files, and the data server.

accept()	Accept a connection on a socket
addrinfo	TCP/IP address information
bind()	Bind a name to a socket
bindresvport()	Bind a socket to a privileged IP port
connect()	Initiate connection on a socket
dn_comp()	Compress an Internet domain name
dn_expand()	Expand a compressed Internet domain name
ds_clear()	Delete a data server variable
ds_create()	Create a data server variable
ds_deregister()	Deregister an application with the data server
ds_flags()	Set the flags for a data server variable
ds_get()	Retrieve a data server variable
ds_register()	Register an application with the data server
ds_set()	Set a data server variable
endhostent()	Close the TCP connection and the hosts file
endnetent()	Close the network database
endprotoent()	Close protocol name database file

endservent()	Close network services database file
freeaddrinfo()	Free an address information structure
freeifaddrs()	Free an address information structure
gai_strerror()	Return the string associated with a *getaddrinfo()* error code
getaddrinfo()	Get address information
getdomainname()	Get the domain name of the current host
gethostbyaddr()	Get a network host entry, given an Internet address
gethostbyaddr_r()	Get a network host entry, in a thread-safe manner
gethostbyname()	Get a network host entry, given a name
gethostbyname2()	Get a network host entry, given a name
gethostbyname_r()	Get a network host entry by name
gethostent()	Get the next entry from the host database
gethostent_r()	Get the next entry from the host database
gethostname()	Get the name of the current host
getifaddrs()	Get a network interface address
getnetbyaddr()	Get network entry
getnetbyname()	Get network entry
getnetent()	Get an entry from the network database
getpeername()	Get name of connected peer

getprotobyname()
: Get protocol entry

getprotobynumber()
: Get protocol entry by number

getprotoent()
: Read next line of protocol name database file

getservbyname()
: Get service entry

getservbyport()
: Get service entry for a port

getservent()
: Read the next line of network services database file

getsockname()
: Get socket name

getsockopt()
: Get options on socket name

h_errno
: Host error variable

herror()
: Print the message associated with the value of *h_errno* to standard error

`hostent`
: Structure that describes an Internet host

hstrerror()
: Get an error message string associated with the error return status

htonl()
: Convert a 32-bit value from host-byte order to network-byte order

htons()
: Convert a 16-bit value from host-byte order to network-byte order

ICMP
: Internet Control Message Protocol

ICMP6
: Internet Control Message Protocol for IPv6

if_freenameindex()
: Free dynamic memory allocated by *if_nameindex()*

if_indextoname()	Map an interface index to its name
if_nameindex()	Return a list of interfaces
if_nametoindex()	Map an interface name to its index
ifaddrs()	Structure that describes an Internet host
inet_addr()	Convert a string into an Internet address
inet_aton()	Convert a string into an Internet address
inet_lnaof()	Convert an Internet address into a local network address
inet_makeaddr()	Convert a network number and a local network address into an Internet address
inet_net_ntop()	Convert an Internet network number to CIDR format
inet_netof()	Convert Internet address into a network number
inet_net_pton()	Convert an Internet network number from CIDR format to network format
inet_network()	Convert a string into an Internet network number
inet_ntoa()	Convert an Internet address into a string
inet_ntoa_r()	Convert an Internet address into a string
inet_ntop()	Convert a numeric network address to a string
inet_pton()	Convert a text host address to a numeric network address
INET6	Internet Protocol version 6 family
IP	Internet Protocol
IPsec	Internet security protocol

ipsec_dump_policy()
: Generate readable string from IPsec policy specification

ipsec_get_policylen()
: Get length of the IPsec policy

ipsec_strerror()
: Error code for IPsec policy manipulation library

ipsec_set_policy()
: Generate IPsec policy specification structure from readable string

IPv6
: Internet Protocol version 6

isfdtype()
: Determine whether a file descriptor refers to a socket

listen()
: Listen for connections on a socket

nbaconnect()
: Initiate a connection on a socket (nonblocking)

nbaconnect_result()
: Get the status of the previous call to *nbaconnect()*

`netent`
: Structure for information from the network database

ntohl()
: Convert network-byte order value

ntohs()
: Convert network-byte order value

`protoent`
: Structure for information from the protocol database

Raccept()
: Accept a connection on a socket (via a SOCKS server)

Rbind()
: Bind a name to a socket (via a SOCKS server)

rcmd()
: Execute a command on a remote host

Rconnect()	Initiate a connection on a socket (via a SOCKS server)
read_main_config_file()	Read the **`snmpd.conf`** file
recv()	Receive a message from a socket
recvfrom()	Receive a message from a socket
recvmsg()	Receive a message from a socket
res_init()	Initialize the Internet domain name resolver routines
res_mkquery()	Construct an Internet domain name query
res_query()	Make an Internet domain name query
res_querydomain()	Query the local Internet domain name server
res_search()	Make an Internet domain name search
res_send()	Send a preformatted Internet domain name query
Rgetsockname()	Get the name of a socket (via a SOCKS server)
Rlisten()	Listen for connections on a socket (via a SOCKS server)
ROUTE	System packet forwarding database
Rrcmd()	Execute a command on a remote host (via a SOCKS server)
rresvport()	Obtain a socket with a privileged address
Rselect()	Check for descriptors that are ready for reading or writing (via a SOCKS server)
ruserok()	Check the identity of a remote host

send()	Send a message to a socket
sendmsg()	Send a message to a socket
sendto()	Send a message to a socket
servent	Structure for information from the services database
setdomainname()	Set the domain name of the current host
sethostent()	Set the local hosts entry
sethostname()	Set the name of the current host
setnetent()	Open the network database
setprotoent()	Open protocol name database file
setservent()	Open network services database file
setsockopt()	Set options on socket name
shutdown()	Shut down part of a full-duplex connection
snmp_close()	Close an SNMP session
snmp_free_pdu()	Free an SNMP message structure
snmp_open()	Open an SNMP session
snmp_pdu	Structure that describes an SNMP Protocol Data Unit (transaction)
snmp_pdu_create()	Create an SNMP Protocol Data Unit message structure
snmp_read()	Read an SNMP message
snmp_select_info()	Get information that *select()* needs for SNMP

snmp_send()	Send SNMP messages
snmp_session	Structure that defines a set of transactions with similar transport characteristics
snmp_timeout()	Timeout during an SNMP session
sockatmark()	Determine whether a socket is at the out-of-band mark
socket()	Create an endpoint for communication
socketpair()	Create a pair of connected sockets or a bi-directional pipe
SOCKSinit()	Initialize a connection with a SOCKS server
sysctl()	Get or set the system information
TCP	Internet Transmission Control Protocol
UDP	Internet User Datagram Protocol
UNIX	UNIX-domain protocol family

Terminal control functions

The following functions are defined:

cfgetispeed()	Return the input baud rate that's stored in a **termios** structure
cfgetospeed()	Return the output baud rate that's stored in a **termios** structure
cfmakeraw()	Set terminal attributes
cfsetispeed()	Set the input baud rate in a **termios** structure
cfsetospeed()	Set the output baud rate in a **termios** structure
tcdrain()	Wait until all output has been transmitted to a device

tcdropline()	Disconnect a communications line
tcflow()	Perform a flow-control operation on a data stream
tcflush()	Flush the input and/or output stream
tcgetattr()	Get the current terminal control settings
tcgetpgrp()	Get the process group ID associated with a device
tcgetsid()	Get the process group ID of the session leader for a controlling terminal
tcgetsize()	Get the size of a character device
tcinject()	Inject characters into a devices input buffer
tcischars()	Determine the number of characters waiting to be read
tcsendbreak()	Assert a break condition over a communications line
tcsetattr()	Change the terminal control settings for a device
tcsetpgrp()	Set the process group ID for a device
tcsetsid()	Make a terminal device a controlling device
tcsetsize()	Set the size of a character device
`termios`	Terminal control structure

Thread functions

These functions deal with threads and the objects used to synchronize threads:

pthread_abort()	Unconditionally terminate the target thread
pthread_atfork()	Register fork handlers

pthread_attr_destroy()

Destroy the thread attribute object

pthread_attr_getdetachstate()

Get the thread detach state attribute

pthread_attr_getguardsize()

Get the thread guardsize attribute

pthread_attr_getinheritsched()

Get the thread inherit scheduling attribute

pthread_attr_getschedparam()

Get the thread scheduling parameters attribute

pthread_attr_getschedpolicy()

Get the thread scheduling policy attribute

pthread_attr_getscope()

Get the thread contention scope attribute

pthread_attr_getstackaddr()

Get the thread stack address attribute

pthread_attr_getstacklazy()

Get thread stack attribute

pthread_attr_getstacksize()

Get the thread stack size attribute

pthread_attr_init()

Initialize thread attribute object

pthread_attr_setdetachstate()

Set the thread detach state attribute

pthread_attr_setguardsize()

Set the thread guardsize attribute

pthread_attr_setinheritsched()

Set the thread inherit scheduling attribute

pthread_attr_setschedparam()

Set the thread scheduling parameters attribute

pthread_attr_setschedpolicy()

Set the thread scheduling policy attribute

pthread_attr_setscope()

Set the thread contention scope attribute

pthread_attr_setstackaddr()

Set the thread stack address attribute

pthread_attr_setstacklazy()

Set thread stack attribute

pthread_attr_setstacksize()

Set the thread stack size attribute

pthread_barrierattr_destroy()

Destroy barrier attributes object

pthread_barrierattr_getpshared()

Get process-shared attribute of barrier attributes object

pthread_barrierattr_init()

Initialize barrier attributes object

pthread_barrierattr_setpshared()

Set process-shared attribute of barrier attributes object

pthread_barrier_destroy()

Destroy a barrier object

pthread_barrier_init()

Initialize a barrier object

pthread_barrier_wait()

Synchronize at a barrier

pthread_cancel() Cancel thread

pthread_cleanup_pop()

Pop the cancellation cleanup handler

pthread_cleanup_push()

Push the cancellation cleanup handler

pthread_condattr_destroy()

Destroy the condition variable attribute object

pthread_condattr_getclock()

Get the clock selection condition variable attribute

pthread_condattr_getpshared()

Get the process-shared attribute from a condition variable attribute object

pthread_condattr_init()

Initialize the condition variable attribute object

pthread_condattr_setclock()

Set the clock selection condition variable attribute

pthread_condattr_setpshared()

Set the process-shared attribute in a condition variable attribute object

pthread_cond_broadcast()

Unblock threads waiting on a condition

pthread_cond_destroy()

Destroy the condition variable

pthread_cond_init()

Initialize the condition variable

pthread_cond_signal()

Unblock the thread waiting on condition variable

pthread_cond_timedwait()

Timed wait on the condition variable

pthread_cond_wait()

Wait on the condition variable

pthread_create() Create a thread

pthread_detach() Detach a thread from a process

pthread_equal() Compare two thread IDs

pthread_exit() Terminate the thread

pthread_getconcurrency()

Get the level of thread concurrency

pthread_getcpuclockid()

Return the clock ID of the CPU-time clock from a specified thread

pthread_getschedparam()

Get the thread scheduling parameters

pthread_getspecific()

Get the thread specific data value

pthread_join() Join the thread

pthread_key_create()

Create the thread-specific data key

pthread_key_delete()

Delete the thread-specific data key

pthread_kill() Send a signal to a thread

pthread_mutexattr_destroy()
Destroy the mutex attribute object

pthread_mutexattr_getprioceiling()
Get the priority ceiling of a mutex attribute object

pthread_mutexattr_getprotocol()
Get a mutex's scheduling protocol

pthread_mutexattr_getpshared()
Get the process-shared attribute from a mutex attribute object

pthread_mutexattr_getrecursive()
Get the recursive attribute from a mutex attribute object

pthread_mutexattr_gettype()
Get a mutex type

pthread_mutexattr_init()
Initialize a mutex attribute object

pthread_mutexattr_setprioceiling()
Set the priority ceiling of a mutex attribute object

pthread_mutexattr_setprotocol()
Set a mutex's scheduling protocol

pthread_mutexattr_setpshared()
Set the process-shared attribute in a mutex attribute object

pthread_mutexattr_setrecursive()
Set the recursive attribute in a mutex attribute object

pthread_mutexattr_settype()
Set a mutex type

pthread_mutex_destroy()
Destroy a mutex

pthread_mutex_getprioceiling()
Get a mutex's priority ceiling

pthread_mutex_init()
Initialize a mutex

pthread_mutex_lock()
Lock a mutex

pthread_mutex_setprioceiling()
Set a mutex's priority ceiling

pthread_mutex_timedlock()
Lock a mutex

pthread_mutex_trylock()
Attempt to lock a mutex

pthread_mutex_unlock()
Unlock a mutex

pthread_once() Dynamic package initialization

pthread_sleepon_timedwait()
Make a thread sleep while waiting

pthread_timedjoin()
Join a thread, with a time limit

pthread_rwlockattr_destroy()
Destroy a read-write lock attribute object

pthread_rwlockattr_getpshared()

Get the process-shared attribute of a read-write lock attribute object

pthread_rwlockattr_init()

Create a read-write lock attribute object

pthread_rwlockattr_setpshared()

Set the process-shared attribute of a read-write lock attribute object

pthread_rwlock_destroy()

Destroy a read/write lock

pthread_rwlock_init()

Initialize a read/write lock

pthread_rwlock_rdlock()

Acquire a shared read lock on a read/write lock

pthread_rwlock_timedrdlock()

Lock a read-write lock for writing

pthread_rwlock_timedwrlock()

Attempt to acquire an exclusive write lock on a read/write lock

pthread_rwlock_tryrdlock()

Attempt to acquire a shared read lock on a read/write lock

pthread_rwlock_trywrlock()

Attempt to acquire an exclusive write lock on a read/write lock

pthread_rwlock_unlock()

Unlock a read/write lock

pthread_rwlock_wrlock()

Acquire an exclusive write lock on a read/write lock

pthread_self() Get the calling thread's ID

pthread_setcancelstate()

Set a thread's cancellation state

pthread_setcanceltype()

Set a thread's cancellation type

pthread_setconcurrency()

Set the concurrency level for a thread

pthread_setschedparam()

Set the thread scheduling parameters

pthread_setspecific()

Set a thread-specific data value

pthread_sigmask()

Examine and change blocked signals

pthread_sleepon_broadcast()

Unblock waiting threads

pthread_sleepon_lock()

Lock the *pthread_sleepon*()* functions

pthread_sleepon_signal()

Signal a sleeping thread

pthread_sleepon_unlock()

Unlock the *pthread_sleepon*()* functions

pthread_sleepon_wait()

Make a thread sleep while waiting

pthread_spin_destroy()
: Destroy a thread spinlock

pthread_spin_init()
: Initialize a thread spinlock

pthread_spin_lock()
: Lock a thread spinlock

pthread_spin_trylock()
: Try to lock a thread spinlock

pthread_spin_unlock()
: Unlock a thread spinlock

pthread_testcancel()
: Test the thread cancellation

_sleepon_broadcast()
: Wake up multiple threads

_sleepon_destroy()
: Destroy a sleepon lock

_sleepon_init() Initialize a sleepon lock

_sleepon_lock() Lock a sleepon lock

_sleepon_signal()
: Wake up a single thread

_sleepon_unlock()
: Unlock a sleepon lock

_sleepon_wait() Wait on a sleepon lock

Time functions

These functions are concerned with dates and times. (Some of these functions have wide-character versions in the "Wide-character functions" section of the function summary.)

asctime(), asctime_r()
: Convert time information to a string

clock()
: Return the number of clock ticks used by the program

ClockAdjust(), ClockAdjust_r()
: Adjust the time of a clock

ClockCycles()
: Get the number of clock cycles

clock_getcpuclockid()
: Return the clock ID of the CPU-time clock from a specified process

ClockId(), ClockId_r()
: Get a clock ID for a given process and thread

ClockPeriod(), ClockPeriod_r()
: Get or set a clock period

ClockTime(), ClockTime_r()
: Get or set a clock

ctime(), ctime_r()
: Convert calendar time to local time

daylight
: Indicator of support for daylight saving time in the locale

difftime()
: Calculate the difference between two times

ftime()
: Get the current time, and store it in a structure

gettimeofday()	Get the current time
gmtime()	Convert calendar time to a broken-down time
gmtime_r()	Convert calendar time to a broken-down time
localtime()	Convert calendar time to local time
localtime_r()	Convert calendar time to local time
mktime()	Convert local time to calendar time
settimeofday()	Set the time and date
strftime()	Format a time into a string
time()	Determine the current calendar time
TimerAlarm(), TimerAlarm_r()	Send an alarm signal
TimerCreate(), TimerCreate_r()	Create a timer for a process
TimerDestroy(), TimerDestroy_r()	Destroy a process timer
TimerInfo(), TimerInfo_r()	Get information about a timer
TimerSettime(), TimerSettime_r()	Set the expiration time for a timer
timer_timeout(), timer_timeout_r()	Set a timeout on a blocking state
TimerTimeout(), TimerTimeout_r()	Set a timeout on a blocking state
times()	Get time-accounting information

timezone	The number of seconds by which the local time zone is earlier than UTC
tm	Structure that describes calendar time
tzname	The abbreviations for the time zone for standard and daylight savings time
tzset()	Set the time according to the current time zone

Variable-length argument list functions

Variable-length argument lists are used when a function doesn't have a fixed number of arguments. These macros provide the capability to access these arguments:

va_arg()	Get the next item in a list of variable arguments
va_copy()	Make a copy of a variable argument list
va_end()	Finish getting items from a variable argument list
va_start()	Start getting items from a variable argument list

Wide-character functions

If your application must use international characters, you'll probably need to work with Unicode and wide characters. The functions in this section are wide-character versions of many functions from the following function summary categories:

- Character manipulation functions
- Memory manipulation functions
- Stream I/O functions
- String manipulation functions
- Time functions

- Multibyte character functions
- Searching and sorting functions

The functions are:

btowc()	Convert a single-byte character to a wide character
fgetwc()	Read a wide character from a stream
fgetws()	Read a string of wide characters from a stream
fputwc()	Write a wide character to a stream
fputws()	Write a wide character string to an output stream
fwide()	Set the stream orientation
fwprintf()	Write wide-character output to a stream
fwscanf()	Scan wide-character input from a stream
getwc()	Read a wide character from *stdin*
getwchar()	Read a wide character from a stream
iswalnum()	Test for an alphabetic or a decimal digit wide character
iswalpha()	Test for an alphabetic wide character
iswcntrl()	Test for a control wide character
iswctype()	Test for an alphabetic or a decimal digit wide character
iswdigit()	Test for a decimal digit wide character
iswgraph()	Test for any graphical wide character
iswlower()	Test for a lowercase letter wide character
iswprint()	Test for a printable wide character

iswpunct()	Test for any punctuation wide character
iswspace()	Test for a whitespace wide character
iswupper()	Test for an uppercase wide character
iswxdigit()	Test for any hexadecimal digit wide character
putwc()	Write a wide character to a stream
putwchar()	Write a wide character to a stdout
swprintf()	Print formatted wide-character output into a string
swscanf()	Scan input from a wide character string
towctrans()	Convert a wide character in a specified manner
towlower()	Convert a wide character to lowercase
towupper()	Convert a wide character to uppercase
ungetwc()	Push a wide character back onto an input stream
vfwprintf()	Write formatted wide-character output to a file (varargs)
vfwscanf()	Scan input from a file (varargs)
vswprintf()	Write formatted wide-character output to a buffer (varargs)
vswscanf()	Scan input from a string (varargs)
vwprintf()	Write formatted wide-character output to standard output (varargs)
vwscanf()	Scan input from standard input (varargs)
wcrtomb()	Convert a wide-character code into a multibyte character (restartable)
wcscat()	Concatenate two wide-character strings

wcschr()	Find the first occurrence of a wide character in a string
wcscmp()	Compare two wide-character strings
wcscoll()	Compare two wide-character strings, using the locale's collating sequence
wcscpy()	Copy a wide-character string
wcscspn()	Count the wide characters at the beginning of a string that aren't in a given character set
wcsftime()	Format the time into a wide-character string
wcslen()	Compute the length of a wide-character string
wcsncat()	Concatenate two wide-character strings, up to a maximum length
wcsncmp()	Compare two wide-character strings, up to a given length
wcsncpy()	Copy a wide-character string, to a maximum length
wcspbrk()	Find the first wide character in a string that's in a given character set
wcsrtombs()	Convert a wide-character string into a multibyte character string (restartable)
wcsrchr()	Find the last occurrence of a wide character in a string
wcsspn()	Count the wide characters at the beginning of a string that are in a given character set
wcsstr()	Find one wide-character string inside another
wcstod(), wcstof(), wcstold()	Convert a wide-character string into a double, float, or long double

wcstoimax(), wcstoumax()	Convert a wide-character string into an integer
wcstok()	Break a wide-character string into tokens
wcstol(), wcstoll()	Convert a wide-character string into a long or long long
wcstombs()	Convert a wide-character string into a multibyte character string
wcstoul(), wcstoull()	Convert a wide-character string into an unsigned long integer or unsigned long long
wcsxfrm()	Transform one wide-character string into another, to a given length
wctob()	Convert a wide character into a single-byte code
wctomb()	Convert a wide character into a multibyte character
wctrans()	Define a wide-character mapping
wctype()	Define a wide-character class
wmemchr()	Locate the first occurrence of a wide character in a buffer
wmemcmp()	Compare wide characters in two buffers
wmemcpy()	Copy wide characters from one buffer to another
wmemmove()	Copy wide characters from one buffer to another
wmemset()	Set wide characters in memory
wprintf()	Write formatted wide-character output to standard output
wscanf()	Scan formatted wide-character input from standard input

What's in a function description?

Each description contains the following sections:

Synopsis:

This section gives the header files that should be included within a source file that references the function or macro. It also shows an appropriate declaration for the function or for a function that could be substituted for a macro. This declaration isn't included in your program; only the header file(s) should be included.

When a pointer argument is passed to a function that doesn't modify the item indicated by that pointer, the argument is shown with **`const`** before the argument. For example, the following indicates that the array pointed at by *string* isn't changed:

```
const char *string
```

Arguments:

This section gives a brief description of the arguments to the function.

Library:

The section indicates the library that you need to bind with your application in order to use the function.

Description:

This section describes the function or macro.

Returns:

This section gives the return value (if any) for the function or macro.

Errors:

This section describes the special values that the function might assign to the global variable *errno*.

This section doesn't necessarily list *all* of the values that the function could set *errno* to.

See also:

This optional section provides a list of related functions or macros as well as pertinent docs to look for more information.

Examples:

This optional section gives one or more examples of the use of the function. The examples are often just code snippets, not complete programs.

Classification:

This section tells where the function or macro is commonly found, which may be helpful when porting code from one environment to another. Here are the classes:

ANSI	These functions or macros are defined by the ANSI C standard.
Large-file support	These functions support 64-bit offsets.
POSIX 1003.1	These functions are specified in the document *Information technology — Portable Operating System Interface* (IEEE Std 1003.1, 1996 Edition). This document is being replaced by POSIX Std. 1003.1-2001.

☞ For an up-to-date status of the many POSIX drafts/standards documents, see the PASC (Portable Applications Standards Committee of the IEEE Computer Society) report at **`http://www.pasc.org/standing/sd11.html`**.

POSIX 1003.1-2001

The standard incorporates the POSIX 1003.2-1992 and 1003.1-1996 standards, the approved drafts (POSIX 1003.1a, POSIX 1003.1d, POSIX 1003.1g and POSIX 1003.1j) and the Standard Unix specification. A joint technical working group — the Austin Common Standards Revision Group (CSRG) — was formed to merge these standards.

POSIX 1003.1 (Realtime Extensions)

This portion of POSIX defines optional sets of systems interfaces to support the source portability of applications with realtime requirements. Facilities include an efficient process creation mechanism, additional realtime scheduling policies, interfaces for execution time monitoring, for interacting with special devices, for improving I/O performance, and timeouts for blocking functions. The scope is to take existing realtime OS practice and add it to the base standard. The document has been integrated into the IEEE POSIX Std. 1003.1-2001 spec.

POSIX 1003.1 (Threads)

This portion provides the POSIX base standard with interfaces and functionality to support the multiple flows of control, called *threads*, within a process. The facilities provided represent a small set of syntactic and semantic extensions to POSIX.1 in order to support a convenient interface for multithreading functions. The document has

been integrated into the IEEE POSIX Std. 1003.1-2001 spec.

POSIX 1003.1a — Some of these functions are described in the appendix to 1003.2 (*Shell and Utilities*), others are in the *System Application Program Interface (API) [C Language] — Amendment* (POSIX 1003.1a Draft 15). The document has been integrated into the IEEE POSIX Std. 1003.1-2001 spec.

POSIX 1003.1d (*IEEE Approved Draft*: Additional Realtime Extensions)

This portion extends the system interfaces defined by 1003.1 (Realtime Extensions). The document has been integrated into the IEEE POSIX Std. 1003.1-2001 spec.

POSIX 1003.1g (*Draft*: Protocol Independent Interfaces)

This portion defines a programmatic interface for network process-to-process communication, such that the application may be independent of the underlying protocols. The document has been integrated into the IEEE POSIX Std. 1003.1-2001 spec.

POSIX 1003.1j (*IEEE Approved Draft*: Advanced Realtime Extensions)

This portion extends the POSIX interfaces to provide C-language bindings for additional realtime functions for Typed Memory, Absolute Nanosleep, Barrier Synchronization, Reader/Writer Lock, Monotonic Clock, and Synchronized Clock. The document has been integrated into the IEEE POSIX Std. 1003.1-2001 spec.

QNX 4 — These functions or macros are neither ANSI nor POSIX. They perform a function related to the QNX OS version 4. They may be found in other

implementations of C for personal computers with the QNX 4 OS. Use these functions with caution if portability is a consideration.

Any QNX 4 functions in the C library are provided *only* to make it easier to port QNX 4 programs. Don't use these in QNX Neutrino programs.

QNX Neutrino	These functions or macros are neither ANSI nor POSIX. They perform a function related to the QNX Neutrino OS. They may be found in other implementations of C for personal computers with the QNX OS. Use these functions with caution if portability is a consideration.
SNMP	Simple Network Management Protocol is a network-management protocol whose base document is *RFC 1067*. It's used to query and modify network device states.
SOCKS	These functions are part of the SOCKS package consisting of a proxy server, client programs (**`rftp`** and **`rtelnet`**), and a library (**`libsocks`**) for adapting other applications into new client programs. For more information, see the appendix SOCKS — A Basic Firewall.
Unix	These Unix-class functions reside on some Unix systems, but are outside of the POSIX or ANSI standards. We've created the following Unix categories to differentiate: Legacy Unix — Functions included for backwards compatibility only. New applications shouldn't implement these functions.

Standard Unix	Functions that match XOPEN specifications. These functions are part of the IEEE POSIX Std. 1003.1-2001 spec.
Unix	Unix functions that don't fall into the above two categories. ;-)

Function safety:

This section summarizes whether or not it's safe to use the C library functions in certain situations:

Cancellation point

Indicates whether calling a function may or may not cause the thread to be terminated if a cancellation is pending.

Interrupt handler

An interrupt-safe function behaves as documented even if used in an interrupt handler. Functions flagged as interrupt-unsafe shouldn't be used in interrupt handlers.

Signal handler

A signal-safe function behaves as documented even if called from a signal handler *even if the signal interrupts a signal-unsafe function*.

Some of the signal-safe functions modify *errno* on failure. If you use any of these in a signal handler, asynchronous signals may have the side effect of modifying *errno* in an unpredictable way. If any of the code that can be interrupted checks the value of *errno* (this also applies to library calls, so you should assume that most library calls may internally check *errno*), make sure that your signal handler saves *errno* on entry and restores it on exit.

All of the above also applies to signal-unsafe functions, with one exception: if a signal handler calls a

signal-unsafe function, make sure that signal doesn't interrupt a signal-unsafe function.

Thread A thread-safe function behaves as documented even if called in a multi-threaded environment.

Most functions in the QNX Neutrino libraries are thread-safe. Even for those that aren't, there are still ways to call them safely in a multi-threaded program (e.g. by protecting the calls with a mutex). Such cases are explained in each function's description.

The "safety" designations documented in this manual are valid for the this release and could change in future versions. Floating-point functions aren't safe to use in interrupt handlers or signal handlers.

For a summary, see the Summary of Safety Information appendix.

Manifests

Manifests are used by C/C++ for compile-time changes or inspection. Here are the defined items:

Manifest	Header file to include	Description
__BEGIN_DECLS	**sys/platform.h**	Denotes start of C code for a C++ compiled program.
__BIGENDIAN__	**sys/platform.h**	Code is compiled for a big-endian target.
__CHAR_SIGNED__	**sys/platform.h**	Code is compiled with the char type defaulting to **signed**.
__CHAR_UNSIGNED__	**sys/platform.h**	Code is compiled with the char type defaulting to **unsigned**.
__END_DECLS	**sys/platform.h**	Denotes end of C code for a C++ compiled program
__INT_BITS__	**sys/platform.h**	The number of bits in the **int** datatype.
__LITTLEENDIAN__	**sys/platform.h**	Code is compiled for a little-endian target.
__LONG_BITS__	**sys/platform.h**	The number of bits in the **long** datatype.
_NTO_VERSION	**sys/neutrino.h**	A version number times 100 (e.g. 2.00 is 200).
__PTR_BITS__	**sys/platform.h**	The number of bits in a void pointer.
__OPTIMIZE__	**sys/platform.h**	Code is compiled for optimization.
__QNX__	N/A	The target is for a QNX operating system (QNX 4 or QNX Neutrino).

continued...

Manifest	Header file to include	Description
__QNXNTO__	N/A	The target is the QNX Neutrino operating system.

abort()

Raise the SIGABRT signal to terminate program execution

Synopsis:

```
#include <stdlib.h>

void abort( void );
```

Library:

libc

Description:

The *abort()* function causes abnormal process termination to occur, unless the signal SIGABRT is caught and the signal handler doesn't return. The status *unsuccessful termination* is returned to the invoking process by means means of the function call *raise*(SIGABRT).

Under QNX Neutrino, the *unsuccessful termination* status value is 6.

Returns:

The *abort()* function doesn't return to its caller.

Examples:

```
#include <stdlib.h>

int main( void )
{
    int major_error = 1;

    if( major_error )
        abort();

    /* You'll never get here. */
    return EXIT_SUCCESS;
}
```

Classification:

ANSI, POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Read the *Caveats*
Thread	Yes

Caveats:

A strictly-conforming POSIX application *can't* assume that the *abort()* function is safe to use in a signal handler on other platforms.

See also:

atexit(), *close()*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *_exit()*, *exit()*, *getenv()*, *main()*, *putenv()*, *sigaction()*, *signal()*, *spawn*()* functions, *system()*, *wait()*, *waitpid()*

Synopsis:

```
#include <stdlib.h>

int abs( int j );
```

Arguments:

j The number you want the absolute value of.

Library:

libc

Description:

The *abs()* function returns the absolute value of the integer argument *j*. If the result can't be represented as an **int**, a warning occurs.

Returns:

The absolute value of its argument.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    printf( "%d %d %d\n", abs (-5), abs (0), abs (5));
    return EXIT_SUCCESS;
}
```

produces the following output:

```
5 0 5
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

cabs(), fabs(), labs()

accept()

Accept a connection on a socket

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>


int accept( int s,
            struct sockaddr * addr,
            socklen_t * addrlen );
```

Arguments:

s	A socket that's been created with *socket()*.
addr	A result parameter that's filled in with the address of the connecting entity, as known to the communications layer. The exact format of the *addr* parameter is determined by the domain in which the connection was made.
addrlen	A value-result parameter. It should initially contain the amount of space pointed to by *addr*; on return it contains the actual length (in bytes) of the address returned. This call is used with connection-based socket types, currently with SOCK_STREAM.

Library:

libsocket

Description:

The *accept()* function:

1. Extracts the first connection request on the queue of pending connections.
2. Creates a new socket with the same properties of *s*, where *s* is a socket that's been created with *socket()*, bound to an address with *bind()*, and is listening for connections after a *listen()*.

3 Allocates a new file descriptor for the socket.

If no pending connections are present on the queue, and the socket isn't marked as nonblocking, *accept()* blocks the caller until a connection is present. If the socket is marked as nonblocking and no pending connections are present on the queue, *accept()* returns an error as described below. The accepted socket may *not* be used to accept more connections. The original socket *s* remains open.

If you do a *select()* for read on an unconnected socket (on which a *listen()* has been done), the *select()* indicates when a connect request has occurred. In this way, an *accept()* can be made that won't block. For more information, see *select()*.

For certain protocols that require an explicit confirmation, *accept()* can be thought of as merely dequeuing the next connection request and *not* implying confirmation. Confirmation can be implied by a normal read or write on the new file descriptor, and rejection can be implied by closing the new socket.

You can obtain user-connection request data without confirming the connection by:

- Issuing a *recvmsg()* call with a *msg_iovlen* of 0 and a nonzero *msg_controllen*

  Or

- Issuing a *getsockopt()* request.

Similarly, you can provide user-connection rejection information by issuing a *sendmsg()* call with only the control information, or by calling *setsockopt()*.

Returns:

A descriptor for the accepted socket, or -1 if an error occurs (*errno* is set).

Errors:

EAGAIN Insufficient resources to create the new socket.

EBADF Invalid descriptor *s*.

EFAULT The *addr* parameter isn't in a writable part of the user address space.

EOPNOTSUPP
The referenced socket isn't a SOCK_STREAM socket.

ESRCH Can't find the socket manager (**npm-ttcpip.so**).

EWOULDBLOCK
The socket is marked nonblocking and no connections are present to be accepted.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

bind(), close(), connect(), listen(), select(), socket()

access()

Check to see if a file or directory can be accessed

Synopsis:

```
#include <unistd.h>

int access( const char * path,
            int amode );
```

Arguments:

path The path to the file or directory that you want to access.

amode The access mode you want to check. This must be either:

- F_OK — test for file existence.

or a bitwise ORing of the following access permissions to be checked, as defined in the header **<unistd.h>**:

- R_OK — test for read permission.
- W_OK — test for write permission.
- X_OK — for a directory, test for search permission. Otherwise, test for execute permission.

Library:

libc

Description:

The *access()* function checks to see if the file or directory specified by *path* exists and if it can be accessed with the file access permissions given by *amode*. However, unlike other functions (*open()* for example), it uses the real user ID and real group ID in place of the effective user and group IDs.

Returns:

0 The file or directory exists and can be accessed with the specified mode.

-1 An error occurred (*errno* is set).

Errors:

EACCES	The permissions specified by *amode* are denied, or search permission is denied on a component of the path prefix.
EINVAL	An invalid value was specified for *amode*.
ELOOP	Too many levels of symbolic links or prefixes.
ENAMETOOLONG	The length of the *path* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.
ENOENT	A component of the path isn't valid.
ENOSYS	The *access()* function isn't implemented for the filesystem specified in *path*.
ENOTDIR	A component of the path prefix isn't a directory.
EROFS	Write access was requested for a file residing on a read-only file system.

Examples:

```
#include <unistd.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv )
  {
    if( argc!= 2 ) {
      fprintf( stderr,
        "use: readable <filename>\n" );
      return EXIT_FAILURE;
    }

    if( !access( argv[1], R_OK ) ) {
      printf( "ok to read %s\n", argv[1] );
      return EXIT_SUCCESS;
    } else {
      perror( argv[1] );
      return EXIT_FAILURE;
    }
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chmod(), eaccess, errno, fstat(), open(), stat()

acos(), acosf()

Compute the arccosine of an angle

Synopsis:

```
#include <math.h>

double acos( double x );

float acosf( float x );
```

Arguments:

x The cosine for which you want to find the angle.

Library:

libm

Description:

These functions compute the arccosine (specified in radians) of *x*.

Returns:

The arccosine in the range (0, π).

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", acos(.5) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
1.047197
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

asin(), atan(), atan2()

acosh(), acoshf()

Compute the inverse hyperbolic cosine

Synopsis:

```
#include <math.h>

double acosh( double x );

float acoshf( float x );
```

Arguments:

x The value for which you want to compute the inverse hyperbolic cosine.

Library:

libm

Description:

These functions compute the inverse hyperbolic cosine (specified in radians) of *x*.

Returns:

The inverse hyperbolic cosine of *x* (specified in radians).

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", acosh( 1.5 ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
0.962424
```

Classification:

acosh() is standard Unix; *acoshf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

asinh(), atanh(), cosh(), errno

Synopsis:

```
struct addrinfo {
    int ai_flags;
    int ai_family;
    int ai_socktype;
    int ai_protocol;
    size_t ai_addrlen;
    char * ai_canonname;
    struct sockaddr * ai_addr;
    struct addrinfo * ai_next
};
```

Description:

The **addrinfo** structure describes address information for use with TCP/IP. To get this information, call *getaddrinfo()*; to free a linked list of these structures, call *freeaddrinfo()*.

The **addrinfo** structure includes these members:

ai_flags — Flags. Includes AI_PASSIVE, AI_CANONNAME, and AI_NUMERICHOST. For a complete list, see **<netdb.h>**.

ai_family — Protocol family. Includes PF_UNSPEC and PF_INET. For a complete list, see **<sys/socket.h>**.

ai_socktype — Socket type. Includes SOCK_STREAM and SOCK_DGRAM. For a complete list, see **<sys/socket.h>**.

ai_protocol — Protocol. Includes IPPROTO_TCP and IPPROTO_UDP. For a complete list, see **<netinet/in.h>**.

ai_addrlen — The length of the *ai_addr* member.

ai_canonname — The canonical name for *nodename*.

ai_addr	Binary socket address.
ai_next	A pointer to the next **addrinfo** structure in the linked list.

Classification:

POSIX 1003.1-2001

See also:

freeaddrinfo(), *gai_strerror()*, *getaddrinfo()*

aio_cancel()

Cancel an asynchronous I/O operation

Synopsis:

```
#include <aio.h>

int aio_cancel( int fd,
                struct aiocb * aiocbptr );
```

Library:

libc

Description:

The *aio_cancel()* function attempts to cancel one or more asynchronous I/O requests currently outstanding against a file descriptor.

☞ Asynchronous I/O operations aren't currently supported.

Returns:

-1; *errno* is set.

Errors:

ENOSYS The *aio_cancel()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

aio_error()

Get the error status for an asynchronous I/O operation

Synopsis:

```
#include <aio.h>

int aio_error( const struct aiocb * aiocbptr );
```

Library:

libc

Description:

The *aio_error()* function returns the error status associated with the **aiocb** structure referenced by the *aiocbptr* argument. The error status for an asynchronous I/O operation is the *errno* value that's set by the corresponding *read()*, *write()*, or *fsync()* operation.

☞ Asynchronous I/O operations aren't currently supported.

Returns:

-1; *errno* is set.

Errors:

ENOSYS The *aio_error()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

aio_fsync()

Asynchronously synchronize a file

Synopsis:

```
#include <aio.h>

int aio_fsync( int op,
               struct aiocb * aiocbptr );
```

Library:

libc

Description:

The *aio_fsync()* function asynchronously forces all I/O operations associated with the file indicated by the file descriptor to the synchronized I/O completion state.

Asynchronous I/O operations aren't currently supported.

Returns:

-1; *errno* is set.

Errors:

ENOSYS The *aio_fsync()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

aio_read()

Asynchronously read from a file

Synopsis:

```
#include <aio.h>

int aio_read( struct aiocb * aiocbptr );
```

Library:

libc

Description:

☞ Asynchronous I/O operations aren't currently supported.

Returns:

-1; *errno* is set.

Errors:

ENOSYS The *aio_read()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

aio_return()

Get the return status for an asynchronous I/O operation

Synopsis:

```
#include <aio.h>

ssize_t aio_return( struct aiocb * aiocbptr );
```

Library:

libc

Description:

The *aio_return()* function returns the return status associated with the **aiocb** structure referenced by the *aiocbptr* argument. The return status for an asynchronous I/O operation is the value that's returned by the corresponding *read()*, *write()*, or *fsync()* operation.

Asynchronous I/O operations aren't currently supported.

Returns:

-1; *errno* is set.

Errors:

ENOSYS — The *aio_return()* function function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

aio_suspend()

Wait for asynchronous I/O operations to complete

Synopsis:

```
#include <aio.h>

int aio_suspend( const struct aiocb * const list[],
                 int nent,
                 const struct timespec * timeout );
```

Library:

libc

Description:

The *aio_suspend()* function suspends the calling thread until at least one of the asynchronous I/O operations referenced by the *list* argument has completed, until a signal interrupts the function, or, if *timeout* isn't NULL, until the time interval specified by *timeout* has passed.

Asynchronous I/O operations aren't currently supported.

Returns:

-1; *errno* is set.

Errors:

ENOSYS The *aio_suspend()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

aio_write()

Asynchronously write to a file

Synopsis:

```
#include <aio.h>

int aio_write( struct aiocb * aiocbptr );
```

Library:

libc

Description:

Asynchronous I/O operations aren't currently supported.

Returns:

-1; *errno* is set.

Errors:

ENOSYS The *aio_write()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

alarm()

Schedule an alarm

Synopsis:

```
#include <unistd.h>

unsigned int alarm( unsigned int seconds );
```

Arguments:

seconds The number of seconds of realtime to let elapse before raising the alarm, or zero to cancel any previous *alarm()* requests.

Library:

libc

Description:

The *alarm()* function causes the system to send the calling process a SIGALRM signal after a specified number of realtime seconds have elapsed. To add a handler for the signal, call *signal()* or *SignalAction()*.

☞ Processor scheduling delays may cause the process to handle the signal after the desired time.

The *alarm()* requests aren't stacked; you can schedule only a single SIGALRM generation in this manner. If the SIGALRM hasn't yet been generated, *alarm()* reschedules the time at which the SIGALRM is generated.

Returns:

The number of seconds before the calling process is scheduled to receive a SIGALRM from the system, or zero if there was no previous *alarm()* request.

If an error occurs, an **(unsigned)-1** is returned (*errno* is set).

Errors:

EAGAIN	All timers are in use. You'll have to wait for a process to release one.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main()
  {
    unsigned int  timeleft;

    printf( "Set the alarm and sleep\n" );
    alarm( 10 );
    sleep( 5 );   /* go to sleep for 5 seconds */

    /*
     * To get the time left before the SIGALRM is
     * to arrive, one must cancel the initial timer,
     * which returns the amount of time it had
     * remaining.
     */
    timeleft = alarm( 0 );
    printf( "Time left before cancel, and rearm: %d\n",
        timeleft );

    /*
     * Start a new timer that kicks us when timeleft
     * seconds have passed.
     */

    alarm( timeleft );

    /*
     * Wait until we receive the SIGALRM signal; any
     * signal kills us, though, since we don't have
     * a signal handler.
     */
    printf( "Hanging around, waiting to die\n" );
    pause();
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Requests from *alarm()*, *TimerAlarm()*, and *ualarm()* aren't "stacked;" only a single SIGALRM generator can be scheduled with these functions. If the SIGALRM signal hasn't been generated, the next call to *alarm()*, *TimerAlarm()*, or *ualarm()* reschedules it.

See also:

errno, *pause()*, *signal()*, *SignalAction()*, *sleep()*, *TimerAlarm()*, *timer_create()*, *timer_delete()*, *timer_gettime()*, *timer_settime()*, *ualarm()*

alloca()

Allocate automatic space from the stack

Synopsis:

```
#include <alloca.h>

void* alloca( size_t size );
```

Arguments:

size The number of bytes of memory to allocate.

Library:

libc

Description:

The *alloca()* function allocates space for an object of *size* bytes from the stack. The allocated space is automatically discarded when the current function exits.

Don't use this function in an expression that's an argument to a function.

Returns:

A pointer to the start of the allocated memory, or NULL if an error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <string.h>
#include <malloc.h>
#include <stdlib.h>

FILE *open_err_file( char *name )
{
    char *buffer;

    /* allocate temporary buffer for file name */
    buffer = (char *)alloca( strlen( name ) + 5 );
```

```
    if( buffer ) {
        FILE *fp;

        sprintf( buffer, "%s.err", name );
        fp = fopen( buffer, "w" );

        return fp;
    }

    return (FILE *)NULL;
}

int main( void )
{
    FILE *fp;

    fp = open_err_file( "alloca_test" );
    if( fp == NULL ) {
        printf( "Unable to open error file\n" );
    } else {
        fprintf( fp, "Hello from the alloca test.\n" );
        fclose( fp );
    }

    return EXIT_SUCCESS;
}
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Don't use *alloca()* as an argument to a function.

See also:

calloc(), malloc()

alphasort()

Compare two directory entries

Synopsis:

```
#include <sys/types.h>
#include <sys/dir.h>

struct direct {
    unsigned long d_fileno;
    unsigned short d_reclen;
    unsigned short d_namlen;
    char d_name[1];
};

int alphasort( struct direct **d1,
               struct direct **d2);
```

Arguments:

d1, *d2* Pointers to the directory entries that you want to compare.

Library:

libc

Description:

The *alphasort()* function alphabetically compares two directory entries. You can use it as the *compar* argument to *scandir()*.

Returns:

< 0 The *d1* entry precedes the *d2* entry alphabetically.

0 The entries are equivalent.

> 0 The *d1* entry follows the *d2* entry alphabetically.

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

closedir(), opendir(), readdir(), rewinddir(), scandir(), seekdir(), telldir()

Synopsis:

```
#include <stdlib.h>

unsigned int _amblksiz
```

Description:

The *_amblksiz* global variable holds the increment by which the "break" pointer for memory allocation is advanced when there's no freed block large enough to satisfy a request to allocate a block of memory. You can change this at any time.

Classification:

QNX Neutrino

See also:

malloc()

The number of arguments passed to main()

Synopsis:

```
int _argc
```

Description:

This global variable holds the number of arguments passed to *main()*.

This variable isn't defined in any header file. If you want to refer to it, you need to add your own **extern** statement.

Classification:

QNX Neutrino

See also:

_argv, *_auxv*, *getopt()*, *main()*

A pointer to the vector of arguments passed to main()

Synopsis:

```
char ** _argv;
```

Description:

This global variable holds a pointer to a vector containing the actual arguments passed to *main()*.

☞ This variable isn't defined in any header file. If you want to refer to it, you need to add your own **extern** statement.

Classification:

QNX Neutrino

See also:

_argc, *_auxv*, *getopt()*, *main()*

asctime(), asctime_r()

Convert time information to a string

Synopsis:

```
#include <time.h>

char* asctime( const struct tm* timeptr );

char* asctime_r( const struct tm* timeptr,
                 char* buf );
```

Arguments:

timeptr A pointer to a **tm** structure that contains the time that you want to convert to a string.

buf (*asctime_r()* only) A buffer in which *asctime_r()* can store the resulting string. This buffer must be large enough to hold at least 26 characters.

Library:

libc

Description:

The *asctime()* and *asctime_r()* functions convert the time information in the structure pointed to by *timeptr* into a string containing exactly 26 characters, in the form:

```
Tue May  7 10:40:27 2002\n\0
```

The *asctime()* function places the result string in a static buffer that's reused every time *asctime()* or *ctime()* is called. The result string for *asctime_r()* is contained in the buffer pointed to by *buf*.

All fields have a constant width. The newline character (**'\n'**) and a NUL character (**'\0'**) occupy the last two positions of the string.

Returns:

A pointer to the character string result, or NULL if an error occurred.

Classification:

asctime() is ANSI; *asctime_r()* is POSIX 1003.1 (Threads)

asctime()

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

asctime_r()

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *asctime()* and *ctime()* functions place their results in a static buffer that's reused for each call to *asctime()* or *ctime()*.

See also:

clock(), *ctime()*, *difftime()*, *gmtime()*, *localtime()*, *localtime_r()*, *mktime()*, *strftime()*, *time()*, `tm`, *tzset()*

asin(), *asinf()*

Compute the arcsine of an angle

Synopsis:

```
#include <math.h>

double asin( double x );

float asinf( float x );
```

Arguments:

x The sine for which you want to find the angle.

Library:

libm

Description:

These functions compute the value of the arcsine (specified in radians) of *x*.

Returns:

The arcsine, in the range (-π/2, π/2).

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", asin(.5) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
0.523599
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

acos(), *atan()*, *atan2()*, *errno*

asinh(), *asinhf()*

Compute the inverse hyperbolic sine

Synopsis:

```
#include <math.h>

double asinh( double x );

float asinhf( float x );
```

Arguments:

x The value for which you want to compute the inverse hyperbolic sine.

Library:

libm

Description:

These functions compute the inverse hyperbolic sine of *x*.

Returns:

The inverse hyperbolic sine (specified in radians) of *x*.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", asinh( 0.5 ) );
    return EXIT_SUCCESS;
}
```

produces the output:

```
0.481212
```

Classification:

asinh() is standard Unix; *asinhf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

acosh(), atanh(), sinh(), errno

assert()

Print a diagnostic message and optionally terminate the program

Synopsis:

```
#include <assert.h>

void assert( int expression );
```

Arguments:

expression	Zero if you want to terminate the program; a nonzero value if you don't.

Library:

libc

Description:

The *assert()* macro prints a diagnostic message on the *stderr* stream, and terminates the program, using *abort()*, if *expression* is false (0).

The diagnostic message includes the *expression*, the name of the source file (the value of __FILE__) and the line number of the failed assertion (the value of __LINE__).

No action is taken if *expression* is true (nonzero).

You typically use the *assert()* macro while developing a program, to identify program logic errors. You should choose the *expression* so that it's true when the program is functioning as intended.

After the program has been debugged, you can use the special "no debug" identifier, NDEBUG, to remove calls to *assert()* from the program when it's recompiled. If you use the **-D** option to **qcc** or a **#define** directive to define NDEBUG (with any value), the C preprocessor ignores all *assert()* calls in the program source.

To remove the calls to *assert()*, you must define NDEBUG in the code *before* including the **<assert.h>** header file (i.e. **#include <assert.h>**).

If you define NDEBUG, the preprocessor also ignores the expression you pass to *assert()*. For example, if your code includes:

```
assert((fd = open("filename", O_RDWR)) != -1);
```

and you define NDEBUG, the preprocessor ignores the entire call to *assert()*, including the call to *open()*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <assert.h>

void process_string( char *string )
{
    /* use assert to check argument */
    assert( string != NULL );
    assert( *string != '\0' );
    /* rest of code follows here */
}

int main( void )
{
    process_string( "hello" );
    process_string( "" );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

assert() is a macro.

See also:

abort(), *stderr*

atan(), atanf()

Compute the arctangent of an angle

Synopsis:

```
#include <math.h>

double atan( double x );

float atanf( float x );
```

Arguments:

x The tangent for which you want to find the angle.

Library:

libm

Description:

These functions compute the arctangent (specified in radians) of *x*.

Returns:

The arctangent, in the range $(-\pi/2, \pi/2)$.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", atan(.5) );
    return EXIT_SUCCESS;
}
```

produces the output:

```
0.463648
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

acos(), asin(), atan2()

atan2(), atan2f()

Compute the arctangent, determining the quadrant

Synopsis:

```
#include <math.h>

double atan2( double y,
              double x );

float atan2f( float y,
              float x );
```

Arguments:

x, *y* The value (*y*/*x*) for which you want to find the angle.

Library:

libm

Description:

These functions compute the value of the arctangent (specified in radians) of *y*/*x*, using the signs of both arguments to determine the quadrant of the return value. A domain error occurs if both arguments are zero.

Returns:

The arctangent of *y*/*x*, in the range (-π, π).

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>
```

```
int main( void )
{
    printf( "%f\n", atan2( .5, 1. ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
0.463648
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

acos(), asin(), atan(), errno

atanh(), atanhf()

Compute an inverse hyperbolic tangent

Synopsis:

```
#include <math.h>

double atanh( double x );

float atanhf( float x );
```

Arguments:

x The value for which you want to compute the inverse hyperbolic tangent.

Library:

libm

Description:

These functions compute the inverse hyperbolic tangent (specified in radians) of *x*.

Returns:

The inverse hyperbolic tangent of *x*.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", atanh( 0.5 ) );
    return EXIT_SUCCESS;
}
```

produces the output:

```
0.549306
```

Classification:

atanh() is standard Unix; *atanhf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

acosh(), asinh(), errno, tanh()

atexit()

Register functions to be called during normal program termination

Synopsis:

```
#include <stdlib.h>

int atexit( register void (*func)(void) );
```

Arguments:

func A pointer to the function you want to be called when the program terminates normally. This function has no arguments and doesn't return a value; its prototype should be:

```
void func( void );
```

Library:

libc

Description:

The *atexit()* function registers a function to be called when the program terminates normally. If you register more than one function with *atexit()*, they're executed in a "last-in, first-out" order. Normal termination occurs either by a call to *exit()* or a return from *main()*.

You can register a total of 32 functions with *atexit()*.

☞ The functions registered with *atexit()* aren't called when the program terminates with a call to *_exit()*.

Returns:

0 for success, or nonzero if an error occurs.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

void func1( void )
{
    printf( "last.\n" );
}

void func2( void )
{
    printf( "this " );
}

void func3( void )
{
    printf( "Do " );
}

int main( void )
{
    atexit( func1 );
    atexit( func2 );
    atexit( func3 );

    printf( "Do this first.\n" );

    return EXIT_SUCCESS;
}
```

produces the output:

```
Do this first.
Do this last.
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

abort(), *_exit()*, *exit()*

atof()

Convert a string into a **double**

Synopsis:

```
#include <stdlib.h>

double atof( const char* ptr );
```

Arguments:

ptr A pointer to the string to parse.

Library:

libc

Description:

The *atof()* function converts the string pointed to by *ptr* to a **double**. Calling it is equivalent to calling *strtod()* like this:

```
strtod( ptr, (char**)NULL )
```

Returns:

The converted **double**, or **0.0** if an error occurs.

Errors:

If an error occurs, *errno* is set to ERANGE.

Examples:

```
#include <stdlib.h>
#include <stdio.h>

int main( void )
{
    double x;

    x = atof( "3.1415926" );
    printf( "x = %f\n", x );
    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, sscanf(), strtod()

atoh()

Convert a string containing a hexadecimal number into an unsigned number

Synopsis:

```
#include <stdlib.h>

unsigned atoh( const char* ptr );
```

Arguments:

ptr A pointer to the string to parse.

Library:

libc

Description:

The *atoh()* function converts the string pointed to by *ptr* to **unsigned** representation, assuming the string contains a hexadecimal (base 16) number.

Returns:

The converted value.

Examples:

```
#include <stdlib.h>
#include <stdio.h>

int main( void )
  {
    unsigned x;

    x = atoh( "F1A6" );
    printf( "number is %x\n", x );
    return EXIT_SUCCESS;
  }
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

sscanf()

atoi()

Convert a string into an integer

Synopsis:

```
#include <stdlib.h>

int atoi( const char* ptr );
```

Arguments:

ptr A pointer to the string to parse.

Library:

libc

Description:

The *atoi()* function converts the string pointed to by *ptr* to an **int**.

Returns:

The converted integer.

Examples:

```
#include <stdlib.h>
#include <stdio.h>

int main( void )
{
    int x;

    x = atoi( "-289" );
    printf( "x = %d\n", x );
    return EXIT_SUCCESS;
}
```

produces the output:

```
x = -289
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atol(), itoa(), ltoa(), sscanf(), strtol(), strtoul(), ultoa(), utoa()

atol(), *atoll()*

Convert a string into a long integer

Synopsis:

```
#include <stdlib.h>

long atol( const char* ptr );

int64_t atoll( const char* ptr );
```

Arguments:

ptr A pointer to the string to parse.

Library:

libc

Description:

The *atol()* function converts the string pointed to by *ptr* to a **long** integer; *atoll()* converts the string pointed to by *nptr* to an **int64_t** (**long long**) integer.

Returns:

atol() A **long** integer.

atoll() An **int64_t** integer.

Examples:

```
#include <stdlib.h>
#include <stdio.h>

int main( void )
{
    long x;

    x = atol( "-289" );
    printf( "x = %d\n", x );
    return EXIT_SUCCESS;
}
```

produces the output:

```
x = -289
```

Classification:

atol() is ANSI; *atoll()* is Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atoi(), itoa(), ltoa(), sscanf(), strtol(), strtoul(), ultoa(), utoa()

atomic_add()

Safely add to a variable

Synopsis:

```
#include <atomic.h>

void atomic_add( volatile unsigned * loc,
                 unsigned incr );
```

Arguments:

loc A pointer to the value that you want to add to.

incr The number that you want to add.

Library:

libc

Description:

The *atomic_add()* function is a thread-safe way of doing an **(*loc) += incr** operation, even in a symmetric-multiprocessing system.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

Examples:

To safely increment a counter shared between multiple threads:

```
#include <atomic.h>
...

volatile unsigned count;
...
```

```
atomic_add( &count, 1 );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add_value(), *atomic_clr()*, *atomic_clr_value()*, *atomic_set()*, *atomic_set_value()*, *atomic_sub()*, *atomic_sub_value()*, *atomic_toggle()*, *atomic_toggle_value()*

atomic_add_value()

Safely add to a variable, returning the previous value

Synopsis:

```
#include <atomic.h>

unsigned atomic_add_value( volatile unsigned * loc,
                           unsigned incr );
```

Arguments:

loc A pointer to the value that you want to add to.

incr The number that you want to add.

Library:

libc

Description:

The *atomic_add_value()* function is a thread-safe way of doing an **(*loc) += incr** operation, even in a symmetric-multiprocessing system.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are also useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

The *atomic_add_value()* function may be slower than *atomic_add()*.

Returns:

The previous value of *loc*'s contents.

Examples:

To safely increment a counter shared between multiple threads:

```
#include <atomic.h>
...

volatile unsigned count;
unsigned previous;
...

previous = atomic_add_value( &count, 1 );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), *atomic_clr()*, *atomic_clr_value()*, *atomic_set()*, *atomic_set_value()*, *atomic_sub()*, *atomic_sub_value()*, *atomic_toggle()*, *atomic_toggle_value()*

atomic_clr()

Safely clear a variable

Synopsis:

```
#include <atomic.h>

void atomic_clr( volatile unsigned * loc,
                 unsigned bits );
```

Arguments:

loc A pointer to the value that you want to clear bits in.

bits The bits that you want to clear.

Library:

libc

Description:

The *atomic_clr()* function is a thread-safe way of doing an **(*loc) &= ~bits** operation.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread, even in a symmetric-multiprocessing system.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are also useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

Examples:

To safely clear the **0x10101010** bits in a flag:

```
#include <atomic.h>
...

volatile unsigned flags;
...
```

```
atomic_clr( &flags, 0x10101010 );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), *atomic_add_value()*, *atomic_set()*, *atomic_set_value()*, *atomic_sub()*, *atomic_sub_value()*, *atomic_toggle()*, *atomic_toggle_value()*

atomic_clr_value()

Safely clear a variable, returning the previous value

Synopsis:

```
#include <atomic.h>

unsigned atomic_clr_value( volatile unsigned * loc,
                           unsigned bits );
```

Arguments:

loc A pointer to the value that you want to clear bits in.

bits The bits that you want to clear.

Library:

libc

Description:

The *atomic_clr_value()* function is a thread-safe way of doing an **(*loc) &= ~bits** operation.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread, even in a symmetric-multiprocessing system.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are also useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

The *atomic_clr_value()* function may be slower than *atomic_clr()*.

Returns:

The previous value of *loc*'s contents.

Examples:

To safely clear the `0x10101010` bits in a flag:

```
#include <atomic.h>
...

volatile unsigned flags;
unsigned previous;
...

previous = atomic_clr_value( &flags, 0x10101010 );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), *atomic_add_value()*, *atomic_clr()*, *atomic_set()*, *atomic_set_value()*, *atomic_sub()*, *atomic_sub_value()*, *atomic_toggle()*, *atomic_toggle_value()*

atomic_set()

Safely set bits in a variable

Synopsis:

```
#include <atomic.h>

void atomic_set( volatile unsigned * loc,
                 unsigned bits );
```

Arguments:

loc A pointer to the location whose bits you want to toggle.

bits The bits that you want to set.

Library:

libc

Description:

The *atomic_set()* function is a thread-safe way of doing an **(*loc) |= bits** operation.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread, even in a symmetric-multiprocessing system.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are also useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

Examples:

To safely set the 1 bit in a flag:

```
#include <atomic.h>
...

volatile unsigned flags;
...
```

```
atomic_set( &flags, 0x01 );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), *atomic_add_value()*, *atomic_clr()*, *atomic_clr_value()*, *atomic_sub()*, *atomic_sub_value()*, *atomic_toggle()*, *atomic_toggle_value()*

atomic_set_value()

Safely set bits in a variable, returning the previous value

Synopsis:

```
#include <atomic.h>

unsigned atomic_set_value( volatile unsigned * loc,
                           unsigned bits );
```

Arguments:

loc A pointer to the location whose bits you want to toggle.

bits The bits that you want to set.

Library:

libc

Description:

The *atomic_set_value()* function is a thread-safe way of doing an **(*loc) |= bits** operation.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread, even in a symmetric-multiprocessing system.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are also useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

The *atomic_set_value()* function may be slower than *atomic_set()*.

Returns:

The previous value of *loc*'s contents.

Examples:

To safely set the 1 bit in a flag:

```
#include <atomic.h>
...

volatile unsigned flags;
unsigned previous;
...

previous = atomic_set_value( &flags, 0x01 );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), *atomic_add_value()*, *atomic_clr()*, *atomic_clr_value()*, *atomic_set()*, *atomic_sub()*, *atomic_sub_value()*, *atomic_toggle()*, *atomic_toggle_value()*

atomic_sub()

Safely subtract from a variable

Synopsis:

```
#include <atomic.h>

void atomic_sub( volatile unsigned * loc,
                 unsigned decr );
```

Arguments:

loc A pointer to the value that you want to subtract from.

decr The number that you want to subtract.

Library:

libc

Description:

The *atomic_sub()* function is a thread-safe way of doing a **(*loc) -= decr** operation, even in a symmetric-multiprocessing system.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are also useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

Examples:

Safely subtract 1 from a counter:

```
#include <atomic.h>
...

volatile unsigned count;
...
```

```
atomic_sub( &count, 1 );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), *atomic_add_value()*, *atomic_clr()*, *atomic_clr_value()*, *atomic_set()*, *atomic_set_value()*, *atomic_sub_value()*, *atomic_toggle()*, *atomic_toggle_value()*

atomic_sub_value()

Safely subtract from a variable, returning the previous value

Synopsis:

```
#include <atomic.h>

unsigned atomic_sub_value( volatile unsigned * loc,
                           unsigned decr );
```

Arguments:

loc A pointer to the value that you want to subtract from.

decr The number that you want to subtract.

Library:

libc

Description:

The *atomic_sub_value()* function is a thread-safe way of doing a **(*loc) -= decr** operation, even in a symmetric-multiprocessing system.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are also useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

The *atomic_sub_value()* function may be slower than *atomic_sub()*.

Returns:

The previous value of *loc*'s contents.

Examples:

Safely subtract 1 from a counter:

```
#include <atomic.h>
...

volatile unsigned count;
unsigned previous;
...

previous = atomic_sub_value( &count, 1 );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), *atomic_add_value()*, *atomic_clr()*, *atomic_clr_value()*, *atomic_set()*, *atomic_set_value()*, *atomic_sub()*, *atomic_toggle()*, *atomic_toggle_value()*

atomic_toggle()

Safely toggle a variable

Synopsis:

```
#include <atomic.h>

void atomic_toggle( volatile unsigned * loc,
                    unsigned bits );
```

Arguments:

loc A pointer to the location whose bits you want to toggle.

bits The bits that you want to change.

Library:

libc

Description:

The *atomic_toggle()* function is a thread-safe way of doing an **(*loc) ^= bits** operation.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread, even in a symmetric-multiprocessing system.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are also useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

Examples:

To safely toggle the **0xdeadbeef** bits in a flag:

```
#include <atomic.h>
...

volatile unsigned flags;
...
```

```
atomic_toggle( &flags, 0xdeadbeef );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), *atomic_add_value()*, *atomic_clr()*, *atomic_clr_value()*, *atomic_set()*, *atomic_set_value()*, *atomic_sub()*, *atomic_sub_value()*, *atomic_toggle_value()*

atomic_toggle_value()

Safely toggle a variable, returning the previous value

Synopsis:

```
#include <atomic.h>

unsigned atomic_toggle_value(
            volatile unsigned * loc,
            unsigned bits );
```

Arguments:

loc A pointer to the location whose bits you want to toggle.

bits The bits that you want to change.

Library:

libc

Description:

The *atomic_toggle_value()* function is a thread-safe way of doing an **(*loc) ^= bits** operation.

The *atomic_*()* functions are guaranteed to complete without being preempted by another thread, even in a symmetric-multiprocessing system.

When modifying a variable shared between a thread and an interrupt, you *must* either disable interrupts or use the *atomic_*()* functions.

The *atomic_*()* functions are also useful for modifying variables that are referenced by more than one thread (that aren't necessarily in the same process) without having to use a mutex.

The *atomic_toggle_value()* function may be slower than *atomic_toggle()*.

Returns:

The previous value of *loc*'s contents.

Examples:

To safely toggle the **0xdeadbeef** bits in a flag:

```
#include <atomic.h>
...

volatile unsigned flags;
unsigned previous;
...

previous = atomic_toggle_value( &flags, 0xdeadbeef );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), *atomic_add_value()*, *atomic_clr()*, *atomic_clr_value()*, *atomic_set()*, *atomic_set_value()*, *atomic_sub()*, *atomic_sub_value()*, *atomic_toggle()*

A pointer to a vector of auxiliary arguments to main()

Synopsis:

```
auxv_t * _auxv;
```

Description:

This global variable holds a pointer to a vector of auxiliary arguments to *main()*. For more information, see **<sys/auxv.h>**.

This variable isn't defined in any header file. If you want to refer to it, you need to add your own **extern** statement.

Classification:

QNX Neutrino

See also:

_argc, *_argv*, *getopt()*, *main()*

basename()

Find the part of a string after the last slash (/)

Synopsis:

```
#include <libgen.h>

char* basename( char* path );
```

Arguments:

path The string to parse.

Library:

libc

Description:

The *basename()* function takes the pathname pointed to by *path* and returns a pointer to the final component of the pathname, deleting any trailing "/" characters.

The *basename()* function returns:

A pointer to the string "/"
: If the string consists entirely of the "/" character

A pointer to the string "."
: If *path* is a NULL pointer, or points to an empty string

The *basename()* function modifies the string pointed to by *path*, and returns a pointer to static storage.

Returns:

A pointer to the final component of *path*.

Examples:

```
#include <stdio.h>
#include <libgen.h>
#include <stdlib.h>

int main( int argc, char** argv )
{
        int x;

        for( x = 1; x < argc; x++ ) {
                printf( "%s\n", basename( argv[x] ) );
        }

        return EXIT_SUCCESS;
}
```

The table below shows the output of the program, given the input:

Input	Output
"/usr/lib"	"lib"
"/usr/"	"usr"
"/"	"/"

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

dirname()

bcmp()

Compare a given number of characters in two strings

Synopsis:

```
#include <strings.h>

int bcmp( const void *s1,
          const void *s2,
          size_t n );
```

Arguments:

s1, *s2*	The strings you want to compare.
n	The number of bytes to compare.

Library:

libc

Description:

The *bcmp()* function compares the byte string pointed to by *s1* to the string pointed to by *s2*. The number of bytes to compare is specified by *n*. NUL characters may be included in the comparison.

This function is similar to the ANSI *memcmp()* function, but tests only for equality. New code should use the ANSI function.

Returns:

0	The byte strings are identical.
1	The byte strings aren't identical.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <string.h>

int main( void )
  {
```

```
  if( bcmp( "Hello there", "Hello world", 6 ) ) {
    printf( "Not equal\n" );
  } else {
    printf( "Equal\n" );
  }
  return EXIT_SUCCESS;
}
```

produces the output:

```
Equal
```

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

bcopy(), bzero(), memcmp(), strcmp()

bcopy()

Copy a number of characters in one string to another

Synopsis:

```
#include <strings.h>

void bcopy( const void *src,
            void *dst,
            size_t n );
```

Arguments:

src	The string you want to copy.
dst	An existing array into which you want to copy the string.
n	The number of bytes to copy.

Library:

libc

Description:

The *bcopy()* function copies the byte string pointed to by *src* (including any NUL characters) into the array pointed to by *dst*. The number of bytes to copy is specified by *n*. Copying of overlapping objects is guaranteed to work properly.

This function is similar to the ANSI *memmove()* function, but the order of arguments is different. New code should use the ANSI function.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <string.h>

int main( void )
  {
    auto char buffer[80];
```

```
    bcopy( "Hello ", buffer, 6 );
    bcopy( "world",  &buffer[6], 6 );
    printf( "%s\n", buffer );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
Hello world
```

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

bcmp(), *bzero()*, *memmove()*, *strcpy()*

bind()

Bind a name to a socket

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

int bind( int s,
          const struct sockaddr * name,
          socklen_t namelen );
```

Arguments:

s	The file descriptor to be bound.
name	A pointer to the **sockaddr** structure that holds the address to be bound to the socket. The socket length and format depend upon its address family.
namelen	The length of the **sockaddr** structure pointed to by *name*.

Library:

libsocket

Description:

When a socket is created with *socket()*, it exists in a namespace (address family) but has no name assigned to it. The *bind()* function assigns a name to that unnamed socket.

The *bind()* function assigns a local address. Use *connect()* to assign a remote address.

The rules used for binding names vary between communication domains.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES The requested address is protected, and the current user has inadequate permission to access it.

EADDRINUSE
The specified address is already in use.

EADDRNOTAVAIL
The specified address isn't available from the local machine.

EBADF Invalid descriptor *s*.

EFAULT The *name* parameter isn't in a valid part of the user address space.

EINVAL The socket is already bound to an address.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ICMP, IP, TCP, and UDP protocols

connect(), *getsockname()*, *listen()*, *socket()*

bindresvport()

Bind a socket to a privileged IP port

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>

int bindresvport( int sd,
                  struct sockaddr_in * sin );
```

Arguments:

sd The socket descriptor to bind to the port.

sin A pointer to a **sockaddr_in** structure that specifies the privileged IP port.

Library:

libsocket

Description:

The *bindresvport()* function binds a socket descriptor to a privileged IP port (i.e. a port number in the range 0-1023).

Only **root** can bind to a privileged port; this call fails for any other user.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES You must be **root** to call *bindresvport()*.

EADDRINUSE

The specified address is already in use.

EADDRNOTAVAIL
: The specified address isn't available from the local machine.

EBADF
: Invalid descriptor *sd*.

EFAULT
: The *sin* parameter isn't a valid pointer to a **sockaddr_in** structure.

EINVAL
: The socket is already bound to a port.

EPFNOSUPPORT
: The protocol family isn't supported.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

connect(), getsockname(), listen(), socket()

Change the amount of space allocated for the calling process's data segment

Synopsis:

```
#include <unistd.h>

int brk( void* endds );
```

Arguments:

endds A pointer to the new end of the data segment.

Library:

libc

Description:

The *brk()* function is used to change dynamically the amount of space allocated for the calling process's data segment (see the *exec** functions).

The change is made by resetting the process's break value and allocating the appropriate amount of space. The break value is the address of the first location beyond the end of the data segment. The amount of allocated space increases as the break value increases. Newly allocated space is set to zero. If, however, the same memory space is reallocated to the same process, its contents are undefined.

When a program begins execution using *execve()*, the break is set at the highest location defined by the program and data storage areas.

You can call *getrlimit()* to determine the maximum permissible size of the data segment; it isn't possible to set the break beyond the *rlim_max* value returned from *getrlimit()*, i.e:

```
end + rlim.rlim_max
```

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

ENOMEM This could mean:

- The data segment size limit, as set by *setrlimit()*, would be exceeded.
- The maximum possible size of a data segment (compiled into the system) would be exceeded.
- Insufficient space exists in the swap area to support the expansion.
- Out of address space; the new break value would extend into an area of the address space defined by some previously established mapping (see *mmap()*).

EAGAIN The total amount of system memory available for private pages is temporarily insufficient. This may occur even though the space requested was less than the maximum data segment size.

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The behavior of *brk()* is unspecified if an application also uses any other memory functions (such as *malloc()*, *mmap()*, *free()*). The *brk()* function has been used in specialized cases where no other memory allocation function provided the same capability. Use *mmap()* instead because it can be used portably with all other memory allocation functions and with any function that uses other allocation functions.

The value of the argument to *brk()* is rounded up for alignment with eight-byte boundaries.

Setting the break may fail due to a temporary lack of swap space. It isn't possible to distinguish this from a failure caused by exceeding the maximum size of the data segment without consulting *getrlimit()*.

See also:

_btext, *_edata*, *_end*, *_etext*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *free()*, *getrlimit()*, *malloc()*, *mmap()*, *sbrk()*

bsearch()

Perform a binary search on a sorted array

Synopsis:

```
#include <stdlib.h>

void *bsearch( const void *key,
               const void *base,
               size_t num,
               size_t width,
               int (*compar)( const void *pkey,
                              const void *pbase) );
```

Arguments:

key	The object to search for.
base	A pointer to the first element in the array.
num	The number of elements in the array.
width	The size of an element, in bytes.
compare	A pointer to a user-supplied function that *lfind()* calls to compare an array element with the *key*. The arguments to the comparison function are: • *pkey* — the same pointer as *key* • *pbase* — a pointer to an element in the array. The comparison function must return an integer less than, equal to, or greater than zero if the *key* object is less than, equal to, or greater than the element in the array.

Library:

libc

Description:

The *bsearch()* function performs a binary search on the sorted array of *num* elements pointed to by *base*, for an item that matches the object pointed to by *key*.

Returns:

A pointer to a matching member of the array, or NULL if a matching object couldn't be found.

☞ If there are multiple values in the array that match the *key*, the return value could be any of these duplicate values.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

static const char *keywords[] = {
    "auto",
    "break",
    "case",
    "char",
/*  ... */
    "while"
  };

#define NUM_KW    sizeof(keywords) / sizeof(char *)

int kw_compare( const void *p1, const void *p2 )
{
    const char *p1c = (const char *) p1;
    const char **p2c = (const char **) p2;

    return( strcmp( p1c, *p2c ) );
}

int keyword_lookup( const char *name )
{
    const char **key;

    key = (char const **) bsearch( name, keywords,
           NUM_KW, sizeof( char * ),  kw_compare );
    if( key == NULL ) return( -1 );
```

```
    return key - keywords;
}

int main( void )
{
    printf( "%d\n", keyword_lookup( "case" ) );
    printf( "%d\n", keyword_lookup( "crigger" ) );
    printf( "%d\n", keyword_lookup( "auto" ) );

    return EXIT_SUCCESS;
}
```

This program produces the following output:

```
2
-1
0
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

lfind(), lsearch(), qsort()

Synopsis:

N/A

Description:

This linker symbol defines the beginning of the text segment. This variable isn't defined in any header file.

Classification:

QNX Neutrino

See also:

brk(), *_edata*, *_end*, *_etext*, *sbrk()*

btowc()

Convert a single-byte character to a wide character

Synopsis:

```
#include <wchar.h>

wint_t btowc( int c );
```

Arguments:

c The single-byte character that you want to convert.

Library:

libc

Description:

The *btowc()* function converts the given character (if it's a valid one-byte character in the initial shift state) into a wide character.

This function is the single-byte version of *mbtowc()*.

Returns:

The wide-character representation of the character, or WEOF if *c* has the value EOF or (**unsigned char**) *c* isn't a valid one-byte character in the initial conversion state.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

bzero()

Set the first part of an object to null bytes

Synopsis:

```
#include <strings.h>

void bzero( void *dst,
            size_t n );
```

Arguments:

dst An existing object that you want to fill with zeroes.

n The number of bytes to fill.

Library:

libc

Description:

The *bzero()* function fills the first *n* bytes of the object pointed to by *dst* with zero (NUL) bytes.

This function is similar to the ANSI *memset()* function. New code should use the ANSI function.

Examples:

```
#include <stdlib.h>
#include <string.h>

int main( void )
  {
    char buffer[80];

    bzero( buffer, 80 );
    return EXIT_SUCCESS;
  }
```

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

bcmp(), bcopy(), memset(), strset()

cabs(), *cabsf()*

Compute the absolute value of a complex number

Synopsis:

```
#include <math.h>

struct __cabsargs {
    double  x;   /* real part      */
    double  y;   /* imaginary part */
};

double cabs( struct __cabsargs value );

struct __cabsfargs {
    float  x;   /* real part      */
    float  y;   /* imaginary part */
};

float cabsf( struct __cabsfargs value );
```

Arguments:

value The complex value that you want to get the absolute value of.

Library:

libm

Description:

These functions compute the absolute value of the complex number specified by *value*, using a calculation equivalent to:

```
sqrt( ( value.x * value.x ) + ( value.y * value.y ) );
```

Returns:

The absolute value of *value*.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

struct __cabsargs c = { -3.0, 4.0 };

int main( void )
{
    printf( "%f\n", cabs( c ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
5.000000
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abs(), fabs(), labs()

calloc()

Allocate space for an array

Synopsis:

```
#include <stdlib.h>

void* calloc ( size_t n,
               size_t size );
```

Arguments:

n	The number of array elements to allocate.
size	The size, in bytes, of one array element.

Library:

libc

Description:

The *calloc()* function allocates space from the heap for an array of *n* objects, each of *size* bytes, and initializes them to 0.

A block of memory allocated with the *calloc()* function should be freed using the *free()* function.

Returns:

A pointer to the start of the allocated memory, or NULL if an error occurred (*errno* is set).

Errors:

ENOMEM	Not enough memory.
EOK	No error.

Examples:

```
#include <stdlib.h>
#include <stdio.h>

int main( void )
{
    char* buffer;

    buffer = (char* )calloc( 80, sizeof(char) );
    if( buffer == NULL ) {
        printf( "Can't allocate memory for buffer!\n" );
        return EXIT_FAILURE;
    }

    free( buffer );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

free(), malloc(), realloc(), sbrk()

cbrt(), *cbrtf()*

Compute the cube root of a number

Synopsis:

```
#include <math.h>

double cbrt ( double x );

float cbrtf ( float x );
```

Arguments:

x The number whose cube root you want to calculate.

Library:

libm

Description:

The *cbrt()* and *cbrtf()* functions compute the cube root of *x*.

Returns:

The cube root of *x*. If *x* is NAN, *cbrt()* returns NAN.

Examples:

```
#include <stdio.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv) {
        double a, b;

        a = 27.0;
        b = cbrt(a);
        printf("The cube root of %f is %f \n", a, b);

        return(0);
}
```

produces the output:

```
The cube root of 27.000000 is 3.000000
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

sqrt()

ceil(), *ceilf()*

Round up a value to the next integer

Synopsis:

```
#include <math.h>

double ceil( double x );

float ceilf( float x );
```

Arguments:

x The value you want to round.

Library:

libm

Description:

The *ceil()* and *ceilf()* functions round the value of *x* up to the next integer (rounding towards the "ceiling").

Returns:

The smallest integer ≥ *x*.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f %f %f %f %f\n", ceil( -2.1 ),
      ceil( -2. ), ceil( 0.0 ), ceil( 2. ),
      ceil( 2.1 ) );
```

```
    return EXIT_SUCCESS;
}
```

produces the output:

```
-2.000000 -2.000000 0.000000 2.000000 3.000000
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

floor()

cfmakeraw()

Set terminal attributes

Synopsis:

```
#include <termios.h>

int cfmakeraw( struct termios * termios_p );
```

Arguments:

termios_p	A pointer to a **termios** structure that describes the terminal's control attributes.

Library:

libc

Description:

The *cfmakeraw()* function sets the terminal attributes as follows:

```
termios_p->c_iflag &= ~(IGNBRK|BRKINT|PARMRK|ISTRIP|INLCR|IGNCR|ICRNL|IXON);
termios_p->c_oflag &= ~OPOST;
termios_p->c_lflag &= ~(ECHO|ECHONL|ICANON|ISIG|IEXTEN);
termios_p->c_cflag &= ~(CSIZE|PARENB);
termios_p->c_cflag |= CS8;
```

You can get a valid **termios** control structure for an opened device by calling *tcgetattr()*.

Returns:

0	Success.
-1	An error occurred (*errno* indicates the reason).

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *cfgetispeed()*, *cfgetospeed()*, *cfsetispeed()*, *cfsetospeed()*, *tcgetattr()*, *tcsetattr()*, **`termios`**

cfgetispeed()

Return the input baud rate that's stored in a **termios** *structure*

Synopsis:

```
#include <termios.h>

speed_t cfgetispeed(
            const struct termios* termios_p );
```

Arguments:

termios_p	A pointer to a **termios** structure that describes the terminal's control attributes.

Library:

libc

Description:

The *cfgetispeed()* function returns the input baud rate that's stored in the **termios** structure pointed to by *termios_p*.

You can get a valid **termios** control structure for an opened device by calling *tcgetattr()*.

Returns:

The input baud rate stored in **termios_p*, or -1 if an error occurs (*errno* is set).

Errors:

EINVAL	One of the arguments is invalid.
ENOTTY	This function isn't supported by the system.

Examples:

```
#include <termios.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>
#include <stdio.h>
```

```
int main( void )
  {
    int fd;
    struct termios termios_p;
    speed_t speed;

    fd = open( "/dev/ser1", O_RDWR );
    tcgetattr( fd, &termios_p);

    /*
     *  Get input baud rate
     */
    speed = cfgetispeed( &termios_p);
    printf( "Input baud: %ld\n", speed );

    close( fd );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *cfgetospeed()*, *cfsetispeed()*, *cfsetospeed()*, *tcgetattr()*, *tcsetattr()*, **termios**

cfgetospeed()

Return the output baud rate that's stored in a **termios** *structure*

Synopsis:

```
#include <termios.h>

speed_t cfgetospeed(
            const struct termios* termios_p );
```

Arguments:

termios_p	A pointer to a **termios** structure that describes the terminal's control attributes.

Library:

libc

Description:

The *cfgetospeed()* function returns the output baud rate that's stored in the **termios** structure pointed to by *termios_p*.

You can get a valid **termios** control structure for an opened device by calling *tcgetattr()*.

Returns:

The output baud rate stored in **termios_p*, or -1 if an error occurs (*errno* is set).

Errors:

EINVAL	One of the arguments is invalid.
ENOTTY	This function isn't supported by the system.

Examples:

```
#include <termios.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>
#include <stdio.h>
```

```
int main( void )
  {
    int fd;
    struct termios termios_p;
    speed_t speed;

    fd = open( "/dev/ser1", O_RDWR );
    tcgetattr( fd, &termios_p);

    /*
     *  Get output baud rate
     */
    speed = cfgetospeed( &termios_p);
    printf( "Output baud: %ld\n", speed );

    close( fd );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *cfgetispeed()*, *cfsetispeed()*, *cfsetospeed()*, *tcgetattr()*, *tcsetattr()*, **termios**

cfgopen()

Open a configuration file

Synopsis:

```
#include <cfgopen.h>

int cfgopen( const char * path,
             unsigned flags,
             const char * historical,
             char * namebuf,
             int nblen );
```

Arguments:

path	The name of the configuration file that you want to open.
flags	Flags that control the opening; see below.
historical	A optional file to open as a last resort if none of the criteria for finding the path is met. This string works like a path search order, and lets you search more than one location. You can also specify **%H** to substitute the hostname value into the string. Specify NULL to ignore this option.
namebuf	A buffer to save the pathname in. Specify NULL to ignore this option.
nblen	The length of the buffer pointed to by *namebuf*. Specify 0 to ignore this option.

Library:

libc

Description:

The *cfgopen()* function opens the configuration file named by *path*. This function is a cover function for *open()* that searches several default system locations for your files, based on specified characteristics.

The value of *flags* correspond to, and have similar limitations of, the standard *open()* flags. The *flags* value is constructed by the bitwise ORing of values from the following list, defined in the **<cfgopen.h>** header file. Applications must specify exactly one of these file-access modes in the value of *flag*:

CFGFILE_RDONLY

Open for reading only.

CFGFILE_RDWR

Open for reading and writing.

CFGFILE_WRONLY

Open for writing only.

You can also include any combination of these bits in the value of *flag*:

CFGFILE_APPEND

If set, the file offset is set to the end of the file prior to each write.

CFGFILE_CREAT

If the file doesn't exist, it's created with mode 0644, the file's user ID is set to the effective user ID of the process, and the group ID is set to the effective group ID of the process or the group ID of the file's parent directory (see *chmod()*).

CFGFILE_EXCL

If CFGFILE_EXCL and CFGFILE_CREAT are set, and the file exists, *cfgopen()* fails. The check for the existence of the file and the creation of the file if it doesn't exist is atomic with respect to other processes attempting the same operation with the same filename. Specifying CFGFILE_EXCL without CFGFILE_CREAT has no effect.

CFGFILE_TRUNC

If the file exists and is a regular file, and the file is successfully opened CFGFILE_WRONLY or CFGFILE_RDWR, the file length

is truncated to zero and the mode and owner are left unchanged. CFGFILE_TRUNC has no effect on FIFO or block or character special files or directories. Using CFGFILE_TRUNC with CFGFILE_RDONLY has no effect.

Search condition flags

In order to hint to the function where it should access or construct (in the case of CFGFILE_CREAT) *path*, there are several bits that you can specify and OR into *flags*. When specified, the bits are accessed using the following search order:

1. CFGFILE_USER_NODE

   `$HOME/.cfg/`*node_name*`/`*path*

2. CFGFILE_USER

   `$HOME/.cfg/`*path*

3. CFGFILE_NODE

   `/etc/host_cfg/`*node_name*`/`*path*

4. CFGFILE_GLOBAL

   path

where *node_name* is the value you get by calling *confstr()* for CS_HOSTNAME.

If the directory **`/etc/host_cfg`** doesn't exist on the system, the following *flags* are transformed automatically:

- CFGFILE_USER_NODE becomes CFGFILE_USER
- CFGFILE_NODE becomes CFGFILE_GLOBAL

When creating a file or opening a file for writing, you can specify only one of the above location flags. Set CFGFILE_NOFD when you need only the pathname, not the file descriptor. If a directory path doesn't exist when a file is opened for creation, *cfgopen()* attempts to create the path.

Returns:

A valid file descriptor if CFGFILE_NOFD isn't specified, a nonnegative value if CFGFILE_NOFD is specified, or -1 if an error occurs.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

confstr(), *fcfgopen()*, *open()*

mib.txt, **snmpd.conf** in the *Utilities Reference*

cfree()

Free allocated memory

Synopsis:

```
#include <malloc.h>

int cfree( void *ptr );
```

Arguments:

ptr A pointer to the block of memory that you want to free. It's safe to call *cfree()* with a NULL pointer.

Library:

libc

Description:

The *cfree()* function deallocates the memory block specified by *ptr*, which was previously returned by a call to *calloc()*, *malloc()* or *realloc()*.

Returns:

1

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

Calling *cfree()* on a pointer already deallocated by a call to *cfree()*, *free()*, or *realloc()* could corrupt the memory allocator's data structures.

See also:

alloca(), *calloc()*, *free()*, *malloc()*, *realloc()*, *sbrk()*

cfsetispeed()

Set the input baud rate in a **termios** *structure*

Synopsis:

```
#include <termios.h>

int cfsetispeed( struct termios* termios_p,
                 speed_t speed );
```

Arguments:

termios_p	A pointer to a **termios** structure that describes the terminal's control attributes.
speed	The new speed. Valid values for *speed* are defined in **<termios.h>**.

Library:

libc

Description:

The *cfsetispeed()* function sets the input baud rate within the **termios** structure pointed to by *termios_p* to be *speed*.

You can get a valid **termios** control structure for an opened device by calling *tcgetattr()*.

- The new baud rate isn't effective until you call *tcsetattr()* with this modified **termios** structure.
- Attempts to set baud rates to values that aren't supported by the hardware are ignored, and cause *tcsetattr()* to return an error, but *cfsetispeed()* doesn't indicate an error.
- Attempts to set input baud rates to a value that's different from the output baud rate, when the hardware doesn't support split baud rates, cause the input baud rate to be ignored, but no error is generated.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EINVAL	One of the arguments is invalid.
ENOTTY	This function isn't supported by the system.

Examples:

```
#include <termios.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {
    int fd;
    struct termios termios_p;
    speed_t speed;

    fd = open( "/dev/ser1", O_RDWR );
    tcgetattr( fd, &termios_p);

    /*
     *    Set input baud rate
```

```
    */
   speed = 9600;
   cfsetispeed( &termios_p, speed );
   tcsetattr( fd, TCSADRAIN, &termios_p);

   close( fd );
   return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *cfgetispeed()*, *cfgetospeed()*, *cfsetospeed()*, *tcgetattr()*, *tcsetattr()*, **termios**

cfsetospeed()

Set the output baud rate in a **termios** *structure*

Synopsis:

```
#include <termios.h>

int cfsetospeed( struct termios *termios_p,
                 speed_t speed );
```

Arguments:

termios_p	A pointer to a **termios** structure that describes the terminal's control attributes.
speed	The new speed. Valid values for *speed* are defined in **<termios.h>**.

Library:

libc

Description:

The *cfsetospeed()* function sets the output baud rate within the **termios** structure pointed to by *termios_p* to be *speed*.

You can get a valid **termios** control structure for an opened device by calling *tcgetattr()*.

☞

- The new baud rate isn't effective until you call *tcsetattr()*, with this modified **termios** structure.
- Attempts to set baud rates to values that aren't supported by the hardware are ignored, and cause *tcsetattr()* to return an error, but *cfsetospeed()* doesn't indicate an error.

Setting the output baud rate to B0 causes the connection to be dropped. If *termios_p* represents a modem, the modem control lines will be turned off.

Returns:

0 Success.

-1 An error occurred (*errno* indicates the reason).

Errors:

EINVAL One of the arguments is invalid.

ENOTTY This function isn't supported by the system.

Examples:

```
#include <termios.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {
    int fd;
    struct termios termios_p;
    speed_t speed;

    fd = open( "/dev/ser1", O_RDWR );
    tcgetattr( fd, &termios_p);

    /*
     *    Set output baud rate
     */
    speed = B9600;
    cfsetospeed( &termios_p, speed );
    tcsetattr( fd, TCSADRAIN, &termios_p);

    close( fd );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *cfgetispeed()*, *cfgetospeed()*, *cfsetispeed()*, *tcgetattr()*, *tcsetattr()*, **termios**

ChannelCreate(), *ChannelCreate_r()*

Create a communications channel

Synopsis:

```
#include <sys/neutrino.h>

int ChannelCreate( unsigned flags );

int ChannelCreate_r( unsigned flags );
```

Arguments:

flags Flags that can be used to request notification pulses from the kernel or request other changes in behavior; a combination of the following:

- _NTO_CHF_COID_DISCONNECT
- _NTO_CHF_DISCONNECT
- _NTO_CHF_FIXED_PRIORITY
- _NTO_CHF_NET_MSG
- _NTO_CHF_REPLY_LEN
- _NTO_CHF_SENDER_LEN
- _NTO_CHF_THREAD_DEATH
- _NTO_CHF_UNBLOCK

For more information, see below.

Library:

libc

Description:

The *ChannelCreate()* and *ChannelCreate_r()* kernel calls create a channel that can be used to receive messages and pulses. Once created, the channel is owned by the process and isn't bound to the creating thread.

These functions are identical, except in the way they indicate errors. See the Returns section for details.

Threads wishing to communicate with the channel attach to it by calling *ConnectAttach()*. The threads may be in the same process, or in another process on the same node (or a remote node if the network manager is running). Once attached, these threads use *MsgSendv()* or *MsgSendPulse()* to enqueue messages and pulses on the channel. Messages and pulses are enqueued in priority order.

To dequeue and read messages and pulses from a channel, use *MsgReceivev()*. Any number of threads may call *MsgReceivev()* at the same time, in which case they block and queue (if no messages or pulses are waiting) for a message or pulse to arrive. A multi-threaded I/O manager typically creates multiple threads and has them all RECEIVE-blocked on the channel.

The return value of *ChannelCreate()* is a channel ID, an **`int`** taken from a channel vector on the process. Most managers use a single channel for most, if not all, their communications with clients. Additional channels can be used as special channels for information.

By default, when a message is received from a channel, the thread priority of the receiver is set to match that of the thread that sent the message. This basic priority inheritance prevents priority inversion. If a message arrives at a channel and there's no thread waiting to receive it, the system boosts (if necessary) all threads in the process that have received a message from the channel in the past. This boost prevents a priority inversion of the client in the case where all threads are currently working on behalf of other clients, perhaps at a lower priority. When a thread is first created, it isn't associated with a channel until it does a *MsgReceivev()* on it. In the case of multiple channels, a thread is associated with the last channel it received from.

After receiving a message, a thread can dissociate itself from the channel by calling *MsgReceivev()* with a -1 for the channel ID. Priority inheritance can be disabled by setting _NTO_CHF_FIXED_PRIORITY in the *flags* argument. In this case a thread's priority isn't be affected by messages it receives on a channel.

A manager typically involves the following loop. There may be one or more threads in the loop at a time. Note that your program (not each thread) should call *ChannelCreate()* only once.

```
iov_t iov;
...
SETIOV( &iov, &msg, sizeof( msg ) );
...
chid = ChannelCreate(flags);
...
for(;;) {
    /*
     Here's a one-part message; you could just as
     easily receive a 20-part message by filling in the
     iov appropriately.
    */
    rcvid = MsgReceivev(chid, &iov, 1, &info);

    /* msg is filled in by MsgReceivev() */
    switch(msg.type) {
        ...
    }

    /* iov could be filled in again to point to a new message */
    MsgReplyv(rcvid, iov, 1);
}
```

Some of the channel flags in the *flags* argument request changes from the default behavior; others request notification pulses from the kernel. The pulses are received by *MsgReceivev()* on the channel and are described by a **_pulse** structure.

The channel flags and (where appropriate) associated values for the pulse's *code* and *value* are described below.

_NTO_CHF_COID_DISCONNECT

Pulse code: _PULSE_CODE_COIDDEATH

Pulse value: Connection ID (*coid*) of a connection that was attached to a destroyed channel.

Deliver a pulse to this channel for each connection that belongs to the calling process when the channel that the connection is attached to is destroyed. Only one channel per process can have this flag set.

If a channel has one or both of _NTO_CHF_COID_DISCONNECT or _NTO_CHF_THREAD_DEATH set, neither flag may be set for any other channel in the process.

_NTO_CHF_DISCONNECT

Pulse code: _PULSE_CODE_DISCONNECT

Pulse value: None

Deliver a pulse when all connections from a process are detached (e.g. *close()*, *ConnectDetach()*, *name_close()*). If a process dies without detaching all its connections, the kernel detaches them from it. When this flag is set, the server must call *ConnectDetach*(*scoid*) where *scoid* is the server connection ID in the pulse message. Failure to do so leaves an invalid server connection ID that can't be reused. Over time, the server may run out of available IDs. If this flag isn't set, the kernel removes the server connection ID automatically, making it available for reuse.

_NTO_CHF_FIXED_PRIORITY

Suppress priority inheritance when receiving messages. Receiving threads won't change their priorities to those of the sending threads.

_NTO_CHF_NET_MSG

Reserved for the **io_net** resource manager.

_NTO_CHF_REPLY_LEN

Request that the length of the reply be included in the *dstmsglen* member of the **_msg_info** structure that *MsgReceivev()* fills in. The *dstmsglen* member is valid only if you set this channel flag when you create the channel.

_NTO_CHF_SENDER_LEN

Request that the length of the source message be included in the *srcmsglen* member of the **_msg_info**, structure that *MsgReceivev()* fills in. The *srcmsglen* member is valid only if you set this channel flag when you create the channel.

_NTO_CHF_THREAD_DEATH

Pulse code: _PULSE_CODE_THREADDEATH

Pulse value: Thread ID (*tid*)

Deliver a pulse on the death of any thread in the process that owns the channel. Only one channel per process can have this flag set.

If a channel has one or both of _NTO_CHF_COID_DISCONNECT or _NTO_CHF_THREAD_DEATH set, neither flag may be set for any other channel in the process.

_NTO_CHF_UNBLOCK

Pulse code: _PULSE_CODE_UNBLOCK

Pulse value: Receive ID (*rcvid*)

In most cases, you'll set the _NTO_CHF_UNBLOCK flag.

Deliver a pulse when a thread that's REPLY-blocked on a channel attempts to unblock before its message is replied to. This occurs between the time of a *MsgReceivev()* and a *MsgReplyv()* by the server. The sending thread may be unblocked because of a signal or a kernel timeout.

If the sending thread unblocks, *MsgReplyv()* fails. The manager may not be in a position to handle this failure. It's also possible that the client will die because of the signal and never send another message. If the manager is holding onto resources for the client (such as an

open file), it may want to receive notification that the client wants to break out of its *MsgSendv()*.

Setting the _NTO_CHF_UNBLOCK bit in *flags* prevents a thread that's in the REPLY-blocked state from unblocking. Instead, a pulse is sent to the channel, informing the manager that the client wishes to unblock. In the case of a signal, the signal will be pending on the client thread. When the manager replies, the client is unblocked and at that point, any pending signals are acted upon. From the client's point of view, its *MsgSendv()* will have completed normally and any signal will have arrived on the opcode following the successful kernel call.

When the manager receives the pulse, it can do one of these things:

- If it believes that it will be replying shortly, it can discard the pulse, resulting in a small latency in the unblocking, or it can signal the client. A short blocking request to a filesystem often takes this approach.
- If the reply is going to take some time or an unknown amount of time, the manager should cancel the current operation and reply back with an error or whatever data is available at this time in the reply message to the client thread. A request to a device manager waiting for input would take this approach.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ChannelCreate()

The channel ID of the newly created channel. If an error occurs, the function returns -1 and sets *errno*.

ChannelCreate_r()

The channel ID of the newly created channel. This function does **NOT** set *errno*. If an error occurs, the function returns the negative of a value from the Errors section.

Errors:

EAGAIN	All kernel channel objects are in use.
EBUSY	The _NTO_CHF_COID_DISCONNECT or the _NTO_CHF_THREAD_DEATH flag was given and another channel belonging to this process already has the same flag set.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ChannelDestroy(), *close()*, *ConnectAttach()*, *ConnectDetach()*, **_msg_info**, *MsgReceivev()*, *MsgReplyv()*, *MsgSendv()*, *MsgSendPulse()*, *name_close()*, **_pulse**

ChannelDestroy(), ChannelDestroy_r()

Destroy a communications channel

Synopsis:

```
#include <sys/neutrino.h>

int ChannelDestroy( int chid );

int ChannelDestroy_r( int chid );
```

Arguments:

chid The channel ID, returned by *ChannelCreate()*, of the channel that you want to destroy.

Library:

libc

Description:

These kernel calls remove a channel specified by the channel ID *chid* argument. Once destroyed, any attempt to receive messages or pulses on the channel will fail. Any threads that are blocked on the channel by calling *MsgReceivev()* or *MsgSendv()* will be unblocked and return with an error.

The *ChannelDestroy()* and *ChannelDestroy_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

When the channel is destroyed, all server connection IDs become invalid. The client connections are also marked invalid but remain in existence until the client removes them by calling *ConnectDetach()*. An attempt by the client to use one of these invalid connections using *MsgSendv()* or *MsgSendPulse()* will return with an error.

A server typically destroys its channels prior to its termination. If it fails to do so, the kernel destroys them automatically when the process dies.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ChannelDestroy()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

ChannelDestroy_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, the function may return any value in the Errors section.

Errors:

EINVAL The channel specified by *chid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ChannelCreate(), MsgReceivev()

chdir()

Change the current working directory

Synopsis:

```
#include <unistd.h>

int chdir( const char* path );
```

Arguments:

path The new current working directory.

Library:

libc

Description:

The *chdir()* function changes the current working directory to *path*, which can be relative to the current working directory or an absolute path name.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES Search permission is denied for a component of *path*.

ELOOP Too many levels of symbolic links or prefixes.

ENAMETOOLONG
The *path* argument is longer than PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT The specified *path* doesn't exist, or *path* is an empty string.

ENOMEM There wasn't enough memory to allocate a control structure.

ENOSYS	The *chdir()* function isn't implemented for the filesystem specified in *path*.
ENOTDIR	A component of *path* is not a directory.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main( int argc, char* argv[] )
{
    if( argc != 2 ) {
        fprintf( stderr, "Use: cd <directory>\n" );
        return EXIT_FAILURE;
    }

    if( chdir( argv[1] ) == 0 ) {
        printf( "Directory changed to %s\n", argv[1] );
        return EXIT_SUCCESS;
    } else {
        perror( argv[1] );
        return EXIT_FAILURE;
    }
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

There's only one current working directory per *process*. In a multithreaded application, any thread calling *chdir()* will change the current working directory for all threads in that process.

See also:

errno, *getcwd()*, *mkdir()*, *rmdir()*

chmod()

Change the permissions for a file

Synopsis:

```
#include <sys/types.h>
#include <sys/stat.h>

int chmod( const char * path,
           mode_t mode );
```

Arguments:

path The name of the file whose permissions you want to change.

mode The new permissions for the file. For more information, see "Access permissions" in the documentation for *stat()*.

Library:

libc

Description:

The *chmod()* function changes S_ISUID, S_ISGID, S_ISVTX and the file permission bits of the file specified by the pathname pointed to by *path* to the corresponding bits in the *mode* argument. The application must ensure that the effective user ID of the process matches the owner of the file or the process has appropriate privileges to do this.

If a directory is writable and the sticky bit (S_ISVTX) is set on the directory, a process can remove or rename a file within that directory only if one or more of the following is also true:

- The effective user ID of the process matches the file's owner ID.
- The effective user ID of the process matches the directory's owner ID.
- The file is writable by the effective user ID of the process.
- The user is a superuser (effective user ID of 0).

If a directory has the set-group ID bit set, a file created in that directory will have the same group ID as that directory. Otherwise, the newly created file's group ID is set to the effective group ID of the creating process.

If the calling process doesn't have appropriate privileges, and if the group ID of the file doesn't match the effective group ID, and the file is a regular file, bit S_ISGID (set-group-ID on execution) in the file's mode is cleared on a successful return from *chmod()*.

If the effective user ID of the calling process is equal to the file owner, or the calling process has appropriate privileges (for example, it belongs to the superuser), *chmod()* sets S_ISUID, S_ISGID and the file permission bits, defined in the **<sys/stat.h>** header file, from the corresponding bits in the *mode* argument. These bits define access permissions for the user associated with the file, the group associated with the file and all others.

This call has no effect on file descriptors for files that are already open.

If *chmod()* succeeds, the *st_ctime* field of the file is marked for update.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES Search permission is denied on a component of the path prefix.

ELOOP Too many levels of symbolic links or prefixes.

ENAMETOOLONG
The length of the *path* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOTDIR A component of the path prefix isn't a directory.

ENOENT	The file doesn't exist, or the *path* arguments points to an empty string.
ENOSYS	The *chmod()* function isn't implemented for the filesystem specified in *path*.
EPERM	The effective user ID doesn't match the owner of the file, and the calling process doesn't have appropriate privileges.
EROFS	The file resides on a read-only filesystem.

Examples:

```
/*
 * Change the permissions of a list of files
 * to by read/write by the owner only
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <sys/stat.h>

int main( int argc, char **argv )
{
    int i;
    int ecode = 0;

    for( i = 1; i < argc; i++ ) {
        if( chmod( argv[i], S_IRUSR | S_IWUSR ) == -1 ) {
            perror( argv[i] );
            ecode++;
        }
    }

    return ecode;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chown(), errno, fchmod(), fchown(), fstat(), open(), stat()

chown()

Change the user ID and group ID of a file

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

int chown( const char * path,
           uid_t owner,
           gid_t group );
```

Arguments:

path	The name of the file whose ownership you want to change.
owner	The user ID of the new owner.
group	The group ID of the new owner.

Library:

libc

Description:

The *chown()* function changes the user ID and group ID of the file specified by *path* to be the numeric values contained in *owner* and *group*, respectively.

If the named file is a symbolic link, *chown()* changes the ownership of the file or directory to which the symbolic link refers; *lchown()* changes the ownership of the symbolic link file itself.

Only processes with an effective user ID equal to the user ID of the file or with appropriate privileges (for example, the superuser) may change the ownership of a file.

In QNX Neutrino, the _POSIX_CHOWN_RESTRICTED flag (tested via the _PC_CHOWN_RESTRICTED flag in *pathconf()*), is enforced for *path*. This means that only the superuser may change the ownership or the group of a file to anyone. Normal users can't give a file away to another user by changing the file ownership, nor to another group by changing the group ownership.

If the *path* argument refers to a regular file, the set-user-ID (S_ISUID) and set-group-ID (S_ISGID) bits of the file mode are cleared, if the function is successful.

If *chown()* succeeds, the *st_ctime* field of the file is marked for update.

Returns:

0 Success.

-1 (no changes were made in the user ID and group ID of the file). An error occurred (*errno* is set).

Errors:

EACCES Search permission is denied on a component of the path prefix.

ELOOP Too many levels of symbolic links or prefixes.

ENAMETOOLONG
The length of the *path* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT A component of the path prefix doesn't exist, or the *path* arguments points to an empty string.

ENOSYS The *chown()* function isn't implemented for the filesystem specified in *path*.

ENOTDIR A component of the path prefix isn't a directory.

EPERM The effective user ID doesn't match the owner of the file, or the calling process doesn't have appropriate privileges.

EROFS The named file resides on a read-only filesystem.

Examples:

```
/*
 * Change the ownership of a list of files
 * to the current user/group
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <unistd.h>

int main( int argc, char** argv )
  {
    int i;
    int ecode = 0;

    for( i = 1; i < argc; i++ ) {
      if( chown( argv[i], getuid(), getgid() ) == -1 ) {
        perror( argv[i] );
        ecode++;
      }
    }
    exit( ecode );
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chmod(), errno, fchown(), fstat(), lchown(), open(), stat()

chroot()

Change the root directory

Synopsis:

```
#include <unistd.h>

int chroot( const char *path );
```

Arguments:

path The name of the new root directory.

Library:

libc

Description:

The *chroot()* function causes the *path* directory to become the root directory, the starting point for path searches for path names beginning with **/**. The user's working directory is unaffected.

The effective user ID of the process must be superuser to change the root directory. The **..** entry in the root directory is interpreted to mean the root directory itself. Thus, **..** can't be used to access files outside the subtree rooted at the root directory.

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Errors:

EACCES	Search permission is denied for a component of *path*.
EBADF	The descriptor isn't valid.
EFAULT	The *path* argument points to an illegal address.
EINTR	A signal was caught during the *chroot()* function.

EIO	An I/O error occurred while reading from or writing to the filesystem.
ELOOP	Too many symbolic links were encountered in translating *path*.
EMULTIHOP	Components of *path* require hopping to multiple remote machines, and the filesystem type doesn't allow it.
ENAMETOOLONG	The length of the *path* argument exceeds **{PATH_MAX}**, or the length of a path component exceeds **{NAME_MAX}** while **{_POSIX_NO_TRUNC}** is in effect.
ENOENT	The named directory doesn't exist or is a null pathname.
ENOLINK	The *path* points to a remote machine and the link to that machine is no longer active.
ENOTDIR	Any component of the path name isn't a directory.
EPERM	The effective user of the calling process isn't the superuser.

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

chdir()

chsize()

Change the size of a file

Synopsis:

```
#include <unistd.h>

int chsize( int filedes,
            long size );
```

Arguments:

filedes	A file descriptor for the file whose size you want to change.
size	The new size of the file, in bytes.

Library:

libc

Description:

The *chsize()* function extends or truncates the file specified by *filedes* to *size* bytes The file is padded with NUL (`'\0'`) characters if it needs to be extended.

The *chsize()* function ignores advisory locks that may have been set with the *fcntl()* function.

Returns:

0	Success.
-1	An error occurred.

Errors:

EBADF	The *filedes* argument isn't a valid file descriptor, or the file isn't opened for writing.
ENOSPC	There isn't enough space left on the device to extend the file.

ENOSYS The *chsize()* function isn't implemented for the filesystem specified by *filedes*.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <unistd.h>
#include <fcntl.h>
#include <sys/stat.h>

int main( void )
{
    int  filedes;

    filedes= open( "file", O_RDWR | O_CREAT,
        S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP );
    if( filedes!= -1 ) {
        if( chsize( filedes, 32 * 1024L ) != 0 ) {
            printf( "Error extending file\n" );
        }
        close( filedes);

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

QNX 4

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

close(), creat(), errno, ftruncate(), open()

clearenv()

Clear the environment

Synopsis:

```
#include <stdlib.h>

int clearenv( void );
```

Library:

libc

Description:

The *clearenv()* function clears the environment area; no environment variables are defined immediately after the *clearenv()* call.

Note that *clearenv()* clears the following environment variables, which may then affect the operation of other library functions such as *spawnp()*:

- **PATH**
- **SHELL**
- **TERM**
- **TERMINFO**
- **LINES**
- **COLUMNS**
- **TZ**

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

ENOMEM Not enough memory to allocate a control structure.

Examples:

Clear the entire environment and set up a new **TZ** environment variable:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    if( clearenv() != 0 ) {
        puts( "Unable to clear the environment" );
        return EXIT_FAILURE;
    }

    setenv( "TZ", "EST5EDT", 0 );

    return EXIT_SUCCESS;
}
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The *clearenv()* function manipulates the environment pointed to by the global *environ* variable.

See also:

environ, *errno*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *searchenv()*, *setenv()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *system()*, *unsetenv()*

clearerr()

Clear a stream's end-of-file and error flags

Synopsis:

```
#include <stdio.h>

void clearerr( FILE *fp );
```

Arguments:

fp The stream for which you want to clear the flags.

Library:

libc

Description:

The *clearerr()* function clears the end-of-file and error flags for the stream specified by *fp*.

These indicators are also cleared when the file is opened, or by an explicit call to *clearerr()* or *rewind()*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    int c;

    c = 'J';
    fp = fopen( "file", "w" );
    if( fp != NULL ) {
      fputc( c, fp );
      if( ferror( fp ) ) {  /* if error        */
          clearerr( fp );   /* clear the error */
          fputc( c, fp );   /* and retry it    */
      }
    }

    fclose( fp );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

feof(), *ferror()*, *fopen()*, *perror()*, *rewind()*

clock()

Return the number of clock ticks used by the program

Synopsis:

```
#include <time.h>

clock_t clock( void );
```

Library:

```
libc
```

Description:

The *clock()* function returns the number of clock ticks of processor time used by the program since it started executing. You can convert the number of ticks into seconds by dividing by the value CLOCKS_PER_SEC.

☞ In a multithreaded program, *clock()* returns the time used by *all* threads in the application; *clock()* returns the time since the program started, not the time since a specific thread started.

Returns:

The number of clock ticks.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <time.h>
#include <stdlib.h>

void compute( void )
{
    int i, j;
    double x;

    x = 0.0;
    for( i = 1; i <= 100; i++ ) {
        for( j = 1; j <= 100; j++ ) {
            x += sqrt( (double) i * j );
        }
    }
```

```
    printf( "%16.7f\n", x );
}

int main( void )
{
    clock_t start_time, end_time;

    start_time = clock();
    compute();
    end_time = clock();
    printf( "Execution time was %lu seconds\n",
          (long) ((end_time - start_time) / CLOCKS_PER_SEC) );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

asctime(), asctime_r(), ctime(), difftime(), gmtime(), localtime(), localtime_r(), mktime(), strftime(), time(), tzset()

ClockAdjust(), ClockAdjust_r()

Adjust the time of a clock

Synopsis:

```
#include <sys/neutrino.h>

int ClockAdjust( clockid_t id,
                 const struct _clockadjust * new,
                 struct _clockadjust * old );

int ClockAdjust_r( clockid_t id,
                   const struct _clockadjust * new,
                   struct _clockadjust * old );
```

Arguments:

id The ID of the clock you want to adjust. This must be CLOCK_REALTIME; this clock maintains the system time.

new NULL or a pointer to a **_clockadjust** structure that specifies how to adjust the clock. Any previous adjustment is replaced.

The **_clockadjust** structure contains at least the following members:

- **long** *tick_nsec_inc* — the adjustment to be made on each clock tick, in nanoseconds.
- **unsigned long** *tick_count* — the number of clock ticks over which to apply the adjustment.

old If not NULL, a pointer to a **_clockadjust** structure where the function can store the current adjustment (before being changed by a non-NULL *new*).

Library:

libc

Description:

These kernel calls let you gradually adjust the time of the clock specified by *id*. You can use these functions to speed up or slow down the system clock to synchronize it with another time source – without causing major discontinuities in the time flow.

The *ClockAdjust()* and *ClockAdjust_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

The total time adjustment, in nanoseconds, is:

```
(new->tick_count * new->tick_nsec_inc)
```

If the current clock is ahead of the desired time, you can specify a negative *tick_nsec_inc* to slow down the clock. This is preferable to setting the time backwards with the *ClockTime()* kernel call, since some programs may malfunction if time goes backwards.

Picking small values for *tick_nsec_inc* and large values for *tick_count* adjusts the time slowly, while the opposite approach adjusts it rapidly. As a rule of thumb, don't try to set a *tick_nsec_inc* that exceeds the basic clock tick as set by the *ClockPeriod()* kernel call. This would change the clock rate by more than 100% and if the adjustment is negative, it could make the clock go backwards.

You can cancel any adjustment in progress by setting *tick_count* and *tick_nsec_inc* to 0.

Superuser privileges are required to adjust the clock.

Blocking states:

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ClockAdjust() If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

ClockAdjust_r() EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, the function may return any value in the Errors section.

Errors:

EFAULT A fault occurred when the kernel tried to access the buffers provided.

EINVAL The clock id isn't valid.

EPERM The process tried to adjust the time without having superuser capabilities.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ClockPeriod(), *ClockTime()*

ClockCycles()

Get the number of clock cycles

Synopsis:

```
#include <sys/neutrino.h>
#include <inttypes.h>

uint64_t ClockCycles( void );
```

Library:

libc

Description:

The *ClockCycles()* kernel call returns the current value of a free-running 64-bit cycle counter. This is implemented on each processor as a high-performance mechanism for timing short intervals.

Several CPU architectures have an instruction that reads such a free-running counter (e.g. x86 has the RDTSC instruction). For processors that don't implement such an instruction in hardware (e.g. a 386), the kernel emulates one. This provides a lower time resolution than if the instruction is provided (838.095345 nanoseconds on an IBM PC-compatible system).

In all cases, the **SYSPAGE_ENTRY(qtime)->***cycles_per_sec* field gives the number of *ClockCycles()* increments in one second.

Symmetric MultiProcessing systems

This function, depending on the CPU architecture, returns a value from a register that's unique to each CPU in an SMP system — for instance, the TSC (Time Stamp Counter) on an x86. These registers aren't synchronized between the CPUs. So if you call *ClockCycles()*, and then the thread migrates to another CPU and you call *ClockCycles()* again, you can't subtract the two values to get a meaningful time duration.

If you wish to use *ClockCycles()* on an SMP machine, you must use the following call to "lock" the thread to a single CPU:

```
ThreadCtl(_NTO_TCTL_RUNMASK, ...)
```

Blocking states:

This call doesn't block.

Examples:

See *SYSPAGE_ENTRY()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

SYSPAGE_ENTRY(), *ThreadCtl()*

clock_getcpuclockid()

Return the clock ID of the CPU-time clock from a specified process

Synopsis:

```
#include <sys/types.h>
#include <time.h>

extern int clock_getcpuclockid(
                          pid_t pid,
                          clockid_t* clock_id );
```

Arguments:

pid	The process ID for the process whose clock ID you want to get.
clock_id	A pointer to a **clockid_t** object where the function can store the clock ID.

Library:

libc

Description:

The *clock_getcpuclockid()* function returns the clock ID of the CPU-time clock of the process specified by *pid*. If the process described by *pid* exists and the calling process has permission, the clock ID of this clock is stored in *clock_id*.

If *pid* is zero, the clock ID of the CPU-time clock of the process marking the call is returned in *clock_id*.

A process always has permission to obtain the CPU-time clock ID of another process.

Returns:

Zero for success, or an error value.

Errors:

ESRCH — No process can be found corresponding to the specified *pid*.

Classification:

POSIX 1003.1d (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_getres(), *clock_gettime()*, *ClockId()*, *clock_settime()*, *pthread_getcpuclockid()*, *timer_create()*

clock_getres()

Get the resolution of the clock

Synopsis:

```
#include <time.h>

int clock_getres( clockid_t clock_id,
                  struct timespec * res );
```

Arguments:

clock_id The ID of the clock whose resolution you want to get.

res A pointer to a **timespec** structure in which *clock_getres()* can store the resolution. The function sets the *tv_sec* member to 0, and the *tv_nsec* member to be the resolution of the clock, in nanoseconds.

Library:

libc

Description:

The *clock_getres()* function gets the resolution of the clock specified by *clock_id* and puts it into the buffer pointed to by *res*.

Returns:

0 Success

-1 An error occurred (*errno* is set).

Errors:

EFAULT A fault occurred trying to access the buffers provided.

EINVAL Invalid *clock_id*.

Examples:

```
/*
 * This program prints out the clock resolution.
 */
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

int main( void )
  {
    struct timespec res;

    if ( clock_getres( CLOCK_REALTIME, &res) == -1 ) {
      perror( "clock get resolution" );
      return EXIT_FAILURE;
    }
    printf( "Resolution is %ld micro seconds.\n",
          res.tv_nsec / 1000 );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_gettime(), *clock_settime()*, *ClockPeriod()*, **timespec**

clock_gettime()

Get the current time of a clock

Synopsis:

```
#include <time.h>

int clock_gettime( clockid_t clock_id,
                   struct timespec * tp );
```

Arguments:

clock_id The ID of the clock whose time you want to get.

tp A pointer to a **timespec** structure where *clock_gettime()* can store the time. This function sets the members as follows:

- *tv_sec* — the number of seconds since 1970.
- *tv_nsec* — the number of nanoseconds expired in the current second. This value increases by some multiple of nanoseconds, based on the system clock's resolution.

Library:

libc

Description:

The *clock_gettime()* function gets the current time of the clock specified by *clock_id*, and puts it into the buffer pointed to by *tp*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EFAULT	A fault occurred trying to access the buffers provided.
EINVAL	Invalid *clock_id*.
ESRCH	The process associated with this request doesn't exist.

Examples:

```
/*
 * This program calculates the time required to
 * execute the program specified as its first argument.
 * The time is printed in seconds, on standard out.
 */
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <time.h>

#define BILLION  1000000000L;

int main( int argc, char** argv )
  {
    struct timespec start, stop;
    double accum;

    if( clock_gettime( CLOCK_REALTIME, &start) == -1 ) {
      perror( "clock gettime" );
      return EXIT_FAILURE;
    }

    system( argv[1] );

    if( clock_gettime( CLOCK_REALTIME, &stop) == -1 ) {
      perror( "clock gettime" );
      return EXIT_FAILURE;
    }

    accum = ( stop.tv_sec - start.tv_sec )
             + (double)( stop.tv_nsec - start.tv_nsec )
               / (double)BILLION;
    printf( "%lf\n", accum );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_getres(), *clock_settime()*, *errno*, **`timespec`**

clock_nanosleep()

High resolution sleep with specifiable clock

Synopsis:

```
#include <time.h>

int clock_nanosleep( clockid_t clock_id,
                     int flags,
                     const struct timespec * rqtp,
                     struct timespec * rmtp );
```

Arguments:

clock_id The ID of the clock to use to measure the time. The possible clock types are:

CLOCK_MONOTONIC

A clock that always increases at a constant rate and can't be adjusted.

CLOCK_SOFTTIME

Same as CLOCK_REALTIME, but if the CPU is in powerdown mode, the clock stops running.

CLOCK_REALTIME

A clock that maintains the system time.

The *clock_nanosleep()* function fails if the *clock_id* argument refers to the CPU-time clock of the calling thread.

flags Flags that specify when the current thread is to be suspended from execution:

- when the time interval specified by the *rqtp* argument has elapsed (TIMER_ABSTIME is *not* set).
- when the time value of the clock specified by *clock_id* reaches the absolute time specified by the *rqtp* argument (TIMER_ABSTIME is set).

  If, at the time of the call, the time value specified by *rqtp* is less than or equal to the time value of the

specified clock, then *clock_nanosleep()* returns immediately, and the calling process isn't suspended.

- when a signal is delivered to the calling thread, and the signal's action is to invoke a signal-catching function or terminate the process.

Calling *clock_nanosleep()* with TIMER_ABSTIME *not* set, and *clock_id* set to CLOCK_REALTIME is the equivalent to calling *nanosleep()* with the same *rqtp* and *rmtp* arguments.

rqtp A pointer to a **timespec** structure that specifies the time interval between the requested time and the time actually slept.

rmtp NULL, or a pointer to a **timespec** in which the function can store the amount of time remaining in an interval.

For the relative *clock_nanosleep()* function, if *rmtp* isn't NULL, the **timespec** structure referenced by it is updated to contain the amount of time remaining in the interval (the requested time minus the time actually slept). If it's NULL, the remaining time isn't returned.

The absolute *clock_nanosleep()* function has no effect on the structure referenced by *rmtp*.

Library:

libc

Description:

The *clock_nanosleep()* function suspends the current thread from execution until:

- If TIMER_ABSTIME is set, the time value of the clock specified by *clock_id* reaches the absolute time specified by the *rqtp* argument.

  Or:

- If TIMER_ABSTIME is *not* set, the time interval specified by the *rqtp* argument has elapsed.

  Or:

- A signal is delivered to the calling thread, and the signal's action is to invoke a signal-catching function or terminate the process.

The *nanosleep()* function always uses CLOCK_REALTIME.

The suspension time may be longer than requested because the argument value is rounded up to an integer multiple of the sleep resolution, or because of scheduling and other system activity. Except for the case of being interrupted by a signal, the suspension time for:

- the relative *clock_nanosleep()* function (TIMER_ABSTIME not set) — isn't less than the time interval specified by *rqtp*, as measured by the corresponding clock
- the absolute *clock_nanosleep()* function (TIMER_ABSTIME set) — is in effect at least until the value of the corresponding clock reaches the absolute time specified by *rqtp*, except for the case of being interrupted by a signal.

Using the *clock_nanosleep()* function has no effect on the action or blockage of any signal.

Returns:

Zero if the requested time has elapsed, or a corresponding error value if *clock_nanosleep()* has been interrupted by a signal, or fails.

Errors:

EINTR	The call was interrupted by a signal.
EINVAL	The *rqtp* argument specified a nanosecond value less than zero or greater than or equal to 1000 million; or TIMER_ABSTIME is specified in *flags* and the *rqtp* argument is outside the range for the clock specified by *clock_id*; or the *clock_id* argument doesn't specify a

known clock, or specifies the CPU-time clock of the calling thread.

ENOTSUP — The *clock_id* argument specifies a clock for which *clock_nanosleep()* isn't supported, such as a CPU-time clock.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_settime(), *nanosleep()*, *sleep()*, **`timespec`**

clock_settime()

Set a clock

Synopsis:

```
#include <time.h>

int clock_settime( clockid_t clock_id,
                   const struct timespec * tp );
```

Arguments:

clock_id The ID of the clock you want to set.

tp A pointer to a **timespec** structure containing at least the following members:

- *tv_sec* — the number of seconds since 1970.
- *tv_nsec* — the number of nanoseconds in the current second. This value increases by some multiple of nanoseconds, based on the system clock's resolution.

Library:

libc

Description:

The *clock_settime()* function sets the clock specified by *clock_id*, from the buffer pointed to by *tp*.

☞ Be careful if you set the date during the period that a time zone is switching daylight saving time (DST) to standard time. When a time zone changes to standard time, the local time goes back one hour (for example, 2:00 a.m. becomes 1:00 a.m.). The local time during this hour is ambiguous (e.g. 1:14 a.m. occurs twice in the morning that the time zone switches to standard time). To avoid problems, use UTC time to set the date in this period.

Returns:

0 Success

-1 An error occurred (*errno* is set).

Errors:

EINVAL Invalid *clock_id* or the number of nanoseconds specified by the *tv_nsec* is less than zero or greater than or equal to 1000 million.

EPERM You don't have sufficient privilege to change the time.

Examples:

```
/*  This program sets the clock forward 1 day. */

#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <time.h>

int main( void )
  {
    struct timespec stime;

    if( clock_gettime( CLOCK_REALTIME, &stime) == -1 ) {
       perror( "getclock" );
       return EXIT_FAILURE;
    }

    stime.tv_sec += (60*60)*24L;  /* Add one day */
    stime.tv_nsec = 0;
    if( clock_settime( CLOCK_REALTIME, &stime) == -1 ) {
       perror( "setclock" );
       return EXIT_FAILURE;
    }
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_getres(), *clock_gettime()*, *errno*, **timespec**

ClockId(), *ClockId_r()*

Get a clock ID for a given process and thread

Synopsis:

```
#include <sys/neutrino.h>
#include <inttypes.h>

extern int ClockId( pid_t pid,
                    int tid );

extern int ClockId_r( pid_t pid,
                      int tid );
```

Arguments:

pid The ID of the process that you want to calculate the execution time for. If this argument is zero, the ID of the process making the call is assumed.

tid The ID of the thread that you want to calculate the execution time for, or 0 to get the execution time for the process as a whole.

Library:

libc

Description:

The *ClockId()* and *ClockId_r()* kernel calls return an integer that you can pass as a **clockid_t** to *ClockTime()*. When you pass this clock ID to *ClockTime()*, the function returns (in the location pointed to by *old*) the number of nanoseconds that the specified thread of the specified process has executed.

The *ClockId()* and *ClockId_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

If the *tid* is zero, the number of nanoseconds that the process as a whole has executed is returned. On an SMP box, this number may exceed the realtime number of nanoseconds that have elapsed because multiple threads in the process can run on several CPUs at the same time.

Blocking states:

This call doesn't block.

Returns:

ClockId() An integer that can be passed to *ClockTime()*. If an error occurs, the function returns -1 and sets *errno*.

ClockId_r() An integer that can be passed to *ClockTime()*. This function does **NOT** set *errno*. If an error occurs, the function returns the negative of a value from the Errors section.

Errors:

ESRCH The *pid* and/or *tid* don't exist.

Examples:

Here's how you can determine how busy a system is:

```
id = ClockId(1, 1);
for( ;; ) {
    ClockTime(id, NULL, &start);
    sleep(1);
    ClockTime(id, NULL, &stop);
    printf("load = %f%%\n", (1000000000.0 - (stop-start)) / 10000000.0);
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ClockTime(), clock_getcpuclockid(), pthread_getcpuclockid()

ClockPeriod(), ClockPeriod_r()

Get or set a clock period

Synopsis:

```
#include <sys/neutrino.h>

int ClockPeriod( clockid_t id,
                 const struct _clockperiod * new,
                 struct _clockperiod * old,
                 int reserved );

int ClockPeriod_r( clockid_t id,
                   const struct _clockperiod * new,
                   struct _clockperiod * old,
                   int reserved );
```

Arguments:

id The clock ID of the clock. This must be CLOCK_REALTIME, which is the ID of the clock that maintains the system time.

new NULL, or a pointer to a **_clockperiod** structure that contains the period to set the clock to. This structure contains at least the following members:

- **unsigned long** *nsec* — the period of the clock, in nanoseconds.
- **long** *fract* — reserved for future fractional nanoseconds. Set this member to zero.

old NULL, or a pointer to a **_clockperiod** structure where the function can store the current period (before being changed by a non-NULL *new*).

reserved Set this argument to 0.

Library:

libc

Description:

You can use the *ClockPeriod()* and *ClockPeriod_r()* kernel calls to get or set the clock period of the clock.

These functions are identical except in the way they indicate errors. See the Returns section for details.

☞ You need to have superuser privileges to set the clock period.

All the *timer_*()* calls operate with an accuracy no better than the clock period. Every moment within the Neutrino microkernel is referred to as a *tick*. A tick's initial length is determined by the clock rate of your processor:

CPU clock speed:	Default value:
≥ 40MHz	1 millisecond
< 40MHz	10 milliseconds

Since a very small ticksize imposes an interrupt load on the system, and can consume all available processor cycles, the kernel call limits how small a period can be specified. The lowest clock period that can currently be set on any machine is 10 microseconds.

If an attempt is made to set a value that the kernel believes to be unsafe, the call fails with an EINVAL. The timeslice rate (for "round-robin" and "other" scheduling policies) is always four times the clock period (this isn't changeable).

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ClockPeriod()	If an error occurs, this function returns -1 is and sets *errno*. Any other value returned indicates success.
ClockPeriod_r()	EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, the function can return any value in the Errors section.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EINVAL	Invalid clock ID. A period was set which wasn't in a range considered safe.
EPERM	The process tried to change the period of the clock without having superuser capabilities.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ClockAdjust()

ClockTime(), *ClockTime_r()*

Get or set a clock

Synopsis:

```
#include <sys/neutrino.h>

int ClockTime( clockid_t id,
               const uint64_t * new,
               uint64_t * old );

int ClockTime_r( clockid_t id,
                 const uint64_t * new,
                 uint64_t * old );
```

Arguments:

id The clock ID. This must be CLOCK_REALTIME or CLOCK_MONOTONIC, which is the ID of the clock that maintains the system time, or the clock ID that's returned by *ClockId()*.

new NULL, or a pointer to the absolute time, in nanoseconds, to set the clock to.

old NULL, or a pointer to a location where the function can store the current time (before being changed by a non-NULL *new*).

Library:

libc

Description:

You can use these kernel calls to get or set the system clock specified by *id*. The clock ID, CLOCK_REALTIME or CLOCK_MONOTONIC, maintains the system time.

The *ClockTime()* and *ClockTime_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

If *new* isn't NULL, then it contains the absolute time, in nanoseconds, to set the system clock to. This affects the software clock maintained

by the system. It won't change any underlying hardware clock that maintains the time when the system's power is turned off.

Once set, the system time increments by some number of nanoseconds, based on the resolution of the system clock. You can query or change this resolution by using the *ClockPeriod()* kernel call.

☞ You need to have superuser privileges to set the clock.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ClockTime()	If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.
ClockTime_r()	EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, the function returns a value in the Errors section.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EINVAL	The clock ID isn't CLOCK_REALTIME or CLOCK_MONOTONIC.
EPERM	The process tried to change the time without having superuser capabilities.
ESRCH	The process associated with this request doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ClockAdjust(), ClockPeriod()

close()

Close a file

Synopsis:

```
#include <unistd.h>

int close( int filedes );
```

Arguments:

filedes The file descriptor of the file you want to close. This can be a file descriptor returned by a successful call to *accept(), creat(), dup(), dup2(), fcntl(), modem_open(), open(), shm_open(), socket()* or *sopen()*.

Library:

libc

Description:

The *close()* function closes the file specified by the given file descriptor.

Returns:

Zero for success, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	Invalid file descriptor *filedes*.
EINTR	The *close()* call was interrupted by a signal.
EIO	An I/O error occurred while updating the directory information.
ENOSPC	A previous buffered write call has failed.
ENOSYS	The *close()* function isn't implemented for the filesystem specified by *filedes*.

Examples:

```
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
{
    int filedes;

    filedes = open( "file", O_RDONLY );
    if( filedes != -1 ) {
        /* process file */
        close( filedes );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

accept(), creat(), dup(), dup2(), errno, fcntl(), modem_open(), open(), shm_open(), socket(), sopen()

closedir()

Close a directory

Synopsis:

```
#include <dirent.h>

int closedir( DIR * dirp );
```

Arguments:

dirp A directory pointer for the directory you want to close.

Library:

libc

Description:

The *closedir()* function closes the directory specified by *dirp*, and frees the memory allocated by *opendir()*.

☞ The result of using a directory stream after calling one of the *exec*()* or *spawn*()* family of functions is undefined. After a call to the *fork()* function, either the parent or the child (but not both) may continue processing the directory stream using the *readdir()* and *rewinddir()* functions. If both the parent and child processes use these functions, the result is undefined. Either or both processes may call the *closedir()* function.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF The *dirp* argument doesn't refer to an open directory stream.

EINTR The *closedir()* call was interrupted by a signal.

Examples:

Get a list of files contained in the directory **/home/kenny**:

```
#include <stdio.h>
#include <dirent.h>
#include <stdlib.h>

int main( void )
{
    DIR *dirp;
    struct dirent *direntp;

    dirp = opendir( "/home/kenny" );
    if( dirp != NULL ) {
        for(;;) {
            direntp = readdir( dirp );
            if( direntp == NULL ) {
                break;
            }

            printf( "%s\n", direntp->d_name );
        }

        closedir( dirp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, opendir(), readdir(), readdir_r(), rewinddir(), seekdir(), telldir()

closelog()

Close the system log

Synopsis:

```
#include <syslog.h>

void closelog( void );
```

Library:

libc

Description:

The *closelog()* function closes the connection to **syslogd**.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

openlog(), *setlogmask()*, *syslog()*, *vsyslog()*

logger, **syslogd** in the *Utilities Reference*

Return a file descriptor for the executable file

Synopsis:

```
#include <process.h>

int _cmdfd( void );
```

Library:

libc

Description:

This function returns a file descriptor for the executable file.

Returns:

A file descriptor for the executable file.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

_cmdname(), __progname

_cmdname()

Find the path used to invoke the current process

Synopsis:

```
#include <process.h>

char * _cmdname( char * buff );
```

Arguments:

buff A pointer to a buffer in which the function can store the path. To determine the size required for the buffer, call *fpathconf()* or *pathconf()* with an argument of _PC_PATH_MAX.

Library:

libc

Description:

The *_cmdname()* function determines the full path that the current process was invoked from, and stores it in the buffer specified by *buff*.

Returns:

0 Success.

-1 An error occurred.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <unistd.h>
#include <limits.h>
#include <process.h>

int main( void )
{
    size_t maximum_path;
    char *buff;

    maximum_path = (size_t) pathconf( "/", _PC_PATH_MAX );
    buff = (char* )malloc( maximum_path );
```

```
    if( _cmdname( buff ) ) {
        printf( "I'm \"%s\".\n", buff );
    } else {
        perror( "_cmdname() failed" );
        free (buff);
        return EXIT_FAILURE;
    }

    free (buff);
    return EXIT_SUCCESS;
}
```

If this code is compiled into an executable named **foo**:

```
# ls -F /home/xyzzy/bin/foo
foo*
# /home/xyzzy/bin/foo
I'm "/home/xyzzy/bin/foo".
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

basename(), _cmdfd(), __progname

confstr()

Get configuration-defined string values

Synopsis:

```
#include <unistd.h>

size_t confstr( int name,
                char * buf,
                size_t len );
```

Arguments:

name	The system variable to query; see below.
buf	A pointer to a buffer in which the function can store the value of the system variable.
len	The length of the buffer, in bytes.

Library:

libc

Description:

The *confstr()* functions lets applications get or set configuration-defined string values. This is similar to the *sysconf()* function, but you use it to get string values, rather than numeric values. By default, the function queries and returns values in the system.

The *name* argument represents the system variable to query. The values are defined in **<confname.h>**; at least the following *name* values are valid:

_CS_ARCHITECTURE
: The name of the instruction set architecture for this node's CPU(s).

_CS_DOMAIN
: The domain name.

_CS_HOSTNAME The name of this node in the network.

A hostname can consist only of letters, numbers, and hyphens, and must not start or end with a hyphen. For more information, see *RFC 952*.

_CS_HW_PROVIDER
The name of the hardware manufacturer.

_CS_HW_SERIAL Serial number associated with the hardware.

_CS_LIBPATH A value similar to the **LD_LIBRARY_PATH** environment variable that finds all standard libraries.

_CS_MACHINE This node's hardware type.

_CS_PATH A value similar to the **PATH** environment variable that finds all standard utilities.

_CS_RELEASE The current OS release level.

_CS_RESOLVE The contents of the `resolv.conf` file, excluding the domain name.

_CS_SRPC_DOMAIN
The secure RPC domain.

_CS_SYSNAME The operating system name.

_CS_TIMEZONE Time zone string (**TZ** style)

_CS_VERSION The current OS version number.

The configuration-defined value is returned in the buffer pointed to by *buf*, and will be ≤ *len* bytes long, including the terminating NULL.

To find out the length of a configuration-defined value, call *confstr()* with *buf* set to NULL and *len* set to 0.

To set a configuration value:

- OR your value to be defined (i.e. _CS_HOSTNAME) to _CS_SET
- put this value in a NULL-terminated string
- Set the value of *len* to 0

Returns:

A nonzero value (if a "get" is done, the value is the length of the configuration-defined value), or 0 if an error occurs (*errno* is set).

You can compare the *confstr()* return value against *len* to see if the configuration-defined value was truncated when retrieving a value, (this can't be done when setting a value).

Errors:

EINVAL The *name* argument isn't a valid configuration-defined value.

Examples:

Print information similar to that returned by the *uname()* function:

```
#include <unistd.h>
#include <stdio.h>
#include <limits.h>

#define BUFF_SIZE (256 + 1)

int main( void )
{
    char buff[BUFF_SIZE];

    if( confstr( _CS_SYSNAME, buff, BUFF_SIZE ) > 0 ) {
        printf( "System name: %s\n", buff );
    }

    if( confstr( _CS_HOSTNAME, buff, BUFF_SIZE ) > 0 ) {
        printf( "Host name: %s\n", buff );
    }

    if( confstr( _CS_RELEASE, buff, BUFF_SIZE ) > 0 ) {
        printf( "Release: %s\n", buff );
    }
```

```
    if( confstr( _CS_VERSION, buff, BUFF_SIZE ) > 0 ) {
        printf( "Version: %s\n", buff );
    }

    if( confstr( _CS_MACHINE, buff, BUFF_SIZE ) > 0 ) {
        printf( "Machine: %s\n", buff );
    }

    if( confstr( _CS_SET | _CS_HOSTNAME, "myhostname", 0 ) != 0 ) {
        printf( "Hostname set to: %s\n", "myhostname" );
    }

    return 0;
}
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *confstr()* function is part of a draft standard; its interface and/or behavior may change in the future.

See also:

pathconf(), *sysconf()*

getconf, **setconf** in the *Utilities Reference*

"Configuration strings" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

connect()

Initiate a connection on a socket

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

int connect( int s,
             const struct sockaddr * name,
             socklen_t namelen );
```

Arguments:

s	The descriptor of the socket on which to initiate the connection.
name	The name of the socket to connect to for a SOCK_STREAM connection.
namelen	The length of the *name*, in bytes.

Library:

libsocket

Description:

The *connect()* function establishes the connection according to the socket type specified by *s*:

SOCK_DGRAM

Specifies the peer that the socket is to be associated with. This address is the one that datagrams are to be sent to, and the only one that datagrams are to be received from.

SOCK_STREAM

This call attempts to make a connection to another socket. The other socket is specified by *name*, which is an address in the communications space of that socket. Each communications space interprets *name* in its own way.

Stream sockets may successfully connect only once, whereas datagram sockets may use *connect()* multiple times to change their association. Datagram sockets may dissolve the association by connecting to an invalid address, such as a null address.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EADDRINUSE The address is already in use.

EADDRNOTAVAIL
The specified address isn't available on this machine.

EAFNOSUPPORT
Addresses in the specified address family cannot be used with this socket.

EALREADY The socket is nonblocking; a previous connection attempt hasn't yet been completed.

EBADF Invalid descriptor *s*.

ECONNABORTED
The *connect()* was terminated under software control.

ECONNREFUSED
The attempt to connect was forcefully rejected.

EFAULT The *name* parameter specifies an area outside the process address space.

EHOSTUNREACH
No route to host; the host system can't be reached.

EINPROGRESS	The socket is nonblocking; the connection can't be completed immediately. It's possible to do a *select()* for completion by selecting the socket for writing.
EISCONN	The socket is already connected.
ENETUNREACH	The network isn't reachable from this host.
ETIMEDOUT	The attempt to establish a connection timed out; no connection was made.

Protocols such as TCP do not allow further connection requests on a socket after an ECONNREFUSED error. In such a situation, the socket must be closed and a new one created before a subsequent attempt for connection is made.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ICMP, IP, TCP, and UDP protocols

accept(), bind(), getsockname(), nbaconnect(), select(), socket()

ConnectAttach(), *ConnectAttach_r()*

Establish a connection between a process and a channel

Synopsis:

```
#include <sys/neutrino.h>

int ConnectAttach( uint32_t nd,
                   pid_t pid,
                   int chid,
                   unsigned index,
                   int flags );

int ConnectAttach_r( uint32_t nd,
                     pid_t pid,
                     int chid,
                     unsigned index,
                     int flags );
```

Arguments:

nd The node descriptor of the node on which the process that owns the channel is running; see "Node descriptors," below.

pid The process ID of the owner of the channel. If *pid* is zero, the calling process is assumed.

chid The channel ID, returned by *ChannelCreate()*, of the channel to connect to the process.

index The lowest acceptable connection ID.

☞ Treating a connection as a file descriptor can lead to unexpected behavior. Therefore, you should OR _NTO_SIDE_CHANNEL into *index* when you create a connection. If you do this, the connection ID is returned from a different space than file descriptors; the ID is greater than any valid file descriptor.

Once created there's no difference in the use of the messaging primitives on this ID. The C library creates connections at various times without _NTO_SIDE_CHANNEL (e.g. during *open()*), however, it's unlikely that any applications would want to call it this way.

flags If *flags* contains _NTO_COF_CLOEXEC, the connection is closed when your process calls an *exec*()* function to start a new process.

Library:

libc

Description:

The *ConnectAttach()* and *ConnectAttach_r()* kernel calls establish a connection between the calling process and the channel specified by *chid* owned by the process specified by *pid* on the node specified by *nd*. Any function that passes a node descriptor can use either the value 0 or the constant ND_LOCAL_NODE to refer to the local node.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The return value is a connection ID, which is a small **int** representing the connection. The system returns the first available connection ID starting at the value specified by the *index* argument. Any thread in the calling process can use either *MsgSendv()* to send messages or *MsgSendPulse()* to send pulses over the connection. The connection ID is used directly as a POSIX file descriptor (*fd*) when communicating with I/O Resource managers such as a filesystem manager.

If you don't OR _NTO_SIDE_CHANNEL into *index*, this behavior might result:

- If file descriptor 0 is in use, file descriptor 1 isn't in use, and you call *ConnectAttach()* with 0 specified for *index*, a connection ID of 1 is returned.

  File descriptor 1 (i.e. connection ID 1) is used as *stdout*, which is what *printf()* writes to. If your process makes any calls to *printf()*, NULL-terminated character strings are sent to the channel that you've connected to. Similar situations can happen with connection IDs 0 (*stdin*) and 2 (*stderr*).

- Depending on how a child process is created, it may inherit the parent's file descriptors.

  Since connections are treated like file descriptors, a connection created by the parent without _NTO_SIDE_CHANNEL in *index* and without _NTO_COF_CLOEXEC in *flags*, causes a child process to inherit that connection during process creation. This inheritance is done during process creation by duplicating file descriptors.

  During duplication, an _IO_DUP message (with `0x115`) as the first 2 bytes) is sent to the receiver on the other side of the connection. The receiver won't be expecting this message.

If index has _NTO_SIDE_CHANNEL set, the index is ignored and the connection ID returned is the first available index in the _NTO_SIDE_CHANNEL space.

If a process creates multiple connections to the same channel, the system maintains a link count and shares internal kernel object resources for efficiency.

Connections are owned by the process and may be used simultaneously by any thread in the process. You can detach a connection by calling *ConnectDetach()*. If any threads are blocked on the channel (via *MsgSendv()*) at the time the connection is detached, the send fails and returns with an error.

Connections and connection IDs persist until you call *ConnectDetach()*, even if the other process dies.

The connection is strictly local (i.e. it doesn't resolve across the network) and is resolved on the first use of the connection ID.

Blocking states

These calls don't block.

Node descriptors

The *nd* (node descriptor) is a temporary numeric description of a remote node. For more information, see the Qnet Networking chapter of the *System Architecture* guide.

To:	Use this function:
Compare two *nd* objects	*ND_NODE_CMP()*
Convert a *nd* to text	*netmgr_ndtostr()*
Convert text to a *nd*	*netmgr_strtond()*

Returns:

The only difference between these functions is the way they indicate errors:

ConnectAttach()

A connection ID that's used by the message primitives. If an error occurs, the function returns -1 and sets *errno*.

ConnectAttach_r()

A connection ID that's used by the message primitives. This function does **NOT** set *errno*. If an error occurs, the function returns the negative of a value from the Errors section.

Errors:

EAGAIN	All kernel connection objects are in use.
ESRCH	The node indicated by *nd*, the process indicated by *pid*, or the channel indicated by *chid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ChannelCreate(), *ConnectDetach()*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *MsgSendPulse()*, *MsgSendv()*, *netmgr_remote_nd()*

ConnectClientInfo(), ConnectClientInfo_r()

Store information about a client connection

Synopsis:

```
#include <sys/neutrino.h>

int ConnectClientInfo( int scoid,
                       struct _client_info * info
                       int ngroups );

int ConnectClientInfo_r( int scoid,
                         struct _client_info * info
                         int ngroups );
```

Arguments:

scoid A server connection ID that identifies the client process that you want to get information about. This client is typically a process that's made a connection to the server to try to access a resource. You can get it from the **_msg_info** argument to *MsgReceivev()* or *MsgInfo()*.

info A pointer to a **_client_info** structure that the function can fill with information about the client. For more information, see below.

ngroups The size of the caller's *grouplist* in the credential part of the **_client_info** structure. If you make it smaller than NGROUPS_MAX, you might get information only about a subset of the groups.

Library:

libc

Description:

These calls get information about a client connection identified by *scoid*, and store it in the buffer that *info* points to.

The *ConnectClientInfo()* and *ConnectClientInfo_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

A server uses these functions to determine whether or not a client has permission to access a resource. For example, in a resource manager, it would be called on an *open()* connection request.

`_client_info` structure

The **`_client_info`** structure has at least the following members:

`uint32_t` *nd* The client's node ID.

`pid_t` *pid* The client's process ID.

`struct _cred_info` *cred*
The user and group ID credentials; see below.

`uint32_t` *nd*

The *nd* (node descriptor) is a temporary numeric description of a remote node. For more information, see the Qnet Networking chapter of the *System Architecture* guide.

To:	Use this function:
Compare two *nd* objects	*ND_NODE_CMP()*
Convert a *nd* to text	*netmgr_ndtostr()*
Convert text to a *nd*	*netmgr_strtond()*

`_cred_info` structure

The *cred* member of the **`_client_info`** is a **`_cred_info`** structure that includes at least the following members:

`uid_t` *ruid* The real user ID of the sending process.

`uid_t` *euid* The effective user ID of the sending process.

`uid_t` *suid* The saved user ID of the sending process.

gid_t *rgid* The real group ID of the sending process.

gid_t *egid* The effective group ID of the sending process.

gid_t *sgid* The saved group ID of the sending process.

uint32_t *ngroups*

The number of groups actually stored in *grouplist*.

gid_t *grouplist*[NGROUPS_MAX]

The supplementary group IDs of the sending process.

The *ngroups* argument to *ConnectClientInfo()* indicates the size of the *grouplist* array. If the group array size is zero, the *ngroups* member of the **_cred_info** is set to the number of groups available.

Returns:

The only difference between these functions is the way they indicate errors:

ConnectClientInfo()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

ConnectClientInfo_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, the function can return any value in the Errors section.

Errors:

EFAULT A fault occurred when the kernel tried to access the buffers provided.

EINVAL Process doesn't have a connection *scoid*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectServerInfo(), **_msg_info**, *MsgInfo()*, *MsgReceivev()*, *ND_NODE_CMP()*, *netmgr_ndtostr()*, *netmgr_remote_nd()*, *netmgr_strtond()*

ConnectDetach(), ConnectDetach_r()

Break a connection between a process and a channel

Synopsis:

```
#include <sys/neutrino.h>

int ConnectDetach( int coid );

int ConnectDetach_r( int coid );
```

Arguments:

coid The connection ID of the connection you want to break.

Library:

libc

Description:

The *ConnectDetach()* and *ConnectDetach_r()* kernel calls detach the connection specified by the *coid* argument. If any threads are blocked on the connection (*MsgSendv()*) at the time the connection is detached, the send fails and returns with an error.

These functions are identical except in the way they indicate errors. See the Returns section for details.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ConnectDetach()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

ConnectDetach_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, the function returns a value in the Errors section.

Errors:

EINVAL The connection specified by *coid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), MsgSendv()

Synopsis:

```
#include <sys/neutrino.h>

int ConnectFlags( pid_t pid,
                  int coid,
                  unsigned mask,
                  unsigned bits );

int ConnectFlags_r( pid_t pid,
                    int coid,
                    unsigned mask,
                    unsigned bits );
```

Arguments:

pid The ID of the process that the connection ID belongs to, or 0 for the current process.

coid The ID of the connection whose flags you want to modify.

mask A bitmap that indicates which bits are to be modified in the flags.

bits The new value of the flags. The flags currently defined include:

- _NTO_COF_CLOEXEC — close the connection if the process calls an *exec*()* function to start a new process.

Library:

libc

Description:

The *ConnectFlags()* and *ConnectFlags_r()* kernel calls modify flags associated with the specified connection. These kernel calls don't block.

These functions are identical except in the way they indicate errors. See the Returns section for details.

You need to initialize the bits that correspond to the flag in both the *mask* and *bits* arguments:

- If the bit in the *mask* is 1, and the bit in the *bits* is 1, the function turns the flag on.
- If the bit in the *mask* is 1, and the bit in the *bits* is 0, the function turns the flag off.
- If bit in the mask is 0, the function doesn't change the current value of the flag.

Returns:

The only difference between these functions is the way they indicate errors:

ConnectFlags()

The previous value of the flags associated with the connection. If an error occurs, the function returns -1 and sets *errno*.

ConnectFlags_r()

The previous value of the flags associated with the connection. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

ESRCH The process ID is invalid or the connection ID can't be found.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), fcntl()

ConnectServerInfo(), *ConnectServerInfo_r()*

Get information about a server connection

Synopsis:

```
#include <sys/neutrino.h>

int ConnectServerInfo( pid_t pid,
                       int coid,
                       struct _server_info* info );

int ConnectServerInfo_r( pid_t pid,
                         int coid,
                         struct _server_info* info );
```

Arguments:

pid The process ID of the owner of the connection.

coid The connection ID of the connection.

info A pointer to a **_server_info** structure where the function can store information about the connection. For more information, see below.

Library:

libc

Description:

The *ConnectServerInfo()* and *ConnectServerInfo_r()* kernel calls get information about the connection *coid* owned by process *pid*, and store it in the structure pointed to by *info*. If the process doesn't have a connection *coid*, the call scans for the next higher connection and returns it if present. Otherwise, -1 is returned. If you wish to check for the existence of an exact connection, you must compare the returned connection with the *coid* you requested.

These functions are identical except in the way they indicate errors. See the Returns section for details.

_server_info structure

The _server_info structure that *info* points to includes at least the following members:

uint32_t *nd*	The server's node ID.
pid_t *pid*	The server's process ID.
int32_t *chid*	The server's channel ID.
int32_t *scoid*	The server's connection ID.

uint32_t *nd*

The *nd* (node descriptor) is a temporary numeric description of a remote node. For more information, see the Qnet Networking chapter of the *System Architecture* guide.

To:	Use this function:
Compare two *nd* objects	*ND_NODE_CMP()*
Convert a *nd* to text	*netmgr_ndtostr()*
Convert text to a *nd*	*netmgr_strtond()*

Returns:

The only difference between these functions is the way they indicate errors:

ConnectServerInfo()

A matched *coid*. If an error occurs, the function returns -1 and sets *errno*.

ConnectServerInfo_r()

A matched *coid*. This function does **NOT** set *errno*. If an error occurs, the function returns the negative of a value from the Errors section.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EINVAL	Process *pid* doesn't have a connection >= *coid*.
ESRCH	The process indicated by *pid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), *ConnectClientInfo()*, *MsgInfo()*, *MsgReceivev()*, *ND_NODE_CMP()*, *netmgr_ndtostr()*, *netmgr_remote_nd()*, *netmgr_strtond()*

copysign(), copysignf()

Copy the sign bit from one number to another

Synopsis:

```
#include <math.h>

double copysign ( double x,
                  double y);

float copysignf ( float x,
                  float y );
```

Arguments:

x The number to use the magnitude of.

y The number to use the sign of.

Library:

libm

Description:

The *copysign()* and *copysignf()* functions return the magnitude of *x* and the sign bit of *y*.

If *x* is NAN, the function produces NAN with the sign of *y*.

Returns:

The magnitude of *x* and the sign bit of *y*.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv)
{
   double a, b, c;

   a = 27.0;
```

```
    b = -5;
    c = copysign(a, b);
    printf("The magnitude of %f and sign of %f gives %f\n",
           a, b, c);

    return(0);
}
```

produces the output:

```
The magnitude of 27.000000 and sign of -5.000000 gives -27.000000
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

significand()

cos(), cosf()

Compute the cosine of an angle

Synopsis:

```
#include <math.h>

double cos( double x );

float cosf( float x );
```

Arguments:

x The angle, in radians, for which you want to compute the cosine.

Library:

libm

Description:

These functions compute the cosine of *x* (specified in radians).

☞ An argument with a large magnitude may yield results with little or no significance.

Returns:

The cosine of *x*.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <math.h>
#include <stdio.h>
#include <stdlib.h>
```

```
int main( void )
{
    double value;

    value = cos( M_PI );
    printf( "value = %f\n", value );

    return EXIT_SUCCESS;
}
```

produces the output:

```
value = -1.000000
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

acos(), *errno*, *sin()*, *tan()*

cosh(), coshf()

Compute the hyperbolic cosine

Synopsis:

```
#include <math.h>

double cosh( double x );

float coshf( float x );
```

Arguments:

x The angle, in radians, for which you want to compute the hyperbolic cosine.

Library:

libm

Description:

These functions compute the hyperbolic cosine (specified in radians) of *x*. A range error occurs if the magnitude of *x* is too large.

Returns:

The hyperbolic cosine of *x*.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", cosh(.5) );
```

```
    return EXIT_SUCCESS;
}
```

produces the output:

```
1.127626
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *sinh()*, *tanh()*

creat(), creat64()

Create and open a file (low-level)

Synopsis:

```
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>

int creat( const char* path,
           mode_t mode );

int creat64( const char* path,
             mode_t mode );
```

Arguments:

path The path of the file you want to open.

mode The access permissions that you want to use. For more information, see "Access permissions" in the documentation for *stat()*.

Library:

libc

Description:

The *creat()* and *creat64()* functions create and open the file specified by *path* with the given *mode*.

Calling *creat()* is the same as:

```
open( path, O_WRONLY | O_CREAT | O_TRUNC, mode );
```

Similarly, calling *creat64()* is the same as:

```
open64( path, O_WRONLY | O_CREAT | O_TRUNC | O_LARGEFILE, mode );
```

If *path* exists and is writable, it's truncated to contain no data, and the existing *mode* setting isn't changed.

If *path* doesn't exist, it's created with the access permissions specified by the *mode* argument. The access permissions for the file or directory are specified as a combination of the bits defined in **<sys/stat.h>**.

Returns:

A file descriptor on success, or -1 if an error occurs (*errno* is set).

Errors:

EACCES — Indicates one of the following permission problems:

- Search permission is denied for one of the components in the *path*.
- The file specified by *path* exists, and the permissions specified by *mode* are denied.
- The file specified by *path* doesn't exist, and the file couldn't be created because write permission is denied for the parent directory.

EBADFSYS — While attempting to open *path*, the file itself or a component of its path prefix was found to be corrupted. A system failure — from which no automatic recovery is possible — occurred while the file was being written to or while the directory was being updated. The filesystem must be repaired before proceeding.

EBUSY — The file specified by *path* is a block special device that's already open for writing, or *path* names a file on a filesystem mounted on a block special device that is already open for writing.

EINTR — The call to *creat()* was interrupted by a signal.

EISDIR — The file specified by *path* is a directory and the file creation flags specify write-only or read/write access.

ELOOP — Too many levels of symbolic links.

EMFILE — This process is using too many file descriptors.

ENAMETOOLONG — The length of *path* exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENFILE	Too many files are currently open in the system.
ENOENT	Either the path prefix doesn't exist, or the *path* argument points to an empty string.
ENOSPC	The directory or filesystem that would contain the new file doesn't have enough space available to create a new file.
ENOSYS	The *creat()* function isn't implemented for the filesystem specified by *path*.
ENOTDIR	A component of the path prefix isn't a directory.
EROFS	The file specified by *path* resides on a read-only filesystem.

Examples:

```
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <stdlib.h>

int main( void )
{
    int filedes;

    filedes = creat( "file",
                S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP );
    if( filedes != -1 ) {
        /* process file */

        close( filedes );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

creat() is POSIX 1003.1; *creat64()* is for large-file support

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chsize(), close(), dup(), dup2(), eof(), errno, execl(), execle(), execlp(), execlpe(), execv(), execve(), execvp(), execvpe(), fcntl(), fileno(), fstat(), isatty(), lseek(), open(), read(), sopen(), stat(), tell(), write(), umask()

crypt()

Encrypt a password

Synopsis:

```
#include <unistd.h>

char * crypt( const char * key,
              const char * salt );
```

Arguments:

key A NUL-terminated string (normally a password typed by a user).

salt A two-character string chosen from the set [**a-zA-Z0-9./**]. This function doesn't validate the values for *salt*, and values outside this range may cause undefined behavior. This string is used to perturb the algorithm in one of 4096 different ways.

Library:

libc

Description:

The *crypt()* function performs password encryption. It's based on the Data Encryption Standard algorithm, and also includes code to deter key search attempts.

This function checks only the first eight characters of *key*.

You can obtain a 56-bit key by taking the lowest 7 bits of *key*. The 56-bit key is used to repeatedly encrypt a constant string (usually all zeroes).

Returns:

A pointer to the 13-character encrypted value, or NULL on failure. The first two characters of the encrypted value are the *salt* itself.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

The return value points to static data that's overwritten by each call to *crypt()*.

See also:

encrypt(), *getpass()*, *qnx_crypt()*, *setkey()*

login in the *Utilities Reference*

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ctermid()

Generate the path name of the current controlling terminal

Synopsis:

```
#include <stdio.h>

char * ctermid( char * s );
```

Arguments:

s NULL, or a pointer to a buffer in which the function can store the path name of the controlling terminal. This string should be at least L_ctermid characters long (see **<stdio.h>**).

Library:

libc

Description:

The *ctermid()* function generates a string that contains the path name of the current controlling terminal for the calling process.

☞ If the argument *s* is NULL, the string is built in a static buffer, and the function returns a pointer to the buffer.

Returns:

A pointer to the path name of the controlling terminal, or a pointer to a null string if the function can't locate the controlling terminal.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
  printf( "Controlling terminal is %s\n", ctermid( NULL ) );
  return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Read the *Caveats*

Caveats:

The *ctermid()* function isn't thread-safe if the *s* argument is NULL.

See also:

setsid(), *ttyname()*

ctime(), ctime_r()

Convert calendar time to local time

Synopsis:

```
#include <time.h>

char* ctime( const time_t* timer );

char* ctime_r( const time_t* timer,
               char* buf );
```

Arguments:

timer A pointer to a **time_t** object that contains the time that you want to convert to a string.

buf (*ctime_r()* only) A buffer in which *ctime_r()* can store the resulting string. This buffer must be large enough to hold at least 26 characters.

Library:

libc

Description:

The *ctime()* and *ctime_r()* functions convert the time pointed to by *timer* to local time and formats it as a string containing exactly 26 characters in the form:

```
Tue May  7 10:40:27 2002\n\0
```

This function:	Is equivalent to calling:
ctime()	`asctime( localtime ( timer ) );`
ctime_r()	`asctime_r( localtime ( timer ), buf )`

The *ctime()* function places the result string in a static buffer that's reused each time *ctime()* or *asctime()* is called. The result string for *ctime_r()* is contained in the buffer pointed to by *buf*.

All fields have a constant width. The newline character **'\n'** and NUL character **'\0'** occupy the last two positions of the string.

Whenever the *ctime()* or *ctime_r()* functions are called, the *tzset()* function is also called.

The calendar time is usually obtained by using the *time()* function. That time is Coordinated Universal Time (UTC) (formerly known as Greenwich Mean Time (GMT)).

You typically set the time on the computer with the **date** command to reflect Coordinated Universal Time (UTC), and then use the **TZ** environment variable or **_CS_TIMEZONE** configuration string to establish the local time zone. For more information, see "Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*.

Returns:

A pointer to the string containing the formatted local time, or NULL if an error occurs.

Classification:

ctime() is ANSI, POSIX 1003.1; *ctime_r()* is POSIX 1003.1

ctime()

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	No

ctime_r()

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *asctime()* and *ctime()* functions place their results in a static buffer that's reused for each call to *asctime()* or *ctime()*.

See also:

asctime(), asctime_r(), clock(), difftime(), gmtime(), localtime(), localtime_r(), mktime(), strftime(), time(), tzset()

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

daemon()

Run a process in the background

Synopsis:

```
#include <stdlib.h>

int daemon( int nochdir,
            int noclose );
```

Arguments:

nochdir If this argument is 0 — the current working directory to the root (`/`) is changed.

noclose If this argument is 0 — standard input, standard output and standard error to **`/dev/null`** are redirected.

Library:

`libc`

Description:

The *daemon()* function allows programs to detach themselves from the controlling terminal and run in the background as system daemons.

This function calls *fork()* and *setsid()*.

The controlling terminal behaves like the behavior intended in Unix System Version, Release 4. An *open()* on a terminal device not already associated with another session will cause the device to become the controlling terminal for that process.

Returns:

Zero for success, or -1 if an error occurs (*errno* is set).

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	No

Caveats:

Currently, *daemon()* is supported only in single-threaded applications. If you create a thread and then call *daemon()*, the function returns -1 and sets *errno* to ENOSYS.

See also:

fork(), *procmgr_daemon()*, *setsid()*

Indicator of support for daylight saving time in the locale

Synopsis:

```
#include <time.h>

unsigned int daylight;
```

Description:

This global variable has a value of 1 when daylight saving time is supported in this locale, and 0 otherwise. Whenever you call a time function, *tzset()* is called to set the variable, based on the current time zone.

Classification:

QNX Neutrino

See also:

timezone, *tzname*, *tzset()*

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

DebugBreak()

Enter the process debugger

Synopsis:

```
#include <sys/neutrino.h>

void DebugBreak( void );
```

Library:

libc

Description:

The *DebugBreak()* kernel call activates the process debugger if you're debugging the calling process. If not, it sends a SIGTRAP signal to the process.

Blocking states

None.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

If you call *DebugBreak()* from an interrupt handler, it'll activate the *kernel* debugger (if it's present in your boot image) or send the process a SIGTRAP signal.

See also:

DebugKDBreak(), DebugKDOutput()

DebugKDBreak()

Enter the kernel debugger

Synopsis:

```
#include <sys/neutrino.h>

void DebugKDBreak( void );
```

Library:

libc

Description:

The *DebugKDBreak()* kernel call activates the kernel debugger if it's present in your boot image. If not, nothing happens.

Blocking states

None.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

DebugBreak(), *DebugKDOutput()*

DebugKDOutput()

Print text with the kernel debugger

Synopsis:

```
#include <sys/neutrino.h>

void DebugKDOutput( const char* str,
                    size_t size );
```

Arguments:

str The string that you want to print.

size The number of characters to print.

Library:

libc

Description:

The *DebugKDBreak()* kernel call causes the kernel debugger to print *size* characters from *str* if the kernel debugger is present in your boot image. If it isn't in your boot image, nothing happens.

When, where, and how the kernel debugger displays this message depends on which host debugger you're using.

Blocking states

None.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

DebugBreak(), *DebugKDBreak()*

delay()

Suspends a calling thread for a given length of time

Synopsis:

```
#include <unistd.h>

unsigned int delay( unsigned int duration );
```

Arguments:

duration The number of milliseconds for which to suspend the calling thread from execution.

Library:

libc

Description:

The *delay()* function suspends the calling thread for *duration* milliseconds.

The suspension time may be greater than the requested amount, due to the scheduling of other, higher-priority threads by the system.

Returns:

0 for success, or the number of unslept milliseconds if interrupted by a signal.

Errors:

If an error occurs, *errno* is set to:

EAGAIN No timer resources were available to satisfy the request.

Examples:

```
#include <unistd.h>
#include <stdlib.h>

void play_sound( void )
{
    ...
}

void stop_sound( void )
{
    ...
}

int main( void )
{
    play_sound();
    delay( 500 );  /* delay for 1/2 second */
    stop_sound();

    return EXIT_SUCCESS;
}
```

Classification:

QNX 4

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

alarm(), *errno*, *nanosleep()*, *nap()*, *napms()*, *sleep()*

devctl()

Control a device

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>
#include <devctl.h>

int devctl( int filedes,
            int dcmd,
            void * dev_data_ptr,
            size_t n_bytes,
            int * dev_info_ptr );
```

Arguments:

filedes
: A file descriptor that you obtained by opening the device.

dcmd
: A device-specific command for the process managing the open device. The set of valid device-control commands, the associated data interpretation, the returned *dev_info_ptr* values, and the effect of the command on the device all depend on the device driver.

  For specific commands, see the **<sys/dcmd_*.h>** header files; for general information, see "Device-control commands," below.

dev_data_ptr
: Depending on the command, this argument is one of:

  - a pointer to a buffer containing data to be passed to the driver
  - a receiving area for data coming from the driver
  - both of the above
  - NULL.

n_bytes
: The size of the data to be sent to the driver, or the maximum size of the data to be received from the driver. *MsgSend()* is used to transfer the data.

dev_info_ptr A pointer to a location that the device to can use to return additional status information instead of just success or failure. The data returned via *dev_info_ptr* depends on the device driver.

Library:

libc

Description:

The *devctl()* function sends the device-specific command *dcmd* to the process managing the device opened as *filedes*. For example, you can send commands to specify properties for devices such as keyboards, sound cards or serial ports.

Device-control commands

Use these macros to set up the device-control commands:

__DIOF(*class*, *cmd*, *data*)

Get information from the device.

__DION(*class*, *cmd*)

A command with no associated data.

__DIOT(*class*, *cmd*, *data*)

Pass information to the device.

__DIOTF(*class*, *cmd*, *data*)

Pass some information to the device, and get some from it.

The arguments to these macros are:

class The major category for the command. The device-control commands are divided into the following classes to make organization easier:

- _DCMD_ALL — Common (all I/O servers).

- _DCMD_CAM — Low-level (Common Access Method) devices, such as disks or CD-ROMs.
- _DCMD_CHR — Character devices.
- _DCMD_FSYS, _DCMD_BLK — Filesystem/block I/O managers.
- _DCMD_INPUT — Input devices.
- _DCMD_IP — Internet Protocol.
- _DCMD_MEM — Memory card.
- _DCMD_MISC — Miscellaneous commands.
- _DCMD_MIXER — Mixer (Audio).
- _DCMD_NET — Network devices.
- _DCMD_PHOTON — Photon.
- _DCMD_PROC — Process manager.

cmd The specific command in the class.

data The type of data to pass to and/or from the device. The *dev_data_ptr* argument to *devctl()* must be a pointer to this type of data, and *n_bytes* is usually the size of this type of data.

The size of the structure that's passed as the last field to the *__DIO** macros **must** be less than 2^14 == 16K. Anything larger than this interferes with the upper two directional bits.

Resource managers can use the following macros, which are defined in **<devctl.h>**, when handling commands:

get_device_command(*cmd*)

Extract the class and the specific device command from *cmd* (i.e. strip off the data type and the direction).

get_device_direction(*cmd*)

Get the direction of the command (DEVDIR_TO, DEVDIR_FROM, DEVDIR_TOFROM, or DEVDIR_NONE).

Returns:

EOK	Success.
EAGAIN	The *devctl()* command couldn't be completed because the device driver was in use by another process, or the driver was unable to carry out the request due to an outstanding command in progress.
EBADF	Invalid open file descriptor, *filedes*.
EINTR	The *devctl()* function was interrupted by a signal.
EINVAL	The device driver detected an error in *dev_data_ptr* or *n_bytes*.
EIO	The *devctl()* function couldn't complete because of a hardware error.
ENOSYS	The device doesn't support the *dcmd* command.
ENOTTY	The *dcmd* argument isn't a valid command for this device.
EPERM	The process doesn't have sufficient permission to carry out the requested command.

Examples:

Example 1: Setting RTS on a serial port

Here's a quick example of setting and unsetting RTS (Request to Send) on a serial port:

```
/* For "devctl()" */
#include <devctl.h>
#include <sys/dcmd_chr.h>

/* For "open()" */
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>

/* For Errors */
#include <stdlib.h>
#include <stdio.h>
```

```
int check_RTS(int fd);

int main(void)
{
    int data = 0, fd, error;

    if((fd = open ("/dev/ser2", O_RDONLY)) == -1)
    {
     fprintf(stderr, "Error with open() on /dev/ser2.  Make sure exists.\n");
     perror (NULL);
     exit(EXIT_FAILURE);
    }

    check_RTS(fd);

    /* Let's turn ON RTS now. */
    data = _CTL_RTS_CHG | _CTL_RTS;

    if (error = devctl (fd, DCMD_CHR_SERCTL, &data, sizeof(data), NULL))
    {
    fprintf(stderr, "Error setting RTS: %s\n",
        strerror ( error ));
        exit(EXIT_FAILURE);
    }
    /* RTS should now be ON. */

    check_RTS(fd);

    sleep (2);


    /* Now let's turn RTS OFF. */
    data = _CTL_RTS_CHG | 0;

    if (error = devctl (fd, DCMD_CHR_SERCTL, &data, sizeof(data), NULL))
    {
        fprintf(stderr, "Error setting RTS: %s\n",
            strerror ( error ));
        exit(EXIT_FAILURE);
    }
    /* RTS should now be OFF. */

    check_RTS(fd);

    close(fd);

    return (1);
}


int check_RTS(int fd)
{
    int data = 0, error;

    /*
     Let's see if RTS is set, tell devctl() we're requesting
     line status information and devctl() then assigns data
     the line status information for us. Too easy.
    */
```

```
    if (error = devctl (fd, DCMD_CHR_LINESTATUS, &data,
                        sizeof(data), NULL))
    {
       fprintf(stderr, "Error setting RTS: %s\n",
           strerror ( error ));
       exit(EXIT_FAILURE);
    }

    if (data & _LINESTATUS_SER_RTS)

        printf("RTS is SET!\n");

    else

        printf("RTS is NOT set\n");

    return(1);
}
```

The two main areas of interest are the setting of *data* and the *devctl()* call. The data variable is used for both sending and receiving data.

When setting RTS, *data* is assigned a value that's sent to the device via *devctl()*.

If *data* equals:	RTS is turned:
_CTL_RTS_CHG | _CTL_RTS	ON
_CTL_RTS_CHG	OFF

When checking to see if RTS is set, we call *devctl()* with *dcmd* set to the DCMD_CHR_LINESTATUS macro and *data* containing any value (zero is clean). The *devctl()* function returns with *data* containing the Line Status value. This then can be used to determine what lines are set on that device. In our example, we check against _LINESTATUS_SER_RTS.

To find out what values to use with different DCMD_* commands, look in the appropriate **<sys/dcmd_*.h>**header file. For example, you'll find macros for the following values under DCMD_CHR_LINESTATUS in **<sys/dcmd_chr.h>**:

- Serial Port (DTR, RTS, CTS, DSR, RI, CD)

- Keyboard (Scroll/Caps/Num Lock, Shift, CTRL, ALT)
- Parallel Port (No Error, Selected, Paper Out, No Tack, Not Busy)

The value that's in the header is a "bitwise &" with the value in *data* to see if the value is high for that line.

Example 2: Cycling through Caps Lock, Num Lock, and Scroll Lock

In the following example, we open the device **/dev/kbd** and we start applying changes to the Caps Lock, Scroll Lock, and Num Lock properties.

The key lines in this example are the same as in the last example; they focus around the data variable. This value is just a simple integer value that's passed into the *devctl()* function. The data variable is assigned its values by simply performing a bitwise OR to the predefined values in the **</usr/include/sys/dcmd_chr.h>** header. Note the values used in the bitwise OR:

- _CONCTL_NUM_CHG (Console Control Num Lock Change) ORed together with _CONCTL_NUM (Console Control Num Lock) turns on Num Lock.
- _CONCTL_NUM_CHG on its own turns off Num Lock.

If *data* equals:	Num Lock is turned:
_CONCTL_NUM_CHG | _CONCTL_NUM	ON
_CONCTL_NUM_CHG	OFF

This also applies for the other either/or values in the **<dcmd_chr.h>** header.

```
/* For "devctl()" */
#include <devctl.h>
#include <sys/dcmd_chr.h>

/* For "open()" */
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
```

```
/* For Errors */
#include <stdlib.h>
#include <stdio.h>


int main(void)
{
    int data, fd, toggle = 1, error;

    /* Open the device we wish to manipulate. */
    if((fd = open ("/dev/kbd", O_RDONLY)) == -1)
    {
     fprintf(stderr, "Error with open() on /dev/kbd.  Make sure exists.\n");
     perror (NULL);
     exit(EXIT_FAILURE);
    }

    while(1)
    {
    switch(toggle)
    {
        case 1:
        {
          /*
           Turn on Num Lock and make sure that
           Caps and Scroll lock are turned off.
          */
          data = (_CONCTL_NUM_CHG | _CONCTL_NUM) | _CONCTL_CAPS_CHG | _CONCTL_SCROLL_CHG;
          break;
        }
        case 2:
        {
          /*
           Turn off Num Lock and now turn on Caps Lock
           (Scroll lock is already off).
          */
          data = _CONCTL_NUM_CHG | (_CONCTL_CAPS_CHG | _CONCTL_CAPS);
          break;
        }
        case 3:
        {
          /*
           Turn off Caps lock and turn on Scroll lock
           (Num lock is already off).
          */
          data = _CONCTL_CAPS_CHG | (_CONCTL_SCROLL_CHG | _CONCTL_SCROLL);
          toggle = 0;
          break;
        }
    }

    /* Explanation below. */
    if (error = devctl (fd, DCMD_CHR_SERCTL, &data,
                        sizeof(data), NULL))
    {
        fprintf(stderr, "Error setting KBD: %s\n",
            strerror ( error ));
        exit(EXIT_FAILURE);
    }
```

```
    sleep(1);
    toggle++;
    }

    return (1);
}
```

Here's a quick explanation of the above *devctl()* call:

```
devctl (fd, DCMD_CHR_SERCTL, &data, sizeof(data), NULL)
```

The first parameter, *fd*, is the file descriptor of the device that's being changed. The second parameter is the device class that's being changed. In this case, it's a character device DCMD_CHR, with a "subclass" of _SERCTL. The third parameter is the data variable; this is the ORed value.

Example 3: Duration example

In this code, *tcdropline()*, which is used to disconnect a communications line, uses *devctl()* (this is the actual source code, *tcdropline()* is a standard library function):

```
#include <termios.h>
#include <devctl.h>
#include <errno.h>
#include <sys/dcmd_chr.h>

int tcdropline(int fd, int duration) {
    int error;

    duration = ((duration ? duration : 300) << 16) |
      _SERCTL_DTR_CHG | 0;

    if(error = devctl(fd, DCMD_CHR_SERCTL, &duration, sizeof duration, 0) == -1) {
       if(error == ENOSYS) {
          errno = ENOTTY;
       }
       return -1;
    }
    return 0;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

When *devctl()* fails, the effect of the failed command depends on the device driver. The corresponding data might be transferred, partially transferred, or not transferred at all.

The *devctl()* function was originally part of the POSIX 1003.1d draft standard; but it was deprecated in the IEEE ***Approved*** *Draft 10* standard.

See also:

close(), open(), read(), write()

difftime()

Calculate the difference between two times

Synopsis:

```
#include <time.h>

double difftime( time_t time1,
                 time_t time0 );
```

Arguments:

time1, *time0* The times to compare, expressed as **time_t** objects.

Library:

libc

Description:

The *difftime()* function calculates the difference between the calendar times specified by *time1* and *time0*:

time1 - time0

Returns:

The difference between the two times (in seconds).

Examples:

```
#include <stdio.h>
#include <time.h>
#include <stdlib.h>

void compute( void )
{
    int i, j;

    for( i = 1; i <= 20; i++ ) {
        for( j = 1; j <= 20; j++ ) {
            printf( "%3d ", i * j );
        }
        printf( "\n" );
    }
}
```

```
int main( void )
{
    time_t start_time, end_time;

    start_time = time( NULL );
    compute();
    end_time = time( NULL );
    printf( "Elapsed time: %f seconds\n",
        difftime( end_time, start_time ) );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

asctime(), clock(), ctime(), gmtime(), localtime(), mktime(), strftime(), time(), tzset()

dircntl()

Control an open directory

Synopsis:

```
#include <dirent.h>

int dircntl( DIR * dir,
             int cmd,
             ... );
```

Arguments:

dir Provide control for this directory.

cmd At least the following values are defined in **<dirent.h>**:

- D_GETFLAG — retrieve the flags associated with the directory referenced by *dir*. For more information, see "Flag values," below.
- D_SETFLAG — set the flags associated with the directory referenced by *dir* to the value given as an additional argument. The new value can be any combination of the flags described in "Flag values," below.

Library:

libc

Description:

The *dircntl()* function provides control over the open directory referenced by the *dir* argument. This function behaves in a manner similar to the file control function, *fcntl()*.

Flag values

D_FLAG_FILTER

Filter out duplicate name entries that may occur due to the union filesystem during a *readdir()* operation.

D_FLAG_STAT

Indicate to servers that they should attempt to return extra *stat()* information as part of the *readdir()* operation.

Returns:

The return value depends on the value of *cmd*:

D_GETFLAG	The flags associated with the directory, or -1 if an error occurs (*errno* is set).
D_SETFLAG	0 for success, or -1 if an error occurs (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <dirent.h>

int main(int argc, char **argv) {
    DIR *dp;
    int ret;

    if(!(dp = opendir("/"))) {
        exit(EXIT_FAILURE);
    }

    /* Display the flags that are set on the
       directory by default*/
    if((ret = dircntl(dp, D_GETFLAG)) == -1) {
        exit(EXIT_FAILURE);
    }

    if(ret & D_FLAG_FILTER) {
        printf("Directory names are filtered\n");
    } else {
        printf("Directory names are not filtered\n");
    }

    if(ret & D_FLAG_STAT) {
        printf("Servers asked for extra stat information\n");
    } else {
        printf("Servers not asked for extra stat information\n");
    }

    closedir(dp);

    return 0;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fcntl(), opendir()

dirname()

Find the parent directory part of a file pathname

Synopsis:

```
#include <libgen.h>

char *dirname( char *path );
```

Arguments:

path The string to parse.

Library:

libc

Description:

The *dirname()* function takes a pointer to a character string that contains a pathname, and returns a pointer to a string that's a pathname of the parent directory of that file. Trailing "/" characters in the path aren't counted as part of the path.

If the path *doesn't* contain a "/" character, or *path* is a NULL pointer or points to an empty string, then *dirname()* function returns a pointer to the string **"."** (dot).

Together the *dirname()* and *basename()* functions yield a complete pathname. The expression *dirname*(*path*) obtains the pathname of the directory where *basename*(*path*) is found.

Returns:

A pointer to a string that's the parent directory of *path*. If *path* is a NULL pointer or points to an empty string, a pointer to a string **"."** is returned.

Examples:

String input	String output
"/usr/lib"	"/usr"
"/usr/"	"usr"
"/"	"/"
"."	"."
".."	"."

The following code fragment reads a pathname, changes the current working directory to the parent directory, and opens the file:

```
char path[BUFF_SIZE], *pathcopy;
int fd;

fgets(path, BUFF_SIZE, stdin);
pathcopy = strdup(path);
chdir(dirname(pathcopy));
fd = open(basename(path), O_RDONLY);
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

basename()

dispatch_block()

Block while waiting for an event

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

dispatch_context_t * dispatch_block
                     ( dispatch_context_t * ctp );
```

Arguments:

ctp A pointer to a **dispatch_context_t** structure that defines the dispatch context.

Library:

libc

Description:

The *dispatch_block()* function blocks while waiting for an event (e.g. message or signal) that's registered using one of the attach functions, *message_attach()*, *pulse_attach()*, *resmgr_attach()*, or *select_attach()*. (The *sigwait_attach()* function isn't currently implemented.)

If the type of blocking is:	*dispatch_block()* does a:
message (resmgr, message, select)	*MsgReceive()*
signal	*SignalWaitinfo()*

Returns:

A dispatch context that's passed in by *dispatch_context_alloc()*. or NULL if an error occurs (*errno* is set).

Errors can occur when the blocking kernel call returns with an error, for example, due to the delivery of a signal.

☞ In the case of a timeout, a valid *ctp* is returned, but either the *ctp->message_context.rcvid* or *ctp->sigwait_context.signo* is set to -1.

If a non-NULL context pointer is returned, it could be different from the one passed in, as it's possible for the *ctp* to be reallocated to a larger size. In this case, the old *ctp* is no longer valid. However, if NULL is returned (for example, because a signal interrupted the *MsgReceive()*), the old context pointer is still valid. Typically, a resource manager would target signals to a thread dedicated to handling signals. However, if a signal can be targeted to the thread doing *dispatch_block()*, you could use the following code in this situation:

```
dispatch_context_t   *ctp, *new_ctp;

ctp = dispatch_context_alloc( ... );
while (1) {
   new_ctp = dispatch_block( ctp );
   if ( new_ctp ) {
      ctp = new_ctp
      }
   else {
      /* handle the error condition */
      .
      .
      .
      }
}
```

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers.
EINTR	The call was interrupted by a signal.
EINVAL	Invalid arguments passed to *dispatch_block()*.
ENOMEM	Insufficient memory to allocate internal data structures.

See also the error constants returned in *MsgReceive()* and *SignalWaitinfo()*.

Examples:

```
#include <sys/dispatch.h>

int main( int argc, char **argv ) {
   dispatch_context_t   *ctp;

   .
   .
   .

   for(;;) {
     if( ctp = dispatch_block( ctp ) ) {
       dispatch_handler( ctp );
     }
   }
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

dispatch_context_alloc(), *dispatch_handler()*, *dispatch_timeout()*, *dispatch_unblock()*

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

dispatch_context_alloc()

Return a dispatch context

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

dispatch_context_t * dispatch_context_alloc
                     ( dispatch_t * dpp );
```

Arguments:

dpp A dispatch handle created by *dispatch_create()*.

Library:

libc

Description:

The *dispatch_context_alloc()* function returns a dispatch context pointer. The function is passed in the handle *dpp* from *dispatch_create()*. The dispatch context is used by dispatch to do its work. It's passed as an argument to *dispatch_block()* and *dispatch_handler()*.

☞ The *dispatch_context_alloc()* function fails if you haven't attached any events to dispatch yet (e.g. you didn't call *message_attach()*, *resmgr_attach()*, or *select_attach()*). The dispatch library can't allocate a proper context until it knows what kind of events you want to block.

Returns:

A pointer to a dispatch context, or NULL if an error occurs (*errno* is set).

Errors:

EINVAL	No events were attached.
ENOMEM	Insufficient memory to allocate context.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   dispatch_t           *dpp;
   dispatch_context_t   *ctp;

   if( ( dpp = dispatch_create() ) == NULL ) {
     fprintf( stderr, "%s: Unable to allocate \
              dispatch handle.\n",argv[0] );
     return EXIT_FAILURE;
   }

   &vellip;

   ctp = dispatch_context_alloc( dpp );

   &vellip;

   return EXIT_SUCCESS;
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No

continued...

Safety	
Thread	Yes

See also:

dispatch_block(), dispatch_context_free(), dispatch_create(), dispatch_handler(), dispatch_unblock()

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

dispatch_context_free()

Free a dispatch context

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

void dispatch_context_free(
        dispatch_context_t * ctp );
```

Arguments:

ctp A pointer to a **dispatch_context_t** structure that was allocated by *dispatch_context_alloc()*.

Library:

libc

Description:

The *dispatch_context_free()* function frees the given dispatch context.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   dispatch_t           *dpp;
   dispatch_context_t   *ctp;

   if( ( dpp = dispatch_create() ) == NULL ) {
     fprintf( stderr, "%s: Unable to allocate
              dispatch handle.\n",argv[0] );
     return EXIT_FAILURE;
   }

   .
   .
   .

   ctp = dispatch_context_alloc( dpp );

   .
   .
   .

   dispatch_context_free ( ctp );
```

```
    return EXIT_SUCCESS;
}
```

See *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()* for examples using the dispatch interface.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

dispatch_context_alloc()

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

dispatch_create()

Allocate a dispatch handle

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

dispatch_t *dispatch_create( void );
```

Library:

libc

Description:

The *dispatch_create()* function allocates and initializes a dispatch handle. The attach functions are:

- *message_attach()*
- *pulse_attach()*
- *resmgr_attach()*
- *select_attach()*

If you wish, you can do a *resmgr_attach()* with a NULL path. This has the effect of initializing dispatch to receive messages and creates the channel among other things.

☞ A channel is created only when you first attach something that requires a channel (indicating you will block receiving messages).

Returns:

A handle to a dispatch structure, or NULL if an error occurs.

☞ The dispatch structure, **dispatch_t**, is an opaque data type; you can't access its contents directly.

Errors:

ENOMEM Insufficient memory to allocate context.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <stddef.h>
#include <fcntl.h>
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int my_func( select_context_t *ctp, int fd,
             unsigned flags, void *handle ) {
   int   i, c;

   /* Do some useful stuff with data */
   i = read( fd, &c, 1 );
   fprintf( stderr, "activity on fd %d: read char %c,
                     return code %d\n", fd, c, i );
}

int main( int argc, char **argv ) {
   dispatch_t           *dpp;
   dispatch_context_t   *ctp;
   select_attr_t        attr;
   int                  fd, fd2;

   if( ( dpp = dispatch_create() ) == NULL ) {
     fprintf( stderr, "%s: Unable to allocate \
              dispatch handle.\n",argv[0] );
     return EXIT_FAILURE;
   }

   if( argc ≤ 2 || (fd = open( argv[1],
                    O_RDWR | O_NONBLOCK )) == -1 ) {
     return EXIT_FAILURE;
   }

   if( argc ≤ 2 || (fd2 = open( argv[2],
                    O_RDWR | O_NONBLOCK )) == -1 ) {
     return EXIT_FAILURE;
   }

   select_attach( dpp, &attr, fd,
      SELECT_FLAG_READ | SELECT_FLAG_REARM, my_func, NULL );
   select_attach( dpp, &attr, fd2,
      SELECT_FLAG_READ | SELECT_FLAG_REARM, my_func, NULL );
   ctp = dispatch_context_alloc( dpp );
```

```
    for(;;) {
      if( ctp = dispatch_block( ctp ) ) {
        dispatch_handler( ctp );
      }
    }
    return EXIT_SUCCESS;
}
```

For more examples using the dispatch interface, see *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

dispatch_block(), *dispatch_context_alloc()*, *dispatch_destroy()*, *dispatch_handler()*, *dispatch_timeout()*, *dispatch_unblock()* *message_attach()*, *pulse_attach()*, *resmgr_attach()*, *select_attach()*

dispatch_destroy()

Destroy a dispatch handle

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int dispatch_destroy( dispatch_t *dpp );
```

Arguments:

dpp A dispatch handle created by *dispatch_create()*.

Library:

libc

Description:

The function *dispatch_destroy()* destroys the given dispatch handle.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL The dispatch handle, *dpp*, is invalid.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   dispatch_t    *dpp;
   int           destroyed;

   if( ( dpp = dispatch_create() ) == NULL ) {
     fprintf( stderr, "%s: Unable to allocate \
              dispatch handle.\n",argv[0] );
     return EXIT_FAILURE;
```

```
    }

    .
    .
    .

    if ( (destroyed = dispatch_destroy ( dpp )) == -1 ) {
        fprintf ( stderr, "Dispatch wasn't destroyed, \
                  bad dispatch handle %d.\n", dpp);
        return EXIT_FAILURE;
    }
    /* else dispatch was destroyed */

    .
    .
    .
    return EXIT_SUCCESS;
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

dispatch_create()

dispatch_handler()

Handle events received by dispatch_block()

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int dispatch_handler( dispatch_context_t * ctp );
```

Arguments:

ctp A pointer to a **dispatch_context_t** structure that was allocated by *dispatch_context_alloc()*.

Library:

libc

Description:

The *dispatch_handler()* function handles events received by *dispatch_block()*. Depending on the blocking type, *dispatch_handler()* does one of the following:

- Calls the *message_** subsystem. A search is made (based upon the message type or pulse code) for a matching function (that was attached with *message_attach()* or *pulse_attach()*). If a match is found, the attached function is called.
- If the message type is in the range handled by the resource manager (e.g. I/O messages) and pathnames were attached using *resmgr_attach()*, then the *resmgr_** subsystem is called and handles the resource manager messages.
- If a pulse is received, it may be dispatched to the *resmgr_** subsystem if it's one of the codes (unblock and disconnect pulses) handled by the resource manager. If a *select_attach()* was done and the pulse matches the one used by *select_attach()*, then the *select_** subsystem is called and dispatches that event.
- If a message is received, and no matching handler is found for that message type, *MsgError()* returns ENOSYS to the sender.

- If a *SignalWaitinfo()* blocking type is used, then a search is made based upon the signal number for a matching function attached by the program (using the *sigwait_attach()* function, not currently implemented). If a match is found, that function is called.

Returns:

0 Success.

-1 One of the following occurred:

- The message was a _PULSE_CODE_THREADDEATH pulse message (see *ChannelCreate()*) for which there's no default handler function.
- The message length was less than 2 bytes. A 2-byte message type is required at the beginning of the message so that a handler function can be found or identified.
- The message wasn't in native endian format and there were no handler functions that specified MSG_FLAG_CROSS_ENDIAN on this range, even though a handler was registered for it using *message_attach()*. The MSG_FLAG_CROSS_ENDIAN flag wasn't given to *message_attach()*.
- A handler was found for the message, but the handler determined that there was a problem.

In any case, if the message wasn't a pulse, then the client will be replied to with an appropriate *errno*.

Examples:

```
#include <stdlib.h>
#include <sys/dispatch.h>

int main( int argc, char **argv ) {
   dispatch_context_t   *ctp;

   .
   .
   .

   for(;;) {
     if( ctp = dispatch_block( ctp ) ) {
```

```
        dispatch_handler( ctp );
      }
    }
    return EXIT_SUCCESS;
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

This function might or might not be a cancellation point, depending on the implementation of the handler.

See also:

dispatch_block(), *dispatch_create()*, *dispatch_timeout()*

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

dispatch_timeout()

Set a timeout

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int dispatch_timeout( dispatch_t *dpp,
                      struct timespec *reltime );
```

Arguments:

dpp A dispatch handle created by *dispatch_create()*.

reltime A pointer to a **timespec** structure that specifies the relative time of the timeout.

Library:

libc

Description:

The function *dispatch_timeout()* sets a timeout that's used when blocking with *dispatch_block()*.

Returns:

0 Success.

-1 An error occurred.

Examples:

```
#include <sys/dispatch.h>
#include <time.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   dispatch_t           *dpp;
   struct timespec      time_out;
   int                  timedout;
   time_out.tv_sec = 1;
   time_out.tv_nsec = 2;
```

```
    if( ( dpp = dispatch_create() ) == NULL ) {
      fprintf( stderr, "%s: Unable to allocate \
               dispatch handle.\n",argv[0] );
      return EXIT_FAILURE;
    }

    .
    .
    .

    if ( (timedout = dispatch_timeout ( dpp, &time_out ))
          == -1 ) {
        fprintf ( stderr, "Couldn't set timeout );
        return EXIT_FAILURE;
    }
    /* else successful timeout set */

    .
    .
    .
    return EXIT_SUCCESS;
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

dispatch_block(), *dispatch_create()*, *dispatch_handler()*, *dispatch_unblock()* **timespec**

dispatch_unblock()

Unblock all of the threads that are blocked on a dispatch handle

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

void dispatch_unblock( dispatch_context_t * ctp );
```

Arguments:

ctp A pointer to a **dispatch_context_t** structure that defines the dispatch context.

Library:

libc

Description:

This routine tries to unblock all of the threads that are blocked on the given dispatch handle. You should use this function in the thread pool structure as the unblock function pointer so that *thread_pool_control()* will behave properly.

Currently, this function unblocks only channel resources.

Examples:

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

dispatch_block(), *dispatch_context_alloc()*, *dispatch_handler()*, *dispatch_timeout()*

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

div()

Calculate a quotient and remainder

Synopsis:

```
#include <stdlib.h>

div_t div( int numer,
           int denom );
```

Arguments:

numer The numerator in the division.

denom The denominator.

Library:

libc

Description:

The *div()* function calculates the quotient and remainder of the division of *numer* by *denom*.

Returns:

A **div_t** structure containing the quotient and remainder:

```
typedef struct {
    int quot;       /* quotient  */
    int rem;        /* remainder */
} div_t;
```

Examples:

```
#include <stdio.h>
#include <stdlib.h>

void print_time( int seconds )
{
     div_t min_sec;

     min_sec = div( seconds, 60 );
     printf( "It took %d minutes and %d seconds\n",
```

```
            min_sec.quot, min_sec.rem );
}

int main( void )
{
    print_time( 130 );

    return EXIT_SUCCESS;
}
```

produces the output:

```
It took 2 minutes and 10 seconds
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

ldiv()

dladdr()

Translate an address to symbolic information

Synopsis:

```
#include <dlfcn.h>

int dladdr( void *address,
            Dl_info *dlip );
```

Arguments:

address The address for which you want symbolic information.

dlip A pointer to a **Dl_info** structure where the function can store the symbolic information. Your application must allocate the space for this structure; *dladdr()* fills in the members, based on the specified address.

The **Dl_info** structure includes the following members:

- **const char *** *dli_fname* — a pointer to the filename of the object containing *address*.
- **void ***dli_fbase* — the base address of the object containing *address*.
- **const char ***dli_sname* — a pointer to the symbol name nearest the specified *address*. This symbol is either at *address*, or is the nearest symbol with a lower address.
- **void ***dli_saddr* — the actual address of the *dli_sname* symbol.

If *dladdr()* can't find a symbol that describes the specified *address*, the function sets *dli_sname* and *dli_saddr* to NULL.

Library:

libc

Description:

The *dladdr()* function determines whether the specified *address* is located within one of the objects that make up the calling application's address space.

The *dladdr()* function is available only to dynamically linked processes.

Returns:

0 if the specified *address* can't be matched, or nonzero if it could be matched.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The `Dl_info` pointers may become invalid if objects are removed via *dlclose()*.

There's no way to determine which symbol you'll get if multiple symbols are mapped to the same address.

See also:

dlclose(), dlerror(), dlopen(), dlsym()

dlclose()

Close a shared object

Synopsis:

```
#include <dlfcn.h>

int dlclose( void *handle );
```

Arguments:

handle A handle for a shared object, returned by *dlopen()*.

Library:

libc

Description:

The *dlclose()* function disassociates a shared object opened by *dlopen()* from the calling process. An object's symbols are no longer available after it's been closed with *dlclose()*. All objects loaded as a result of the closed objects dependencies are also closed.

The *handle* argument is the value returned by a previous call to *dlopen()*.

The *dlclose()* function is available only to dynamically linked processes.

Returns:

0 for success, or a nonzero value if an error occurs.

Errors:

If an error occurs, more detailed diagnostic information is available from *dlerror()*.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

An object won't be removed from the address space until all references to that object (via *dlopen()* or dependencies from other objects) have been closed.

Referencing a symbol in a closed object can cause undefined behavior.

See also:

dladdr(), dlerror(), dlopen(), dlsym()

dlerror()

Get dynamic loading diagnostic information

Synopsis:

```
#include <dlfcn.h>

char *dlerror( void );
```

Library:

libc

Description:

The *dlerror()* function returns a NULL-terminated string (with no trailing newline) describing the last error that occurred during a call to one of the *dl*()* functions. If no errors have occurred, *dlerror()* returns NULL.

The *dlopen()* function is available only to dynamically linked processes.

Returns:

A pointer to an error description, or NULL.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

dladdr(), dlclose(), dlopen(), dlsym()

dlopen()

Gain access to an executable object file

Synopsis:

```
#include <dlfcn.h>

void * dlopen( const char * pathname,
               int mode );
```

Arguments:

pathname	NULL, or the path to the executable object file that you want to access.
mode	Flags that control how *dlopen()* operates; see "The *mode*," below.

Library:

libc

Description:

The *dlopen()* function gives you direct access to the dynamic linking facilities by making the executable object file specified in *pathname* available to the calling process. It returns a handle that you can use in subsequent calls to *dlsym()* and *dlclose()*.

The *dlopen/()* function is available only to a dynamically-linked process. A statically-linked process (one where **libc** is linked statically) can't call *dlopen()* because a statically-linked executable:

- doesn't export any of its symbols
- can't export the required structure for libraries to link against
- can't fill structures at startup needed to load subsequent shared objects.

Any dependencies recorded within *pathname* are loaded as part of the *dlopen()* call. These dependencies are searched in load-order to locate

any additional dependencies. This process continues until all of the dependencies for *pathname* have been satisfied. This dependency tree is called a *group*.

If *pathname* is NULL, *dlopen()* provides a handle to the running process's global symbol object. This provides access to the symbols from the original program image file, the dependencies it loaded at startup, plus any objects opened with *dlopen()* calls using the RTLD_GLOBAL flag. This set of symbols can change dynamically if the application subsequently calls *dlopen()* using RTLD_GLOBAL.

You can use *dlopen()* any number of times to open objects whose names resolve to the same absolute or relative path name; the object is loaded into the process's address space only once.

In order to find the shared objects, the following directories or paths are searched in order:

- **RPATH**
- **LD_LIBRARY_PATH**
- **CS_LIBPATH**.

Note that **LD_LIBRARY_PATH** is igonored if the binary is **`setuid`**, and where the **`euid`** is not the same as the **`uid`** of the user running the binary. This is done for security purposes.

☞

The above directories are set as follows:

- The **RPATH** value is set up when binary is linked, using the `ld` command line option `-rpath`. See `ld` for details.
- The **LD_LIBRARY_PATH** is generally set up by other startup script, either in the boot image or by a secondary script. For example, on self hosted QNX system, it is setup by `ph` script. It is not part of any default environment.
- **CS_LIBPATH** is populated by the kernel, and the default value is based on the **LD_LIBRARY_PATH** value of the `procnto` command line in the boot image. Note that, you may use `getconf` utility to inspect this value and `setconf` to set this value. For example:

```
setconf CS_LIBPATH 'getconf CS_LIBPATH':/new/path
```

When loading shared objects, the application should open a specific version instead of relying on the version pointed to by a symbolic link.

The *mode*

The *mode* argument indicates how *dlopen()* operates on *pathname* when handling relocations, and controls the visibility of symbols found in *pathname* and its dependencies.

The *mode* argument is a bitwise-OR of the constants described below. Note that the relocation and visibility constants are mutually exclusive.

Relocation

When you load an object by calling *dlopen()*, the object may contain references to symbols whose addresses aren't known until the object has been loaded; these references must be relocated before accessing the symbols. The *mode* controls when relocations take place, and can be one of:

RTLD_LAZY — References to data symbols are relocated when the object is loaded. References to functions aren't relocated until that function is invoked. This improves performance by preventing unnecessary relocations.

RTLD_NOW — All references are relocated when the object is loaded. This may waste cycles if relocations are performed for functions that never get called, but this behavior could be useful for applications that need to know that all symbols referenced during execution are available as soon as the object is loaded.

RTLD_LAZY isn't currently supported.

Visibility

The following *mode* bits determine the scope of visibility for symbols loaded with *dlopen()*:

RTLD_GLOBAL

Make the object's global symbols available to any other object. Symbol lookup using **`dlopen( 0,`** *mode* **`)`** and an associated *dlsym()* are also able to find the object's symbols.

RTLD_LOCAL

Make the object's global symbols available only to objects in the same group.

The program's image and any objects loaded at program startup have a *mode* of RTLD_GLOBAL; the default *mode* for objects acquired with *dlopen()* is RTLD_LOCAL. A local object may be part of the dependencies for more than one group; any object with a RTLD_LOCAL *mode* referenced as a dependency of an object with a RTLD_GLOBAL *mode* is promoted to RTLD_GLOBAL.

Objects loaded with *dlopen()* that require relocations against global symbols can reference the symbols in any RTLD_GLOBAL object.

You can OR the *mode* with the following values to affect symbol scope:

RTLD_GROUP

Only symbols from the associated group are available. All dependencies between group members must be satisfied by the objects in the group.

RTLD_WORLD

Only symbols from RTLD_GLOBAL objects are available.

The default *mode* is RTLD_WORLD | RTLD_GROUP.

If you specify RTLD_WORLD without RTLD_GROUP, *dlopen()* doesn't load any of the DLL's dependencies.

Symbol Resolution

When resolving the symbols in the shared object, the runtime linker searches for them in the dynamic symbol table using the following order:

By default:

1. main executable
2. the shared object being loaded
3. all other loaded shared objects that were loaded with the RTLD_GLOBAL flag.

When **`-Bsymbolic`** is specified:

1. the shared object being loaded
2. main executable
3. all other loaded shared objects that were loaded with the RTLD_GLOBAL flag.

For executables, the dynamic symbol table typically contains only those symbols that are known to be needed by any shared libraries.

This is determined by the linker when the executable is linked against a shared library.

Since you don't link your executable against a shared object that you load with *dlopen()*, the linker can't determine which executable symbols need to be made available to the shared object.

If your shared object needs to resolve symbols in the executable, then you may force the linker to make *all* of the symbols in the executable available for dynamic linking by specifying the **-E** linker option. For example:

```
qcc -Vgcc_ntox86 -Wl,-E -o main main.o
```

Shared objects always place all their symbols in dynamic symbol tables, so this option isn't needed when linking a shared object.

Returns:

A handle to the object, or NULL if an error occurs.

Don't interpret the value of this handle in any way. For example, if you open the same object repeatedly, don't assume that *dlopen()* returns the same handle.

Errors:

If an error occurs, more detailed diagnostic information is available from *dlerror()*.

Environment variables:

DL_DEBUG Display debugging information about the libraries as they're opened.

LD_LIBRARY_PATH

The **LD_LIBRARY_PATH** environment variable is searched for any dependencies required by *pathname*.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

Some symbols defined in executables or shared objects might not be available to the runtime linker. The symbol table created by `ld` for use by the runtime linker might contain a subset of the symbols defined in the object.

See also:

dladdr(), dlclose(), dlerror(), dlsym()

`ld`, `qcc` in the *Utilities Reference*

dlsym()

Get the address of a symbol in a shared object

Synopsis:

```
#include <dlfcn.h>

void* dlsym( void* handle,
             const char* name );
```

Arguments:

handle	Either a handle for a shared object, returned by *dlopen()*, or the special flag, RTLD_DEFAULT.
name	The name of the symbol that you want to find in the shared object.

Library:

libc

Description:

The *dlsym()* function lets a process obtain the address of the symbol specified by *name* defined in a shared object.

The *dlsym()* function is available only to dynamically linked processes.

If *handle* is a handle returned by *dlopen()*, you must not have closed that shared object by calling *dlclose()*. The *dlsym()* functions also searches for the named symbol in the objects loaded as part of the dependencies for that object.

If *handle* is RTLD_DEFAULT, *dlsym()* searches all objects in the current process, in load-order.

In the case of RTLD_DEFAULT, if the objects being searched were loaded with *dlopen()*, *dlsym()* searches the object only if the caller is part of the same dependency hierarchy, or if the object was loaded with global search access (using the RTLD_GLOBAL mode).

Returns:

A pointer to the named symbol for success, or NULL if an error occurs.

Errors:

If an error occurs, more detailed diagnostic information is available from *dlerror()*.

Examples:

Use *dlsym()* to find a function pointer and a pointer to a global variable in a shared library:

```
typedef int (*foofunc)( int );

void* handle;
int* some_global_int;
foofunc brain;

/* Open a shared library. */
handle = dlopen( "/usr/nto/x86/lib/libfoo.so.1", RTLD_NOW );

/* Find the address of a function and a global integer. */
brain = (foofunc)dlsym( handle, "takeover_world" );
some_global_int = (int* )dlsym( handle, "my_global_int" );

/* Invoke the function and print the int. */
x = (*brain)( 5 );
printf( "that global is %d\n", *some_global_int );
```

Check to see if a function is defined, and call it if it is:

```
typedef int (*funcptr)( void );

funcptr funk = NULL;

funk = (funcptr)dlsym( RTLD_DEFAULT, "get_funky" );
if( funk != NULL ) {
    (*funk)();
}
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

Function pointers are a pain; use **`typedef`**s to help preserve your sanity.

See also:

dladdr(), *dlclose()*, *dlerror()*, *dlopen()*

dn_comp()

Compress an Internet domain name

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <arpa/nameser.h>
#include <resolv.h>

int dn_comp( const char * exp_dn,
             u_char * comp_dn,
             int length,
             u_char ** dnptrs,
             u_char ** lastdnptr );
```

Arguments:

exp_dn	The Internet domain name you want to compress.
comp_dn	A buffer where the function can store the compressed name.
length	The size of the array that *comp_dn* points to.
dnptrs	NULL, or an array of pointers to previously compressed names in the current message; see below.
lastdnptr	NULL, or the limit of the array specified by *dnptrs*.

Library:

libsocket

Description:

The *dn_comp()* routine is a low-level routine used by *res_query()* to compress an Internet domain name. This routine compresses the domain name *exp_dn* and stores it in *comp_dn*.

The compression uses an array of pointers, *dnptrs*, to previously compressed names in the current message. The first pointer points to the beginning of the message and the list ends with NULL. The limit to the array is specified by *lastdnptr*. As a side effect, *dn_comp()*

updates the list of pointers for labels inserted into the message as the name is compressed. If *dnptrs* is NULL, names aren't compressed. If *lastdnptr* is NULL, the list of labels isn't updated.

Returns:

The size of the compressed domain name, in bytes, or -1 if an error occurs.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

dn_expand(), *gethostbyname()*, *res_init()*, *res_mkquery()*, *res_query()*, *res_search()*, *res_send()*

/etc/resolv.conf, **hostname** in the *Utilities Reference*

RFC 974, *RFC 1032*, *RFC 1033*, *RFC 1034*, *RFC 1035*

dn_expand()

Expand a compressed Internet domain name

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <arpa/nameser.h>
#include <resolv.h>

int dn_expand( const u_char * msg,
               const u_char * eomorig,
               const u_char * comp_dn,
               char * exp_dn,
               int length );
```

Arguments:

msg	A pointer to the beginning of the message that contains the compressed name.
eomorig	A pointer to the first location after the message.
comp_dn	The compressed name that you want to expand.
exp_dn	A buffer where the function can store the expanded name.
length	The length of the array specified by *exp_dn*.

Library:

libsocket

Description:

The *dn_expand()* function is a low-level routine used by *res_query()* to expand the compressed domain name, *comp_dn*, to a full domain name.

The compressed name is contained in a query or reply message.

Returns:

The size of the *compressed* domain name (not the expanded name), in bytes, or -1 if an error occurs.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

dn_comp(), *gethostbyname()*, *res_init()*, *res_mkquery()*, *res_query()*, *res_search()*, *res_send()*

`/etc/resolv.conf`, **`hostname`** in the *Utilities Reference*

RFC 974, *RFC 1032*, *RFC 1033*, *RFC 1034*, *RFC 1035*

drand48()

Generate a pseudo-random **double**

Synopsis:

```
#include <stdlib.h>

double drand48( void );
```

Library:

libc

Description:

The *drand48()* function uses a linear congruential algorithm and 48-bit integer arithmetic to generate a nonnegative **double** uniformly distributed over the interval [0.0, 1.0].

Call one of *lcong48()*, *seed48()*, or *srand48()* to initialize the random-number generator before calling *drand48()*, *lrand48()*, or *mrand48()*.

The *erand48()* function is a thread-safe version of *drand48()*.

Returns:

A pseudo-random **double**.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

erand48(), jrand48(), lcong48(), lrand48(), mrand48(), nrand48(), seed48(), srand48()

drem(), dremf()

Compute the remainder of two numbers

Synopsis:

```
#include <math.h>

double drem ( double x,
              double y );

float dremf ( float x,
              float y );
```

Arguments:

x The numerator of the division.

y The denominator.

Library:

libm

Description:

The *drem()* and *dremf()* functions compute the remainder $r = x - n * y$, when *y* is nonzero. The value *n* is the integral value nearest the exact value x/y.

When $|n - x/y| = \frac{1}{2}$, the value *n* is chosen to be even. But *remainder*(*x*, 0) and *remainder*(**infinity**,0) are invalid operations that produce a NAN.

The behavior of *drem()* is independent of the rounding mode.

Returns:

The remainder, $r = x - n * y$, when *y* is nonzero.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

remainder()

ds_clear()

Delete a data server variable

Synopsis:

```
#include <ds.h>

int ds_clear( ds_t dsdes,
              const char* variable_name );
```

Arguments:

dsdes	A data server descriptor returned by *ds_register()*.
variable_name	The name of the variable that you want to delete.

Library:

libds

Description:

The *ds_clear()* function deletes *variable_name* from the data server identified by *dsdes*.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EBADF	Invalid file descriptor *dsdes*.
ESRCH	The variable doesn't exist in the data server.

Examples:

See **slinger** in the *Utilities Reference*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ds_deregister(), ds_flags()

ds_create()

Create a data server variable

Synopsis:

```
#include <ds.h>

int ds_create( ds_t dsdes,
               const char * variable_name,
               char flags,
               struct sigevent * sigevent );
```

Arguments:

dsdes	A data server descriptor returned by *ds_register()*.
variable_name	The name of the variable that you want to create. All variables are global, so only one instance of the variable can exist in the data server process. The maximum length of a variable name is 60 characters.
flags	Flags that specify the variable's behavior: • DS_PERM — don't delete the variable when the application that created it terminates. The variable is removed when the data server process terminates, or if the flag is turned off after the application that created the variable terminates. If *flags* is 0, the variable is removed if you call *ds_deregister()*, or the process terminates.
sigevent	A pointer to a **sigevent** structure that describes a proxy or signal to be sent to the external application that created the variable if the data referenced by the variable changes; see below.

Library:

libds

Description:

The *ds_create()* function creates a variable, whose name is given by *variable_name*, on the data server identified by *dsdes*.

If the data referenced by *variable_name* changes, a proxy or signal, described in the **sigevent** structure, can be sent to the external application that created *variable_name* (see *ds_set()*).

We recommend the following event types for use with this function:

- SIGEV_SIGNAL
- SIGEV_SIGNAL_CODE
- SIGEV_SIGNAL_THREAD
- SIGEV_PULSE
- SIGEV_INTR

To display the current value of a variable on an HTML page, use the **qnxvar** token with the **read** tag. See the description of **slinger** in the *Utilities Reference*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF	Invalid file descriptor *dsdes*.
EEXIST	The variable name already exists in the data server.
ENOMEM	Not enough memory to create the variable or initialize the data.

Examples:

See **slinger** in the *Utilities Reference*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ds_flags(), *ds_get()*, *ds_register()*, *ds_set()*, **sigevent**

ds_deregister()

Deregister an application with the data server

Synopsis:

```
#include <ds.h>

int ds_deregister( ds_t dsdes );
```

Arguments:

dsdes A data server descriptor returned by *ds_register()*.

Library:

libds

Description:

The *ds_deregister()* function deregisters your application with the data server, *dsdes*, and deletes any variables that the data server process created, except those with the DS_PERM flag set (see *ds_flags()*).

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid file descriptor, *dsdes*.

Examples:

See **slinger** in the *Utilities Reference*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ds_flags(), *ds_register()*

ds_flags()

Set the flags for a data server variable

Synopsis:

```
#include <ds.h>

int ds_flags( ds_t dsdes,
              const char* variable_name,
              char flags );
```

Arguments:

dsdes	A data server descriptor returned by *ds_register()*.
variable_name	The name of the data server variable.
flags	The new flags for the variable. The flags include: • DS_PERM — don't delete the variable when the application that created it terminates. The variable is removed when the data server process terminates, or if the flag is turned off after the application that created the variable terminates.

Library:

libds

Description:

The *ds_flags()* function changes the state of the *flags* belonging to the variable called *variable_name* on the data server identified by *dsdes*.

Returns:

0 for success, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	Invalid file descriptor *dsdes*.
ESRCH	The variable doesn't exist in the data server.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ds_clear(), *ds_create()*, *ds_deregister()*, *ds_set()*

ds_get()

Retrieve a data server variable

Synopsis:

```
#include <ds.h>

int ds_get( ds_t dsdes,
            const char* variable_name,
            const char* variable_data,
            size_t data_len );
```

Arguments:

dsdes	A data server descriptor returned by *ds_register()*.
variable_name	The name of the data server variable that you want to get.
variable_data	A buffer where the function can store the data associated with the variable.
data_len	The size of the buffer, in bytes.

Library:

libds

Description:

The *ds_get()* function retrieves the data corresponding to *variable_name* from the data server *dsdes*, and places it in the buffer pointed to by *variable_data*.

Returns:

The amount of data written to the buffer *variable_data*, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	Invalid file descriptor *dsdes*.
EMSGSIZE	The buffer isn't big enough for the data.
ESRCH	The variable doesn't exist in the data server.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ds_create(), *ds_set()*

ds_register()

Register an application with the data server

Synopsis:

```
#include <ds.h>

ds_t ds_register( void );
```

Library:

libds

Description:

The *ds_register()* function registers your application with the data server. The data server must reside on the same node as your application.

Returns:

A data server descriptor, or -1 if an error occurs (*errno* is set).

Errors:

ENOENT	No such file or directory; the data server isn't started.
ENOMEM	Insufficient memory is available to communicate with the data server.

Examples:

See **slinger** in the *Utilities Reference*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ds_deregister()

ds_set()

Set a data server variable

Synopsis:

```
#include <ds.h>

int ds_set( ds_t dsdes,
            const char* variable_name,
            const char* variable_data,
            size_t data_len );
```

Arguments:

dsdes	A data server descriptor returned by *ds_register()*.
variable_name	The name of the data server variable that you want to set.
variable_data	A pointer to the data you want to associate with the variable.
data_len	The size of the data, in bytes.

Library:

libds

Description:

The *ds_set()* function passes the data *variable_data* to the data server identified by *dsdes*. The data server stores the data in the variable whose name is given by *variable_name*, overwriting any existing value.

To display the modified data on an HTML page, use the **qnxvar** token with the **read** tag. See the description of **slinger** in the *Utilities Reference*.

Returns:

0 for success, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	Invalid file descriptor *dsdes*.
ENOMEM	Not enough memory to store the data.
ESRCH	The variable doesn't exist in the data server.

Examples:

See **`slinger`** in the *Utilities Reference*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ds_create(), *ds_flags()*, *ds_get()*

dup()

Duplicate a file descriptor

Synopsis:

```
#include <unistd.h>

int dup( int filedes );
```

Arguments:

filedes The file descriptor that you want to duplicate.

Library:

libc

Description:

The *dup()* function duplicates the file descriptor specified by *filedes*. The new file descriptor refers to the same open file descriptor as the original, and shares any locks. The new file descriptor also:

- references the same file or device
- has the same open mode (read and/or write)
- has an identical file position to the original (changing the position with one descriptor results in a changed position in the other).

Changing the file position with one descriptor results in a changed position for the other.

Calling:

```
dup_filedes = dup( filedes );
```

is the same as:

```
dup_filedes = fcntl( filedes, F_DUPFD, 0 );
```

Returns:

The new file descriptor for success, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	The file descriptor, *filedes*, isn't a valid.
EMFILE	There are already OPEN_MAX file descriptors in use.
ENOSYS	The *dup()* function isn't implemented for the filesystem specified by *filedes*.

Examples:

```
#include <fcntl.h>
#include <unistd.h>
#include <sys/stat.h>
#include <stdlib.h>

int main( void )
{
    int filedes, dup_filedes;

    filedes= open( "file",
        O_WRONLY | O_CREAT | O_TRUNC,
        S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP );

    if( filedes != -1 ) {
        dup_filedes = dup( filedes );
        if( dup_filedes != -1 ) {
            /* process file */
            /* ... */

            close( dup_filedes );
        }
        close( filedes );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chsize(), close(), creat(), dup2(), eof(), errno, execl(), execle(), execlp(), execlpe(), execv(), execve(), execvp(), execvpe(), fcntl(), fileno(), fstat(), isatty(), lseek(), open(), read(), sopen(), stat(), tell(), umask(), write()

dup2()

Duplicate a file descriptor, specifying the new descriptor

Synopsis:

```
#include <unistd.h>

int dup2( int filedes,
          int filedes2 );
```

Arguments:

filedes	The file descriptor that you want to duplicate.
filedes	The number that you want to use for the new file descriptor.

Library:

libc

Description:

The *dup2()* function duplicates the file descriptor specified by *filedes*. The number of the new file descriptor will be *filedes2*. If a file already is opened with this descriptor, the file is closed before the duplication is attempted.

The new file descriptor:

- references the same file or device
- has the same open mode (read and/or write)
- has an identical file position to the original (changing the position with one descriptor results in a changed position in the other).

Calling:

```
dup_filedes = dup2( filedes, filedes2 );
```

Is the same as:

```
close( filedes2 );
dup_filedes = fcntl( filedes , F_DUPFD, filedes2 );
```

Returns:

The value of *filedes2* for success, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	The file descriptor, *filedes* isn't a valid open file descriptor, or *filedes2* is out of range.
EMFILE	There are already OPEN_MAX file descriptors in use.
ENOSYS	The *dup2()* function isn't implemented for the filesystem specified by *filedes*.

Examples:

```
#include <fcntl.h>
#include <unistd.h>
#include <sys/stat.h>
#include <stdlib.h>

int main( void )
{
    int filedes , dup_filedes ;

    filedes = open( "file",
        O_WRONLY | O_CREAT | O_TRUNC,
        S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP );

    if( filedes != -1 ) {
        dup_filedes = 4;
        if( dup2( filedes, dup_filedes ) != -1 ) {
            /* process file */
            /* ... */

            close( dup_filedes );
        }
        close( filedes );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chsize(), close(), creat(), dup(), eof(), errno, execl(), execle(), execlp(), execlpe(), execv(), execve(), execvp(), execvpe(), fcntl(), fileno(), fstat(), isatty(), lseek(), open(), read(), sopen(), stat(), tell(), umask(), write()

eaccess()

Check to see if a file or directory can be accessed (extended version)

Synopsis:

```
#include <libgen.h>
#include <unistd.h>

int eaccess( const char * path,
             int amode );
```

Arguments:

path The path to the file or directory that you want to access.

amode The access mode you want to check. This must be either:

- F_OK — test for file existence.

or a bitwise ORing of the following access permissions to be checked, as defined in the header **<unistd.h>**:

- R_OK — test for read permission.
- W_OK — test for write permission.
- X_OK — for a directory, test for search permission. Otherwise, test for execute permission.

Library:

libc

Description:

The *eaccess()* function is an extended version of *access()*. It checks if the file or directory specified by *path* exists and if it can be accessed with the file access permissions given by *amode*. However, unlike *access()*, it uses the effective user ID and effective group ID.

Returns:

0 The file or directory exists and can be accessed with the specified mode.

-1 An error occurred (*errno* is set.)

Errors:

EACCES — The permissions specified by *amode* are denied, or search permission is denied on a component of the path prefix.

EINVAL — An invalid value was specified for *amode*.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of the *path* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT — A component of the path isn't valid.

ENOSYS — The *eaccess()* function isn't implemented for the filesystem specified in *path*.

ENOTDIR — A component of the path prefix isn't a directory.

EROFS — Write access was requested for a file residing on a read-only file system.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

access(), chmod(), errno, fstat(), open(), stat()

The end of the data segment, excluding BSS data

Synopsis:

N/A

Description:

This linker symbol defines the end of the data segment, excluding BSS data. This variable isn't defined in any header file.

Classification:

QNX Neutrino

See also:

brk(), *_btext*, *_end*, *_etext*, *sbrk()*

encrypt()

Encrypt a string

Synopsis:

```
#include <unistd.h>

void encrypt( char block[64],
              int flag );
```

Arguments:

block	A 64-character array of binary values to encrypt. The function stores the encrypted value in the same array.
flag	If the value of *flag* is 0, the function encrypts *block*; otherwise, *encrypt()* fails.

Library:

libc

Description:

The *encrypt()* function uses the NBS Data Encryption Standard (DES) algorithm and the key you specify by calling *setkey()* to encrypt the given block of data.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

crypt(), setkey()

The end of the data segment, including BSS data

Synopsis:

N/A

Description:

This linker symbol defines the end of the data segment, including BSS data. This variable isn't defined in any header file.

Classification:

QNX Neutrino

See also:

brk(), *_btext*, *_edata*, *_etext*, *sbrk()*

endgrent()

Close the group database file

Synopsis:

```
#include <grp.h>

int endgrent( void );
```

Library:

libc

Description:

The *endgrent()* routine closes the group name database file, so all group access routines behave as if *setgrent()* had never been called.

Returns:

Zero.

Classification:

Standard Unix, POSIX 1003.1g (draft)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getgrent(), *setgrent()*

endhostent()

Close the TCP connection and the hosts file

Synopsis:

```
#include <netdb.h>

void endhostent( void );
```

Library:

libsocket

Description:

The *endhostent()* routine closes the TCP connection and the hosts file.

Files:

/etc/hosts Host database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

gethostbyaddr(), *gethostbyname()*, *gethostent()*, **hostent**, *sethostent()*

/etc/hosts, **/etc/resolv.conf** in the *Utilities Reference*

ENDIAN_BE16()

Return a big-endian 16-bit value in native format

Synopsis:

```
#include <gulliver.h>

uint16_t ENDIAN_BE16( uint16_t num );
```

Arguments:

num The big-endian number you want to convert.

Library:

libc

Description:

The *ENDIAN_BE16()* macro returns the native version of the big-endian value *num*.

Returns:

The native-endian value of *num*.

Examples:

Convert a big-endian value to native-endian:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint16_t val = 0x1234;

    printf( "0x%04x = 0x%04x\n",
            val, ENDIAN_BE16( val ) );

    return EXIT_SUCCESS;
}
```

On a little-endian system, this prints:

```
0x1234 = 0x3412
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_BE16() is implemented as a macro.

See also:

ENDIAN_BE32(), *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_BE32()

Return a big-endian 32-bit value in native format

Synopsis:

```
#include <gulliver.h>

uint32_t ENDIAN_BE32( uint32_t num );
```

Arguments:

num The big-endian number you want to convert.

Library:

libc

Description:

The *ENDIAN_BE32()* macro returns the native version of the big-endian value *num*.

Returns:

The native-endian value of *num*.

Examples:

Convert a big-endian value to native-endian:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint32_t val = 0xdeadbeef;

    printf( "0x%08x = 0x%08x\n",
            val, ENDIAN_BE32( val ) );

    return EXIT_SUCCESS;
}
```

On a little-endian system, this prints:

```
0xdeadbeef = 0xefbeadde
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_BE32() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_BE64()

Return a big-endian 64-bit value in native format

Synopsis:

```
#include <gulliver.h>

uint64_t ENDIAN_BE64( uint64_t num );
```

Arguments:

num The big-endian number you want to convert.

Library:

libc

Description:

The *ENDIAN_BE64()* macro returns the native version of the big-endian value *num*.

Returns:

The native-endian value of *num*.

Examples:

Convert a big-endian value to native-endian:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint64_t val = 0x1234deadbeef5678;

    printf( "0x%016Lx = 0x%016Lx\n",
            val, ENDIAN_BE64( val ) );

    return EXIT_SUCCESS;
}
```

On a little-endian system, this prints:

```
0x1234deadbeef5678 = 0x7856efbeadde3412
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_BE64() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_LE16()

Return a little-endian 16-bit value in native format

Synopsis:

```
#include <gulliver.h>

uint16_t ENDIAN_LE16( uint16_t num );
```

Arguments:

num The little-endian number you want to convert.

Library:

libc

Description:

The *ENDIAN_LE16()* macro returns the native version of the little-endian value *num*.

Returns:

The native-endian value of *num*.

Examples:

Convert a little-endian value to native-endian:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint16_t val = 0x1234;

    printf( "0x%04x = 0x%04x\n",
            val, ENDIAN_LE16( val ) );

    return EXIT_SUCCESS;
}
```

On a big-endian system, this prints:

```
0x1234 = 0x3412
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_LE16() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_LE32()

Return a little-endian 32-bit value in native format

Synopsis:

```
#include <gulliver.h>

uint32_t ENDIAN_LE32( uint32_t num );
```

Arguments:

num The little-endian number you want to convert.

Library:

libc

Description:

The *ENDIAN_LE32()* macro returns the native version of the little-endian value *num*.

Returns:

The native-endian value of *num*.

Examples:

Convert a little-endian value to native-endian:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint32_t val = 0xdeadbeef;

    printf( "0x%08x = 0x%08x\n",
            val, ENDIAN_LE32( val ) );

    return EXIT_SUCCESS;
}
```

On a big-endian system, this prints:

```
0xdeadbeef = 0xefbeadde
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_LE32() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_LE64()

Return a little-endian 64-bit value in native format

Synopsis:

```
#include <gulliver.h>

uint64_t ENDIAN_LE64( uint64_t num );
```

Arguments:

num The little-endian number you want to convert.

Library:

libc

Description:

The *ENDIAN_LE64()* macro returns the native version of the little-endian value *num*.

Returns:

The native-endian value of *num*.

Examples:

Convert a little-endian value to native-endian:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint64_t val = 0x1234deadbeef5678;

    printf( "0x%016Lx = 0x%016Lx\n",
            val, ENDIAN_LE64( val ) );

    return EXIT_SUCCESS;
}
```

On a big-endian system, this prints:

```
0x1234deadbeef5678 = 0x7856efbeadde3412
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_LE64() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_RET16()

Return an endian-swapped 16-bit value

Synopsis:

```
#include <gulliver.h>

uint16_t ENDIAN_RET16( uint16_t num );
```

Arguments:

num The number you want to convert.

Library:

libc

Description:

The *ENDIAN_RET16()* macro returns the endian-swapped value of *num*.

Returns:

The endian-swapped value of *num*.

Examples:

Swap the endianness of a value:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint16_t val = 0x1234;

    printf( "0x%04x = 0x%04x\n",
            val, ENDIAN_RET16( val ) );

    return EXIT_SUCCESS;
}
```

This prints:

```
0x1234 = 0x3412
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_RET16() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_RET32()

Return an endian-swapped 32-bit value

Synopsis:

```
#include <gulliver.h>

uint32_t ENDIAN_RET32( uint32_t num );
```

Arguments:

num The number you want to convert.

Library:

libc

Description:

The *ENDIAN_RET32()* macro returns the endian-swapped value of *num*.

Returns:

The endian-swapped value of *num*.

Examples:

Swap the endianness of a value:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint32_t val = 0xdeadbeef;

    printf( "0x%08x = 0x%08x\n",
            val, ENDIAN_RET32( val ) );

    return EXIT_SUCCESS;
}
```

This prints:

```
0xdeadbeef = 0xefbeadde
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_RET32() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_RET64()

Return an endian-swapped 64-bit value

Synopsis:

```
#include <gulliver.h>

uint64_t ENDIAN_RET64( uint64_t num );
```

Arguments:

num The number you want to convert.

Library:

libc

Description:

The *ENDIAN_RET64()* macro returns the endian-swapped value of *num*.

Returns:

The endian-swapped value of *num*.

Examples:

Swap the endianness of a value:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint64_t val = 0x1234deadbeef5678;

    printf( "0x%016Lx = 0x%016Lx\n",
            val, ENDIAN_RET64( val ) );

    return EXIT_SUCCESS;
}
```

This prints:

```
0x1234deadbeef5678 = 0x7856efbeadde3412
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_RET64() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_SWAP16()

Endian-swap a 16-bit value in place

Synopsis:

```
#include <gulliver.h>

void ENDIAN_SWAP16( uint16_t * num );
```

Arguments:

num A pointer to the number you want to convert.

Library:

libc

Description:

The *ENDIAN_SWAP16()* macro endian-swaps the value pointed to by *num* in place.

Examples:

Swap the endianness of a value:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint16_t val = 0x1234;
    ENDIAN_SWAP16( &val );

    printf( "val = 0x%04x\n", val );

    return EXIT_SUCCESS;
}
```

This prints:

```
val = 0x3412
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_SWAP16() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_SWAP32()

Endian-swap a 32-bit value in place

Synopsis:

```
#include <gulliver.h>

void ENDIAN_SWAP32( uint32_t * num );
```

Arguments:

num A pointer to the number you want to convert.

Library:

libc

Description:

The *ENDIAN_SWAP32()* macro endian-swaps the value pointed to by *num* in place.

Examples:

Swap the endianness of a value:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint32_t val = 0xdeadbeef;
    ENDIAN_SWAP32( &val );

    printf( "val = 0x%08x\n", val );

    return EXIT_SUCCESS;
}
```

This prints:

```
val = 0xefbeadde
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_SWAP32() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*

ENDIAN_SWAP64()

Endian-swap a 64-bit value in place

Synopsis:

```
#include <gulliver.h>

void ENDIAN_SWAP64( uint64_t * num );
```

Arguments:

num A pointer to the number you want to convert.

Library:

libc

Description:

The *ENDIAN_SWAP64()* macro endian-swaps the value pointed to by *num* in place.

Examples:

Swap the endianness of a value:

```
#include <stdio.h>
#include <stdlib.h>
#include <gulliver.h>
#include <inttypes.h>

int main( void )
{
    uint64_t val = 0x1234deadbeef5678LL;
    ENDIAN_SWAP16( &val );

    printf( "val = 0x%016x\n", val );

    return EXIT_SUCCESS;
}
```

This prints:

```
val = 0x7856efbeadde3412
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

ENDIAN_SWAP64() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET16()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()* *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*,

endnetent()

Close the network name database file

Synopsis:

```
#include <netdb.h>

void endnetent( void );
```

Library:

libsocket

Description:

The *endnetent()* routine closes the network name database file.

Files:

/etc/networks

Network name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getnetbyaddr(), *getnetbyname()*, *getnetent()*, **netent**, *setnetent()*

/etc/networks in the *Utilities Reference*

endprotoent()

Close the protocol name database file

Synopsis:

```
#include <netdb.h>

void endprotoent( void );
```

Library:

libsocket

Description:

The *endprotoent()* routine closes the protocol name database file.

Files:

/etc/protocols

Protocol name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getprotobyname() getprotobynumber(), *getprotoent()*, **protoent**, *setprotoent()*

/etc/protocols in the *Utilities Reference*

endpwent()

Close the password database file

Synopsis:

```
#include <sys/types.h>
#include <pwd.h>

int endpwent( void );
```

Library:

libc

Description:

The *endpwent()* function closes the password name database file, so all password access routines behave as if *setpwent()* had never been called.

Returns:

Zero.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getpwent(), setpwent()

endservent()

Close the network services database file

Synopsis:

```
#include <netdb.h>

void endservent( void );
```

Library:

libsocket

Description:

The *endservent()* routine closes the network services database file.

Files:

/etc/services

Network services database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getservbyname(), *getservbyport()*, *getservent()*, **servent**, *setservent()*

/etc/services in the *Utilities Reference*

endspent()

Close the shadow password database file

Synopsis:

```
#include <sys/types.h>
#include <shadow.h>

void endspent( void );
```

Library:

libc

Description:

The *endspent()* function closes the shadow password database file, so all password access routines behave as if *setspent()* had never been called.

Returns:

Zero.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getspent(), *setspent()*

endutent()

Close the current user-information file

Synopsis:

```
#include <utmp.h>

void endutent( void );
```

Library:

libc

Description:

The *endutent()* function closes the currently open file specified in _PATH_UTMP.

Files:

_PATH_UTMP	The name of the user information file.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getutent(), *getutid()*, *getutline()*, *pututline()*, *setutent()*, **utmp**, *utmpname()*

login in the *Utilities Reference*

Synopsis:

```
#include <unistd.h>

extern char ** environ;
```

Library:

libc

Description:

When a process begins, an array of strings called the *environment* is made available. This array is pointed to by the external variable *environ*. The strings in the array have the form:

variable=*value*

and are terminated by a NULL pointer.

Classification:

POSIX 1003.1

Caveats:

Don't modify *environ* directly; use *clearenv()*, *getenv()*, *putenv()*, *searchenv()*, *setenv()*, and *unsetenv()*.

Changes to the environment affect all threads in a multithreaded process.

See also:

clearenv(), *getenv()*, *putenv()*, *searchenv()*, *setenv()*, *unsetenv()*

eof()

Test if the end-of-file has been reached

Synopsis:

```
#include <unistd.h>

int eof( int filedes );
```

Arguments:

filedes A file descriptor for the file that you want to check.

Library:

libc

Description:

The *eof()* function is a low-level function that determines if the end of the file specified by *filedes* has been reached.

Input operations set the current file position; you can call the *eof()* function to detect the end of the file before more input operations to prevent attempts at reading beyond the end of the file.

Returns:

1 The end-of-file has been reached.

0 The end-of-file hasn't been reached.

-1 An error occurred (*errno* is set).

Errors:

EBADF The file descriptor, *filedes*, isn't valid.

Examples:

```
#include <stdio.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>
```

```
int main( void )
{
    int filedes , len;
    char buffer[100];

    filedes = open( "file", O_RDONLY );
    if( filedes != -1 ) {
        while( ! eof( filedes ) ) {
            len = read( filedes , buffer, sizeof(buffer) - 1 );
            buffer[ len ] = '\0';
            printf( "%s", buffer );
        }
        close( filedes );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

QNX 4

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, feof(), open(), read()

erand48()

Generate a pseudo-random **double** *in a thread-safe manner*

Synopsis:

```
#include <stdlib.h>

double erand48( unsigned short int xsubi[3] );
```

Arguments:

xsubi An array that comprises the 48 bits of the initial value that you want to use.

Library:

libc

Description:

The *erand48()* function uses a linear congruential algorithm and 48-bit integer arithmetic to generate a nonnegative **double** uniformly distributed over the interval [0.0, 1.0]. It's a thread-safe version of *drand48()*.

The *xsubi* array should contain the desired initial value; this makes *erand48()* thread-safe, and lets you start a sequence of random numbers at any known value.

Returns:

A pseudo-random **double**.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

drand48(), *jrand48()*, *lcong48()*, *lrand48()*, *mrand48()*, *nrand48()*, *seed48()*, *srand48()*

erf(), *erff()*

Compute the error function of a number

Synopsis:

```
#include <math.h>

double erf ( double x );

float erff ( float x );
```

Arguments:

x The number for which you want to compute the error function.

Library:

libm

Description:

The *erf()* and *erff()* functions compute the following:

$$\frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$$

If *x* is large and the result of *erf()* is subtracted from **1.0**, the results aren't very accurate; use *erfc()* instead.

This equality is true: $erf(-x) = -erf(x)$

Returns:

The value of the error function, or NAN if *x* is NAN.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Classification:

erf() is Standard Unix; *erff()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

erfc()

erfc(), *erfcf()*

Complementary error function

Synopsis:

```
#include <math.h>

double erfc ( double x );

float erfcf ( float x );
```

Arguments:

x The number for which you want to compute the complementary error function.

Library:

libm

Description:

The *erfc()* and *erfcf()* functions calculate the complementary error function of *x* (i.e. the result of the error function, *erf()*, subtracted from `1.0`). This is useful because the error function isn't very accurate when *x* is large.

The *erf()* function computes:

$$\frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$$

This equality is true: *erfc*(-*x*) = 2 - *erfc*(*x*)

Returns:

The value of the error function, or NAN if *x* is NAN.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Classification:

erfc() is standard Unix; *erfcf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

erf()

err(), *errx()*

Display a formatted error message, and then exit

Synopsis:

```
#include <err.h>

void err( int eval,
          const char *fmt, ...);

void errx( int eval,
           const char *fmt, ...);
```

Arguments:

eval The value to use as the exit code of the process.

fmt NULL, or a *printf()*-style string used to format the message.

Additional arguments

As required by the format string.

Library:

libc

Description:

The *err()* and *warn()* family of functions display a formatted error message on *stderr*:

- The functions without an **x** in their names display the string associated with the current value of *errno*.
- Those with a **v** are "varargs" functions.
- Those with **err** exit instead of returning.

Function	*errno* string?	Varargs?	Exits?
err()	Yes	No	Yes
errx()	No	No	Yes
verr()	Yes	Yes	Yes
verrx()	No	Yes	Yes
vwarn()	Yes	Yes	No
vwarnx()	No	Yes	No
warn()	Yes	No	No
warnx()	No	No	No

The *err()* function produces a message that consists of:

- the last component of the program name, followed by a colon and a space
- the formatted message, followed by a colon and a space, if the *fmt* argument isn't NULL
- the string associated with the current value of *errno*
- a newline character.

The *errx()* function produces a similar message, except that it doesn't include the string associated with *errno*. The message consists of:

- the last component of the program name, followed by a colon and a space
- the formatted message, if the *fmt* argument isn't NULL
- a newline character.

The *err()* and *errx()* functions don't return, but exit with the value of the argument *eval*.

Examples:

Display the current *errno* information string and exit:

```
if ((p = malloc(size)) == NULL)
   err(1, NULL);
if ((fd = open(file_name, O_RDONLY, 0)) == -1)
   err(1, "%s", file_name);
```

Display an error message and exit:

```
if (tm.tm_hour < START_TIME)
    errx(1, "too early, wait until %s", start_time_string);
```

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

printf(), *stderr*, *strerror()*, *verr()*, *verrx()*, *vwarn()*, *vwarnx()*, *warn()*, *warnx()*

Synopsis:

```
#include <errno.h>

extern int errno;

char * const sys_errlist[];
int sys_nerr;
```

Library:

libc

Description:

The *errno* variable is set to certain error values by many functions whenever an error has occurred.

☞ You can't assume that the value of *errno* is valid unless the function that you've called indicates that an error has occurred. The runtime library never resets *errno* to 0.

The documentation for a function might list special meanings for certain values of *errno*, but this doesn't mean that these are the only values that the function might set.

The *errno* variable may be implemented as a macro, but you can always examine or set it as if it were a simple integer variable.

☞ Each thread in a multi-threaded program has its own error value in its thread local storage. No matter which thread you're in, you can simply refer to *errno* — it's defined in such a way that it refers to the correct variable for the thread. For more information, see "Local storage for private data" in the documentation for *ThreadCreate()*.

The following variables are also defined in **<errno.h>**:

sys_errlist An array of error messages corresponding to *errno*.

sys_nerr The number of entries in the *sys_errlist* array.

The values for *errno* include at least the following values:

Value	Meaning
E2BIG	Argument list is too long
EACCES	Permission denied
EADDRINUSE	Address is already in use
EADDRNOTAVAIL	Can't assign requested address
EADV	Advertise error
EAFNOSUPPORT	Address family isn't supported by protocol family
EAGAIN	Resource is temporarily unavailable; try again
EALREADY	Operation is already in progress
EBADE	Invalid exchange
EBADF	Bad file descriptor
EBADFD	FD is invalid for this operation
EBADFSYS	Corrupted filesystem detected
EBADMSG	Bad message (1003.1b-1993)
EBADR	Invalid request descriptor
EBADRPC	RPC struct is bad
EBADRQC	Invalid request code
EBADSLT	Invalid slot
EBFONT	Bad font-file format
EBUSY	Device or resource is busy

continued...

Value	Meaning
ECANCELED	Operation canceled (1003.1b-1993)
ECHILD	No child processes
ECHRNG	Channel number is out of range
ECOMM	Communication error occurred on send
ECONNABORTED	Software caused connection to abort
ECONNREFUSED	Connection refused
ECONNRESET	Connection reset by peer
ECTRLTERM	Remap to the controlling terminal
EDEADLK	Resource deadlock avoided
EDEADLOCK	File locking deadlock
EDESTADDRREQ	Destination address is required
EDOM	Math argument is out of domain for the function
EDQUOT	Disk quota exceeded
EEXIST	File exists
EFAULT	Bad address
EFBIG	File is too large
EHOSTDOWN	Host is down
EHOSTUNREACH	Unable to communicate with remote node
EIDRM	Identifier removed
EILSEQ	Illegal byte sequence
EINPROGRESS	Operation now in progress
EINTR	Interrupted function call
EINVAL	Invalid argument

continued...

Value	Meaning
EIO	I/O error
EISCONN	Socket is already connected
EISDIR	Is a directory
EL2HLT	Level 2 halted
EL2NSYNC	Level 2 not synchronized
EL3HLT	Level 3 halted
EL3RST	Level 3 reset
ELIBACC	Can't access shared library
ELIBBAD	Accessing a corrupted shared library
ELIBEXEC	Attempting to exec a shared library
ELIBMAX	Attempting to link in too many libraries
ELIBSCN	The `.lib` section in `a.out` is corrupted
ELNRNG	Link number is out of range
ELOOP	Too many levels of symbolic links or prefixes
EMFILE	Too many open files
EMLINK	Too many links
EMORE	More to do, send message again
EMSGSIZE	Inappropriate message buffer length
EMULTIHOP	Multihop attempted
ENAMETOOLONG	Filename is too long
ENETDOWN	Network is down
ENETRESET	Network dropped connection on reset
ENETUNREACH	Network is unreachable

continued...

Value	Meaning
ENFILE	Too many open files in the system
ENOANO	No anode
ENOBUFS	No buffer space available
ENOCSI	No CSI structure available
ENODATA	No data (for no-delay I/O)
ENODEV	No such device
ENOENT	No such file or directory
ENOEXEC	Exec format error
ENOLCK	No locks available
ENOLIC	No license available
ENOLINK	The link has been severed
ENOMEM	Not enough memory
ENOMSG	No message of desired type
ENONDP	Need an NDP (8087...) to run
ENONET	Machine isn't on the network
ENOPKG	Package isn't installed
ENOPROTOOPT	Protocol isn't available
ENOREMOTE	Must be done on local machine
ENOSPC	No space left on device
ENOSR	Out of streams resources
ENOSTR	Device isn't a stream
ENOSYS	Function isn't implemented
ENOTBLK	Block device is required

continued...

Value	Meaning
ENOTCONN	Socket isn't connected
ENOTDIR	Not a directory
ENOTEMPTY	Directory isn't empty
ENOTSOCK	Socket operation on nonsocket
ENOTSUP	Not supported (1003.1b-1993)
ENOTTY	Inappropriate I/O control operation
ENOTUNIQ	Given name isn't unique
ENXIO	No such device or address
EOK	No error
EOPNOTSUPP	Operation isn't supported
EOVERFLOW	Value too large to be stored in data type
EPERM	Operation isn't permitted
EPFNOSUPPORT	Protocol family isn't supported
EPIPE	Broken pipe
EPROCUNAVAIL	Bad procedure for program
EPROGMISMATCH	Program version wrong
EPROGUNAVAIL	RPC program isn't available
EPROTO	Protocol error
EPROTONOSUPPORT	Protocol isn't supported
EPROTOTYPE	Protocol is wrong type for socket
ERANGE	Result is too large
EREMCHG	Remote address changed
EREMOTE	The object is remote

continued...

Value	Meaning
ERESTART	Restartable system call
EROFS	Read-only filesystem
ERPCMISMATCH	RPC version is wrong
ESHUTDOWN	Can’t send after socket shutdown
ESOCKTNOSUPPORT	Socket type isn’t supported
ESPIPE	Illegal seek
ESRCH	No such process
ESRMNT	Server mount error
ESRVRFAULT	The receive side of a message transfer encountered a memory fault accessing the receive/reply buffer.
ESTALE	Potentially recoverable I/O error
ESTRPIPE	If pipe/FIFO, don’t sleep in stream head
ETIME	Timer expired
ETIMEDOUT	Connection timed out
ETOOMANYREFS	Too many references: can’t splice
ETXTBSY	Text file is busy
EUNATCH	Protocol driver isn’t attached
EUSERS	Too many users (for UFS)
EWOULDBLOCK	Operation would block
EXDEV	Cross-device link
EXFULL	Exchange full

Examples:

```
/*
 *  The following program makes an illegal call
 *  to the write() function, then prints the
 *  value held in errno.
 */
#include <stdio.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>

int main( void )
{
    int errvalue;

    errno = EOK;
    write( -1, "hello, world\n",
           strlen( "hello, world\n" ) );
    errvalue = errno;
    printf( "The error generated was %d\n", errvalue );
    printf( "That means: %s\n", strerror( errvalue ) );
}
```

Classification:

POSIX 1003.1

See also:

h_errno, *perror()*, *stderr*, *strerror()*

Synopsis:

Description:

This linker symbol defines the end of the text segment. This variable isn't defined in any header file.

Classification:

QNX Neutrino

See also:

brk(), *_btext*, *_edata*, *_end*, *sbrk()*

execl()

Execute a file

Synopsis:

```
#include <process.h>

int execl( const char * path,
           const char * arg0,
           const char * arg1,
           :
           const char * argn,
           NULL );
```

Arguments:

path	The path of the file to execute.
arg0, . . . , argn	Pointers to NULL-terminated character strings. These strings constitute the argument list available to the new process image. You must terminate the list with a NULL pointer. The *arg0* argument must point to a filename that's associated with the process being started.

Library:

libc

Description:

The *execl()* function replaces the current process image with a new process image specified by *path*. The new image is constructed from a regular, executable file called the new process image file. No return is made because the calling process image is replaced by the new process image.

When a C-language program is executed as a result of this call, it's entered as a C-language function call as follows:

```
int main (int argc, char *argv[]);
```

where *argc* is the argument count and *argv* is an array of character pointers to the arguments themselves. In addition, the following variable:

```
extern char **environ;
```

is initialized as a pointer to an array of character pointers to the environment strings. The *argv* and *environ* arrays are each terminated by a null pointer. The null pointer terminating the *argv* array isn't counted in *argc*.

Multithreaded applications shouldn't use the *environ* variable to access or modify any environment variable while any other thread is concurrently modifying any environment variable. A call to any function dependent on any environment variable is considered a use of the *environ* variable to access that environment variable.

The arguments specified by a program with one of the *exec** functions are passed on to the new process image in the corresponding *main()* arguments.

The number of bytes available for the new process's combined argument and environment lists is ARG_MAX.

File descriptors open in the calling process image remain open in the new process image, except for when *fcntl()*'s FD_CLOEXEC flag is set. For those file descriptors that remain open, all attributes of the open file description, including file locks remain unchanged. If a file descriptor is closed for this reason, file locks are removed as described by *close()* while locks not affected by *close()* aren't changed.

Directory streams open in the calling process image are closed in the new process image.

Signals set to SIG_DFL in the calling process are set to the default action in the new process image. Signals set to SIG_IGN by the calling process images are ignored by the new process image. Signals set to be caught by the calling process image are set to the default action in the new process image. After a successful call, alternate signal stacks aren't preserved and the SA_ONSTACK flag is cleared for all signals.

After a successful call, any functions previously registered by *atexit()* are no longer registered.

If the *path* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the new process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the new process image is set to the user ID of *path*. Similarly, if the set-group ID mode bit is set, the effective group ID of the new process is set to the group ID of *path*. The real user ID, real group ID, and supplementary group IDs of the new process remain the same as those of the calling process. The effective user ID and effective group ID of the new process image are saved (as the saved set-user ID and the saved set-group ID used by *setuid()*).

Any shared memory segments attached to the calling process image aren't attached to the new process image.

The new process also inherits at least the following attributes from the calling process image:

- process ID
- parent process ID
- process group ID
- session membership
- real user ID
- real group ID
- supplementary group IDs
- time left until an alarm clock signal (see *alarm()*)
- current working directory
- root directory
- file mode creation mask (see *umask()*)

- process signal mask (see *sigprocmask()*)
- pending signal (see *sigpending()*)
- *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* (see *times()*)
- resource limits
- controlling terminal
- interval timers.

If you call this function from a process with more than one thread, all of the threads are terminated and the new executable image is loaded and executed. No destructor functions are called.

Upon successful completion, the *st_atime* field of the file is marked for update. If the *exec** function failed but was able to locate the process image file, whether the *st_atime* field is marked for update is unspecified. On success, the process image file is considered to be opened with *open()*. The corresponding *close()* is considered to occur at a time after this open, but before process termination or successful completion of a subsequent call to one of the *exec** functions.

exec()* summary

Function	Description	POSIX?
execl()	NULL-terminated argument list	Yes
execle()	NULL-terminated argument list, specify the new process environment	Yes
execlp()	NULL-terminated argument list, search for the new process in **PATH**	Yes
execlpe()	NULL-terminated argument list, search for the new process in **PATH**, specify the new process environment	No
execv()	NULL-terminated array of arguments	Yes

continued...

Function	Description	POSIX?
execve()	NULL-terminated array of arguments, specify the new process environment	Yes
execvp()	NULL-terminated array of arguments, search for the new process in **PATH**	Yes
execvpe()	NULL-terminated array of arguments, search for the new process in **PATH**, specify the new process environment	No

Returns:

When *execl()* is successful, it doesn't return; otherwise, it returns -1 (*errno* is set).

Errors:

E2BIG — The argument list and the environment is larger than the system limit of ARG_MAX bytes.

EACCESS — The calling process doesn't have permission to search a directory listed in *path*, or it doesn't have permission to execute *path*, or *path*'s filesystem was mounted with the ST_NOEXEC flag.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *path* or an element of the **PATH** environment variable exceeds PATH_MAX.

ENOENT — One or more components of the pathname don't exist, or the *path* argument points to an empty string.

ENOEXEC — The new process image file has the correct access permissions, but isn't in the proper format.

ENOMEM — There's insufficient memory available to create the new process.

ENOTDIR A component of *path* isn't a directory.

Examples:

Replace the current process with **myprog** as if a user had typed:

```
myprog ARG1 ARG2
```

at the shell:

```
#include <stddef.h>
#include <process.h>

execl( "myprog", "myprog", "ARG1", "ARG2", NULL );
```

In this example, **myprog** will be found if it exists in the current working directory.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abort(), *atexit()*, *errno*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *_exit()*, *exit()*, *getenv()*, *main()*, *putenv()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *system()*

execle()

Execute a file

Synopsis:

```
#include <process.h>

int execle( const char * path,
            const char * arg0,
            const char * arg1,
            ⋮
            const char * argn,
            NULL,
            const char * envp[] );
```

Arguments:

path	The path of the file to execute.
arg0, . . . , *argn*	Pointers to NULL-terminated character strings. These strings constitute the argument list available to the new process image. You must terminate the list with a NULL pointer. The *arg0* argument must point to a filename that's associated with the process being started.
envp	An array of character pointers to NULL-terminated strings. These strings constitute the environment for the new process image. Terminate the *envp* array with a NULL pointer.

Library:

libc

Description:

The *execle()* function replaces the current process image with a new process image specified by *path*. The new image is constructed from a regular, executable file called the new process image file. No return is made because the calling process image is replaced by the new process image.

When a C-language program is executed as a result of this call, it's entered as a C-language function call as follows:

```
int main (int argc, char *argv[]);
```

where *argc* is the argument count and *argv* is an array of character pointers to the arguments themselves. In addition, the following variable:

```
extern char **environ;
```

is initialized as a pointer to an array of character pointers to the environment strings. The *argv* and *environ* arrays are each terminated by a null pointer. The null pointer terminating the *argv* array isn't counted in *argc*.

Multithreaded applications shouldn't use the *environ* variable to access or modify any environment variable while any other thread is concurrently modifying any environment variable. A call to any function dependent on any environment variable is considered a use of the *environ* variable to access that environment variable.

The arguments specified by a program with one of the exec functions are passed on to the new process image in the corresponding *main()* arguments.

The number of bytes available for the new process's combined argument and environment lists is ARG_MAX.

File descriptors open in the calling process image remain open in the new process image, except for when *fcntl()*'s FD_CLOEXEC flag is set. For those file descriptors that remain open, all attributes of the open file description, including file locks remain unchanged. If a file descriptor is closed for this reason, file locks are removed as described by *close()* while locks not affected by *close()* aren't changed.

Directory streams open in the calling process image are closed in the new process image.

Signals set to SIG_DFL in the calling process are set to the default action in the new process image. Signals set to SIG_IGN by the calling

process images are ignored by the new process image. Signals set to be caught by the calling process image are set to the default action in the new process image. After a successful call, alternate signal stacks aren't preserved and the SA_ONSTACK flag is cleared for all signals.

After a successful call, any functions previously registered by *atexit()* are no longer registered.

If the *path* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the new process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the new process image is set to the user ID of *path*. Similarly, if the set-group ID mode bit is set, the effective group ID of the new process is set to the group ID of *path*. The real user ID, real group ID, and supplementary group IDs of the new process remain the same as those of the calling process. The effective user ID and effective group ID of the new process image are saved (as the saved set-user ID and the saved set-group ID used by *setuid()*).

Any shared memory segments attached to the calling process image aren't attached to the new process image.

The new process also inherits at least the following attributes from the calling process image:

- process ID
- parent process ID
- process group ID
- session membership
- real user ID
- real group ID
- supplementary group IDs
- time left until an alarm clock signal (see *alarm()*)
- current working directory

- root directory
- file mode creation mask (see *umask()*)
- process signal mask (see *sigprocmask()*)
- pending signal (see *sigpending()*)
- *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* (see *times()*)
- resource limits
- controlling terminal
- interval timers.

A call to this function from a process with more than one thread results in all threads being terminated and the new executable image being loaded and executed. No destructor functions are called.

Upon successful completion, the *st_atime* field of the file is marked for update. If the *exec** function failed but was able to locate the process image file, whether the *st_atime* field is marked for update is unspecified. On success, the process image file is considered to be opened with *open()*. The corresponding *close()* is considered to occur at a time after this open, but before process termination or successful completion of a subsequent call to one of the *exec** functions.

exec()* summary

Function	Description	POSIX?
execl()	NULL-terminated argument list	Yes
execle()	NULL-terminated argument list, specify the new process's environment	Yes
execlp()	NULL-terminated argument list, search for the new process in **PATH**	Yes

continued…

Function	Description	POSIX?
execlpe()	NULL-terminated argument list, search for the new process in **PATH**, specify the new process's environment	No
execv()	NULL-terminated array of arguments	Yes
execve()	NULL-terminated array of arguments, specify the new process's environment	Yes
execvp()	NULL-terminated array of arguments, search for the new process in **PATH**	Yes
execvpe()	NULL-terminated array of arguments, search for the new process in **PATH**, specify the new process's environment	No

Returns:

When *execle()* is successful, it doesn't return; otherwise, it returns -1 and sets *errno*.

Errors:

E2BIG — The argument list and the environment is larger than the system limit of ARG_MAX bytes.

EACCESS — The calling process doesn't have permission to search a directory listed in *path*, or it doesn't have permission to execute *path*, or *path*'s filesystem was mounted with the ST_NOEXEC flag.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *path* or an element of the **PATH** environment variable exceeds PATH_MAX.

ENOENT — One or more components of the pathname don't exist, or the *path* argument points to an empty string.

ENOEXEC	The new process's image file has the correct access permissions, but isn't in the proper format.
ENOMEM	There's insufficient memory available to create the new process.
ENOTDIR	A component of *path* isn't a directory.

Examples:

Replace the current process with **myprog** as if a user had typed:

```
myprog ARG1 ARG2
```

at the shell:

```
#include <stddef.h>
#include <process.h>

char* env_list[] = { "SOURCE=MYDATA",
             "TARGET=OUTPUT",
             "lines=65",
             NULL
            };

execle( "myprog",
    "myprog", "ARG1", "ARG2", NULL,
     env_list );
```

In this example, **myprog** will be found if it exists in the current working directory. The environment for the invoked program consists of the three environment variables **SOURCE**, **TARGET** and **lines**.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

abort(), atexit(), errno, execl(), execlp(), execlpe(), execv(), execve(), execvp(), execvpe(), _exit(), exit(), getenv(), main(), putenv(), spawn(), spawnl(), spawnle(), spawnlp(), spawnlpe(), spawnp(), spawnv(), spawnve(), spawnvp(), spawnvpe(), system()

execlp()

Execute a file

Synopsis:

```
#include <process.h>

int execlp( const char * file,
            const char * arg0,
            const char * arg1,
            :
            const char * argn,
            NULL );
```

Arguments:

file	Used to construct a pathname that identifies the new process image file. If the *file* argument contains a slash character, the *file* argument is used as the pathname for the file. Otherwise, the path prefix for this file is obtained by a search of the directories passed as the environment variable **PATH**.
arg0, . . . , argn	Pointers to NULL-terminated character strings. These strings constitute the argument list available to the new process image. Terminate the list terminated with a NULL pointer. The *arg0* argument must point to a filename that's associated with the process.

Library:

libc

Description:

The *execlp()* function replaces the current process image with a new process image specified by *file*. The new image is constructed from a regular, executable file called the new process image file. No return is made because the calling process image is replaced by the new process image.

When a C-language program is executed as a result of this call, it's entered as a C-language function call as follows:

```
int main (int argc, char *argv[]);
```

where *argc* is the argument count and *argv* is an array of character pointers to the arguments themselves. In addition, the following variable:

```
extern char **environ;
```

is initialized as a pointer to an array of character pointers to the environment strings. The *argv* and *environ* arrays are each terminated by a null pointer. The null pointer terminating the *argv* array isn't counted in *argc*.

Multithreaded applications shouldn't use the *environ* variable to access or modify any environment variable while any other thread is concurrently modifying any environment variable. A call to any function dependent on any environment variable is considered a use of the *environ* variable to access that environment variable.

The arguments specified by a program with one of the exec functions are passed on to the new process image in the corresponding *main()* arguments.

If the process image file isn't a valid executable object, the contents of the file are passed as standard input to a command interpreter conforming to the *system()* function. In this case, the command interpreter becomes the new process image.

The number of bytes available for the new process's combined argument and environment lists is ARG_MAX.

File descriptors open in the calling process image remain open in the new process image, except for when *fcntl()*'s FD_CLOEXEC flag is set. For those file descriptors that remain open, all attributes of the open file description, including file locks remain unchanged. If a file descriptor is closed for this reason, file locks are removed as described by *close()* while locks not affected by *close()* aren't changed.

Directory streams open in the calling process image are closed in the new process image.

Signals set to SIG_DFL in the calling process are set to the default action in the new process image. Signals set to SIG_IGN by the calling process images are ignored by the new process image. Signals set to be caught by the calling process image are set to the default action in the new process image. After a successful call, alternate signal stacks aren't preserved and the SA_ONSTACK flag is cleared for all signals.

After a successful call, any functions previously registered by *atexit()* are no longer registered.

If the *file* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the new process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the new process image is set to the user ID of *file*. Similarly, if the set-group ID mode bit is set, the effective group ID of the new process is set to the group ID of *file*. The real user ID, real group ID, and supplementary group IDs of the new process remain the same as those of the calling process. The effective user ID and effective group ID of the new process image are saved (as the saved set-user ID and the saved set-group ID used by *setuid()*).

Any shared memory segments attached to the calling process image aren't attached to the new process image.

The new process also inherits at least the following attributes from the calling process image:

- process ID
- parent process ID
- process group ID
- session membership
- real user ID
- real group ID

- supplementary group IDs
- time left until an alarm clock signal (see *alarm()*)
- current working directory
- root directory
- file mode creation mask (see *umask()*)
- process signal mask (see *sigprocmask()*)
- pending signal (see *sigpending()*)
- *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* (see *times()*)
- resource limits
- controlling terminal
- interval timers.

A call to this function from a process with more than one thread results in all threads being terminated and the new executable image being loaded and executed. No destructor functions are called.

Upon successful completion, the *st_atime* field of the file is marked for update. If the *exec** failed but was able to locate the process image file, whether the *st_atime* field is marked for update is unspecified. On success, the process image file is considered to be opened with *open()*. The corresponding *close()* is considered to occur at a time after this open, but before process termination or successful completion of a subsequent call to one of the *exec** functions.

exec()* summary

Function	Description	POSIX?
execl()	NULL-terminated argument list	Yes
execle()	NULL-terminated argument list, specify the new process's environment	Yes

continued...

Function	Description	POSIX?
execlp()	NULL-terminated argument list, search for the new process in **PATH**	Yes
execlpe()	NULL-terminated argument list, search for the new process in **PATH**, specify the new process's environment	No
execv()	NULL-terminated array of arguments	Yes
execve()	NULL-terminated array of arguments, specify the new process's environment	Yes
execvp()	NULL-terminated array of arguments, search for the new process in **PATH**	Yes
execvpe()	NULL-terminated array of arguments, search for the new process in **PATH**, specify the new process's environment	No

Returns:

When *execlp()* is successful, it doesn't return; otherwise, it returns -1 and sets *errno*.

Errors:

E2BIG — The argument list and the environment is larger than the system limit of ARG_MAX bytes.

EACCESS — The calling process doesn't have permission to search a directory listed in *file*, or it doesn't have permission to execute *file*, or *file*'s filesystem was mounted with the ST_NOEXEC flag.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *file* or an element of the **PATH** environment variable exceeds PATH_MAX.

ENOENT	One or more components of the pathname don't exist, or the *file* argument points to an empty string.
ENOMEM	There's insufficient memory available to create the new process.
ENOTDIR	A component of *file* isn't a directory.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abort(), atexit(), errno, execl(), execle(), execlpe(), execv(), execve(), execvp(), execvpe() _exit(), exit(), getenv(), main(), putenv(), spawn(), spawnl(), spawnle(), spawnlp(), spawnlpe(), spawnp(), spawnv(), spawnve(), spawnvp(), spawnvpe(), system()

execlpe()

Execute a file

Synopsis:

```
#include <process.h>

int execlpe( const char * file,
             const char * arg0,
             const char * arg1,
             ⋮
             const char * argn,
             NULL,
             const char * envp[] );
```

Arguments:

file	Used to construct a pathname that identifies the new process image file. If the *file* argument contains a slash character, the *file* argument is used as the pathname for the file. Otherwise, the path prefix for this file is obtained by a search of the directories passed as the environment variable **PATH**.
arg0...argn	Pointers to NULL-terminated character strings. These strings constitute the argument list available to the new process image. Terminate the list terminated with a NULL pointer. The *arg0* argument must point to a filename that's associated with the process.
envp	An array of character pointers to NULL-terminated strings. These strings constitute the environment for the new process image. Terminate the *envp* array with a NULL pointer.

Library:

libc

Description:

See *execl()* for further information on the *exec*()* family of functions.

The *execlpe()* function replaces the current process image with a new process image specified by *file*. The new image is constructed from a regular, executable file called the new process image file. No return is made because the calling process image is replaced by the new process image.

If the new process is a shell script, the first line must start with `#!`, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *execlpe()* function uses the paths listed in the **PATH** environment variable to locate the program to be loaded, provided that the following conditions are met:

- The argument *file* identifies the name of program to be loaded.
- If no path character (`/`) is included in the name, an attempt is made to load the program from one of the paths in the **PATH** environment variable.
- If **PATH** isn't defined, the current working directory is used.
- If a path character (`/`) is included in the name, the program is loaded from the path specified in *file*.

The process is started with the arguments specified in the NULL-terminated arguments *arg1*...*argn*. *arg0* should point to a filename associated with the program being loaded. Only *arg0* is required, *arg1*...*argn* are optional.

The new process's environment is specified in *envp*, a NULL-terminated array of NULL-terminated strings. *envp* cannot be NULL, but *envp*[0] can be a NULL pointer if no environment strings are passed.

Each pointer in *envp* points to a string in the form:

```
variable=value
```

that is used to define an environment variable.

The environment is the collection of environment variables whose values have been defined with the **export** shell command, the **env** utility, or by the successful execution of the *putenv()* or *setenv()* functions.

A program may read these values with the *getenv()* function.

An error is detected when the program cannot be found.

If the *file* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the new process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the new process is set to the owner ID of *file*. Similarly, if the set-group ID mode bit is set, the effective group ID of the new process is set to the group ID of *file*. The real user ID, real group ID and supplementary group IDs of the new process remain the same as those of the calling process. The effective user ID and effective group ID of the new process are saved as the saved set-user ID and the saved set-group ID used by *setuid()*.

exec()* summary

Function	Description	POSIX?
execl()	NULL-terminated argument list	Yes
execle()	NULL-terminated argument list, specify the new process's environment	Yes
execlp()	NULL-terminated argument list, search for the new process in **PATH**	Yes
execlpe()	NULL-terminated argument list, search for the new process in **PATH**, specify the new process's environment	No
execv()	NULL-terminated array of arguments	Yes

continued...

Function	Description	POSIX?
execve()	NULL-terminated array of arguments, specify the new process's environment	Yes
execvp()	NULL-terminated array of arguments, search for the new process in **PATH**	Yes
execvpe()	NULL-terminated array of arguments, search for the new process in **PATH**, specify the new process's environment	No

Returns:

When *execlpe()* is successful, it doesn't return; otherwise, it returns -1 and sets *errno*.

Errors:

E2BIG — The argument list and the environment is larger than the system limit of ARG_MAX bytes.

EACCESS — The calling process doesn't have permission to search a directory listed in *file*, or it doesn't have permission to execute *file*, or *file*'s filesystem was mounted with the ST_NOEXEC flag.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *file* or an element of the **PATH** environment variable exceeds PATH_MAX.

ENOENT — One or more components of the pathname don't exist, or the *file* argument points to an empty string.

ENOMEM — There's insufficient memory available to create the new process.

ENOTDIR — A component of *file* isn't a directory.

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abort(), atexit(), errno, execl(), execle(), execlp(), execv(), execve(), execvp(), execvpe(), _exit(), exit(), getenv(), main(), putenv(), spawn(), spawnl(), spawnle(), spawnlp(), spawnlpe(), spawnp(), spawnv(), spawnve(), spawnvp(), spawnvpe(), system()

execv()

Execute a file

Synopsis:

```
#include <process.h>

int execv( const char * path,
           char * const argv[] );
```

Arguments:

path A path name that identifies the new process image file.

argv An array of character pointers to NULL-terminated strings. Your application must ensure that the last member of this array is a NULL pointer. These strings constitute the argument list available to the new process image. The value in *argv[0]* must point to a filename that's associated with the process being started.

Library:

libc

Description:

The *execv()* function replaces the current process image with a new process image specified by *path*. The new image is constructed from a regular, executable file called the new process image file. No return is made because the calling process image is replaced by the new process image.

When a C-language program is executed as a result of this call, it's entered as a C-language function call as follows:

```
int main (int argc, char *argv[]);
```

where *argc* is the argument count and *argv* is an array of character pointers to the arguments themselves. In addition, the following variable:

```
extern char **environ;
```

is initialized as a pointer to an array of character pointers to the environment strings. The *argv* and *environ* arrays are each terminated by a null pointer. The null pointer terminating the *argv* array isn't counted in *argc*.

Multithreaded applications shouldn't use the *environ* variable to access or modify any environment variable while any other thread is concurrently modifying any environment variable. A call to any function dependent on any environment variable is considered a use of the *environ* variable to access that environment variable.

The arguments specified by a program with one of the exec functions are passed on to the new process image in the corresponding *main()* arguments.

The environment for the new process image is taken from the external variable *environ* in the calling process.

The number of bytes available for the new process's combined argument and environment lists is ARG_MAX.

File descriptors open in the calling process image remain open in the new process image, except for when *fcntl()*'s FD_CLOEXEC flag is set. For those file descriptors that remain open, all attributes of the open file description, including file locks remain unchanged. If a file descriptor is closed for this reason, file locks are removed as described by *close()* while locks not affected by *close()* aren't changed.

Directory streams open in the calling process image are closed in the new process image.

Signals set to SIG_DFL in the calling process are set to the default action in the new process image. Signals set to SIG_IGN by the calling process images are ignored by the new process image. Signals set to be caught by the calling process image are set to the default action in the new process image. After a successful call, alternate signal stacks aren't preserved and the SA_ONSTACK flag is cleared for all signals.

After a successful call, any functions previously registered by *atexit()* are no longer registered.

If the *path* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the new process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the new process image is set to the user ID of *path*. Similarly, if the set-group ID mode bit is set, the effective group ID of the new process is set to the group ID of *path*. The real user ID, real group ID, and supplementary group IDs of the new process remain the same as those of the calling process. The effective user ID and effective group ID of the new process image are saved (as the saved set-user ID and the saved set-group ID used by *setuid()*).

Any shared memory segments attached to the calling process image aren't attached to the new process image.

The new process also inherits at least the following attributes from the calling process image:

- process ID
- parent process ID
- process group ID
- session membership
- real user ID
- real group ID
- supplementary group IDs
- time left until an alarm clock signal (see *alarm()*)
- current working directory
- root directory
- file mode creation mask (see *umask()*)
- process signal mask (see *sigprocmask()*)
- pending signal (see *sigpending()*)

- *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* (see *times()*)
- resource limits
- controlling terminal
- interval timers.

A call to this function from a process with more than one thread results in all threads being terminated and the new executable image being loaded and executed. No destructor functions are called.

Upon successful completion, the *st_atime* field of the file is marked for update. If the *exec** failed but was able to locate the process image file, whether the *st_atime* field is marked for update is unspecified. On success, the process image file is considered to be opened with *open()*. The corresponding *close()* is considered to occur at a time after this open, but before process termination or successful completion of a subsequent call to one of the *exec** functions.

exec()* summary

Function	Description	POSIX?
execl()	NULL-terminated argument list	Yes
execle()	NULL-terminated argument list, specify the new process's environment	Yes
execlp()	NULL-terminated argument list, search for the new process in **PATH**	Yes
execlpe()	NULL-terminated argument list, search for the new process in **PATH**, specify the new process's environment	No
execv()	NULL-terminated array of arguments	Yes
execve()	NULL-terminated array of arguments, specify the new process's environment	Yes

continued...

Function	Description	POSIX?
execvp()	NULL-terminated array of arguments, search for the new process in **PATH**	Yes
execvpe()	NULL-terminated array of arguments, search for the new process in **PATH**, specify the new process's environment	No

Returns:

When *execv()* is successful, it doesn't return; otherwise, it returns -1 and sets *errno*.

Errors:

E2BIG — The argument list and the environment is larger than the system limit of ARG_MAX bytes.

EACCESS — The calling process doesn't have permission to search a directory listed in *path*, or it doesn't have permission to execute *path*, or *path*'s filesystem was mounted with the ST_NOEXEC flag.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *path* or an element of the **PATH** environment variable exceeds PATH_MAX.

ENOENT — One or more components of the pathname don't exist, or the *path* argument points to an empty string.

ENOEXEC — The new process's image file has the correct access permissions, but isn't in the proper format.

ENOMEM — There's insufficient memory available to create the new process.

ENOTDIR — A component of *path* isn't a directory.

Examples:

```
#include <stddef.h>
#include <process.h>

char* arg_list[] = { "myprog", "ARG1", "ARG2", NULL };

execv( "myprog", arg_list );
```

The preceding invokes **myprog** as if the user entered:

```
myprog ARG1 ARG2
```

as a command at the shell. The program will be found if **myprog** exists in the current working directory.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abort(), *atexit()*, *errno*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execve()*, *execvp()*, *execvpe()*, *_exit()*, *exit()*, *getenv()*, *main()*, *putenv()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *system()*

execve()

Execute a file

Synopsis:

```
#include <process.h>

int execve( const char * path,
            char * const argv[],
            char * const envp[] );
```

Arguments:

path A path name that identifies the new process image file.

argv An array of character pointers to NULL-terminated strings. Your application must ensure that the last member of this array is a NULL pointer. These strings constitute the argument list available to the new process image. The value in *argv[0]* must point to a filename that's associated with the process being started.

envp An array of character pointers to NULL-terminated strings. These strings constitute the environment for the new process image. Terminate the *envp* array with a NULL pointer.

Library:

libc

Description:

The *execve()* function replaces the current process image with a new process image specified by *path*. The new image is constructed from a regular, executable file called the new process image file. No return is made because the calling process image is replaced by the new process image.

When a C-language program is executed as a result of this call, it's entered as a C-language function call as follows:

```
int main (int argc, char *argv[]);
```

where *argc* is the argument count and *argv* is an array of character pointers to the arguments themselves. In addition, the following variable:

```
extern char **environ;
```

is initialized as a pointer to an array of character pointers to the environment strings. The *argv* and *environ* arrays are each terminated by a null pointer. The null pointer terminating the *argv* array isn't counted in *argc*.

Multithreaded applications shouldn't use the *environ* variable to access or modify any environment variable while any other thread is concurrently modifying any environment variable. A call to any function dependent on any environment variable is considered a use of the *environ* variable to access that environment variable.

The arguments specified by a program with one of the exec functions are passed on to the new process image in the corresponding *main()* arguments.

The number of bytes available for the new process's combined argument and environment lists is ARG_MAX.

File descriptors open in the calling process image remain open in the new process image, except for when *fcntl()*'s FD_CLOEXEC flag is set. For those file descriptors that remain open, all attributes of the open file description, including file locks remain unchanged. If a file descriptor is closed for this reason, file locks are removed as described by *close()* while locks not affected by *close()* aren't changed.

Directory streams open in the calling process image are closed in the new process image.

Signals set to SIG_DFL in the calling process are set to the default action in the new process image. Signals set to SIG_IGN by the calling process images are ignored by the new process image. Signals set to be caught by the calling process image are set to the default action in the new process image. After a successful call, alternate signal stacks aren't preserved and the SA_ONSTACK flag is cleared for all signals.

After a successful call, any functions previously registered by *atexit()* are no longer registered.

If the *path* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the new process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the new process image is set to the user ID of *path*. Similarly, if the set-group ID mode bit is set, the effective group ID of the new process is set to the group ID of *path*. The real user ID, real group ID, and supplementary group IDs of the new process remain the same as those of the calling process. The effective user ID and effective group ID of the new process image are saved (as the saved set-user ID and the saved set-group ID used by *setuid()*).

Any shared memory segments attached to the calling process image aren't attached to the new process image.

The new process also inherits at least the following attributes from the calling process image:

- process ID
- parent process ID
- process group ID
- session membership
- real user ID
- real group ID
- supplementary group IDs
- time left until an alarm clock signal (see *alarm()*)
- current working directory
- root directory
- file mode creation mask (see *umask()*)

- process signal mask (see *sigprocmask()*)
- pending signal (see *sigpending()*)
- *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* (see *times()*)
- resource limits
- controlling terminal
- interval timers.

A call to this function from a process with more than one thread results in all threads being terminated and the new executable image being loaded and executed. No destructor functions are called.

Upon successful completion, the *st_atime* field of the file is marked for update. If the *exec** failed but was able to locate the process image file, whether the *st_atime* field is marked for update is unspecified. On success, the process image file is considered to be opened with *open()*. The corresponding *close()* is considered to occur at a time after this open, but before process termination or successful completion of a subsequent call to one of the *exec** functions.

exec()* summary

Function	Description	POSIX?
execl()	NULL-terminated argument list	Yes
execle()	NULL-terminated argument list, specify the new process's environment	Yes
execlp()	NULL-terminated argument list, search for the new process in **PATH**	Yes
execlpe()	NULL-terminated argument list, search for the new process in **PATH**, specify the new process's environment	No
execv()	NULL-terminated array of arguments	Yes

continued...

Function	Description	POSIX?
execve()	NULL-terminated array of arguments, specify the new process's environment	Yes
execvp()	NULL-terminated array of arguments, search for the new process in **PATH**	Yes
execvpe()	NULL-terminated array of arguments, search for the new process in **PATH**, specify the new process's environment	No

Returns:

When *execve()* is successful, it doesn't return; otherwise, it returns -1 and sets *errno*.

Errors:

E2BIG — The argument list and the environment is larger than the system limit of ARG_MAX bytes.

EACCESS — The calling process doesn't have permission to search a directory listed in *path*, or it doesn't have permission to execute *path*, or *path*'s filesystem was mounted with the ST_NOEXEC flag.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *path* or an element of the **PATH** environment variable exceeds PATH_MAX.

ENOENT — One or more components of the pathname don't exist, or the *path* argument points to an empty string.

ENOEXEC — The new process's image file has the correct access permissions, but isn't in the proper format.

ENOMEM — There's insufficient memory available to create the new process.

ENOTDIR A component of *path* isn't a directory.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

abort(), atexit(), errno, execl(), execle(), execlp(), execlpe(), execv(), execvp(), execvpe(), _exit(), exit(), getenv(), main(), putenv(), spawn(), spawnl(), spawnle(), spawnlp(), spawnlpe(), spawnp(), spawnv(), spawnve(), spawnvp(), spawnvpe(), system()

execvp()

Execute a file

Synopsis:

```
#include <process.h>

int execvp( const char * file,
            char * const argv[] );
```

Arguments:

file Used to construct a pathname that identifies the new process image file. If the *file* argument contains a slash character, the *file* argument is used as the pathname for the file. Otherwise, the path prefix for this file is obtained by a search of the directories passed as the environment variable **PATH**.

argv An array of character pointers to NULL-terminated strings. Your application must ensure that the last member of this array is a NULL pointer. These strings constitute the argument list available to the new process image. The value in *argv[0]* must point to a filename that's associated with the process being started.

Library:

libc

Description:

The *execvp()* function replaces the current process image with a new process image specified by *file*. The new image is constructed from a regular, executable file called the new process image file. No return is made because the calling process image is replaced by the new process image.

When a C-language program is executed as a result of this call, it's entered as a C-language function call as follows:

```
int main (int argc, char *argv[]);
```

where *argc* is the argument count and *argv* is an array of character pointers to the arguments themselves. In addition, the following variable:

```
extern char **environ;
```

is initialized as a pointer to an array of character pointers to the environment strings. The *argv* and *environ* arrays are each terminated by a null pointer. The null pointer terminating the *argv* array isn't counted in *argc*.

Multithreaded applications shouldn't use the *environ* variable to access or modify any environment variable while any other thread is concurrently modifying any environment variable. A call to any function dependent on any environment variable is considered a use of the *environ* variable to access that environment variable.

The arguments specified by a program with one of the exec functions are passed on to the new process image in the corresponding *main()* arguments.

If the process image file isn't a valid executable object, the contents of the file are passed as standard input to a command interpreter conforming to the *system()* function. In this case, the command interpreter becomes the new process image.

The environment for the new process image is taken from the external variable *environ* in the calling process.

The number of bytes available for the new process's combined argument and environment lists is ARG_MAX.

File descriptors open in the calling process image remain open in the new process image, except for when *fcntl()*'s FD_CLOEXEC flag is set. For those file descriptors that remain open, all attributes of the open file description, including file locks remain unchanged. If a file descriptor is closed for this reason, file locks are removed as described by *close()* while locks not affected by *close()* aren't changed.

Directory streams open in the calling process image are closed in the new process image.

Signals set to SIG_DFL in the calling process are set to the default action in the new process image. Signals set to SIG_IGN by the calling process images are ignored by the new process image. Signals set to be caught by the calling process image are set to the default action in the new process image. After a successful call, alternate signal stacks aren't preserved and the SA_ONSTACK flag is cleared for all signals.

After a successful call, any functions previously registered by *atexit()* are no longer registered.

If the *file* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the new process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the new process image is set to the user ID of *file*. Similarly, if the set-group ID mode bit is set, the effective group ID of the new process is set to the group ID of *file*. The real user ID, real group ID, and supplementary group IDs of the new process remain the same as those of the calling process. The effective user ID and effective group ID of the new process image are saved (as the saved set-user ID and the saved set-group ID used by *setuid()*).

Any shared memory segments attached to the calling process image aren't attached to the new process image.

The new process also inherits at least the following attributes from the calling process image:

- process ID
- parent process ID
- process group ID
- session membership
- real user ID
- real group ID
- supplementary group IDs

- time left until an alarm clock signal (see *alarm()*)
- current working directory
- root directory
- file mode creation mask (see *umask()*)
- process signal mask (see *sigprocmask()*)
- pending signal (see *sigpending()*)
- *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* (see *times()*)
- resource limits
- controlling terminal
- interval timers.

A call to this function from a process with more than one thread results in all threads being terminated and the new executable image being loaded and executed. No destructor functions are called.

Upon successful completion, the *st_atime* field of the file is marked for update. If the *exec* function failed but was able to locate the process image file, whether the *st_atime* field is marked for update is unspecified. On success, the process image file is considered to be opened with *open()*. The corresponding *close()* is considered to occur at a time after this open, but before process termination or successful completion of a subsequent call to one of the *exec** functions.

exec()* summary

Function	Description	POSIX?
execl()	NULL-terminated argument list	Yes
execle()	NULL-terminated argument list, specify the new process's environment	Yes

continued...

Function	Description	POSIX?
execlp()	NULL-terminated argument list, search for the new process in **PATH**	Yes
execlpe()	NULL-terminated argument list, search for the new process in **PATH**, specify the new process's environment	No
execv()	NULL-terminated array of arguments	Yes
execve()	NULL-terminated array of arguments, specify the new process's environment	Yes
execvp()	NULL-terminated array of arguments, search for the new process in **PATH**	Yes
execvpe()	NULL-terminated array of arguments, search for the new process in **PATH**, specify the new process's environment	No

Returns:

When *execvp()* is successful, it doesn't return; otherwise, it returns -1 and sets *errno*.

Errors:

E2BIG — The argument list and the environment is larger than the system limit of ARG_MAX bytes.

EACCESS — The calling process doesn't have permission to search a directory listed in *file*, or it doesn't have permission to execute *file*, or *file*'s filesystem was mounted with the ST_NOEXEC flag.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *file* or an element of the **PATH** environment variable exceeds PATH_MAX.

ENOENT	One or more components of the pathname don't exist, or the *file* argument points to an empty string.
ENOMEM	There's insufficient memory available to create the new process.
ENOTDIR	A component of *file* isn't a directory.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abort(), atexit(), errno, execl(), execle(), execlp(), execlpe(), execv(), execve(), execvpe(), _exit(), exit(), getenv(), main(), putenv(), spawn(), spawnl(), spawnle(), spawnlp(), spawnlpe(), spawnp(), spawnv(), spawnve(), spawnvp(), spawnvpe(), system()

execvpe()

Execute a file

Synopsis:

```
#include <process.h>

int execvpe( const char * file,
             char * const argv[],
             char * const envp[] );
```

Arguments:

file Used to construct a pathname that identifies the new process image file. If the *file* argument contains a slash character, the *file* argument is used as the pathname for the file. Otherwise, the path prefix for this file is obtained by a search of the directories passed as the environment variable **PATH**.

argv An array of character pointers to NULL-terminated strings. Your application must ensure that the last member of this array is a NULL pointer. These strings constitute the argument list available to the new process image. The value in *argv[0]* must point to a filename that's associated with the process being started.

envp An array of character pointers to NULL-terminated strings. These strings constitute the environment for the new process image. Terminate the *envp* array with a NULL pointer.

Library:

libc

Description:

☞ See *execl()* for further information on the *exec*()* family of functions.

The *execvpe()* function replaces the current process image with a new process image specified by *file*. The new image is constructed from a regular, executable file called the new process image file. No return is

made because the calling process image is replaced by the new process image.

If the new process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *execvpe()* function uses the paths listed in the **PATH** environment variable to locate the program to be loaded, provided that the following conditions are met:

- The *file* argument identifies the name of program to be loaded.
- If no path character (**/**) is included in the name, an attempt is made to load the program from one of the paths in the **PATH** environment variable.
- If **PATH** isn't defined, the current working directory is used.
- If a path character (**/**) is included in the name, the program is loaded from the path specified in *file*.

The process is started with the argument specified in *argv*, a NULL-terminated array of NULL-terminated strings. The *argv*[0] entry should point to a filename associated with the program being loaded. The *argv* argument can't be NULL but *argv*[0] can be NULL if no arguments are required.

The new process's environment is specified in *envp*, a NULL-terminated array of NULL-terminated strings. *envp* cannot be NULL, but *envp*[0] can be a NULL pointer if no environment strings are passed.

Each pointer in *envp* points to a string in the form:

```
variable=value
```

that is used to define an environment variable.

The environment is the collection of environment variables whose values have been defined with the **export** shell command, the **env**

utility, or by the successful execution of the *putenv()* or *setenv()* functions.

A program may read these values with the *getenv()* function.

An error is detected when the program cannot be found.

If the *file* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the new process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the new process is set to the owner ID of *file*. Similarly, if the set-group ID mode bit is set, the effective group ID of the new process is set to the group ID of *file*. The real user ID, real group ID and supplementary group IDs of the new process remain the same as those of the calling process. The effective user ID and effective group ID of the new process are saved as the saved set-user ID and the saved set-group ID used by *setuid()*.

exec()* summary

Function	Description	POSIX?
execl()	NULL-terminated argument list	Yes
execle()	NULL-terminated argument list, specify the new process's environment	Yes
execlp()	NULL-terminated argument list, search for the new process in **PATH**	Yes
execlpe()	NULL-terminated argument list, search for the new process in **PATH**, specify the new process's environment	No
execv()	NULL-terminated array of arguments	Yes
execve()	NULL-terminated array of arguments, specify the new process's environment	Yes
execvp()	NULL-terminated array of arguments, search for the new process in **PATH**	Yes

continued...

Function	Description	POSIX?
execvpe()	NULL-terminated array of arguments, search for the new process in **PATH**, specify the new process's environment	No

Returns:

When *execvpe()* is successful, it doesn't return; otherwise, it returns -1 and sets *errno*.

Errors:

E2BIG — The argument list and the environment is larger than the system limit of ARG_MAX bytes.

EACCESS — The calling process doesn't have permission to search a directory listed in *file*, or it doesn't have permission to execute *file*, or *file*'s filesystem was mounted with the ST_NOEXEC flag.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *file* or an element of the **PATH** environment variable exceeds PATH_MAX.

ENOENT — One or more components of the pathname don't exist, or the *file* argument points to an empty string.

ENOMEM — There's insufficient memory available to create the new process.

ENOTDIR — A component of *file* isn't a directory.

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

abort(), *atexit()*, *errno*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *_exit()*, *exit()*, *getenv()*, *main()*, *putenv()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *system()*

Synopsis:

```
#include <stdlib.h>

void _exit( int status );
```

Arguments:

status The exit status to use for the program.

Library:

libc

Description:

The *_exit()* function causes normal program termination to occur.

☞ The functions registered with *atexit()* aren't called when you use *_exit()* to terminate a program. If you want those functions to be called, use *exit()* instead.

The *_exit()* function does the following when a process terminates for any reason:

1. Closes all open file descriptors and directory streams in the calling process.
2. Notifies the parent process of the calling process if the parent called *wait()* or *waitpid()*. The low-order 8 bits of *status* are made available to the parent via *wait()* or *waitpid()*.
3. Saves the exit *status* if the parent process of the calling process isn't executing a *wait()* or *waitpid()* function. If the parent calls *wait()* or *waitpid()* later, this status is returned immediately.
4. Sends a SIGHUP signal to the calling process's children; this can indirectly cause the children to exit if they don't handle SIGHUP. Children of a terminated process are assigned a new parent process.

5 Sends a SIGCHLD signal to the parent process.

6 Sends a SIGHUP signal to each process in the foreground process group if the calling process is the controlling process for the controlling terminal of that process group.

7 Disassociates the controlling terminal from the calling process's session if the process is a controlling process, allowing it to be acquired by a new controlling process.

8 If the process exiting causes a process group to become orphaned, and if any member of the newly-orphaned process group is stopped, then a SIGHUP signal followed by a SIGCONT signal is sent to each process in the newly-orphaned process group.

Returns:

The *_exit()* function doesn't return.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char *argv[] )
{
    FILE *fp;

    if( argc <= 1 ) {
        fprintf( stderr, "Missing argument\n" );
        exit( EXIT_FAILURE );
    }

    fp = fopen( argv[1], "r" );
    if( fp == NULL ) {
        fprintf( stderr, "Unable to open '%s'\n", argv[1] );
        _exit( EXIT_FAILURE );
    }
    fclose( fp );

    /*
     At this point, calling _exit() is the same as calling
     return EXIT_SUCCESS;...
    */
    _exit( EXIT_SUCCESS );
```

```
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

abort(), *atexit()*, *close()*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *exit()*, *getenv()*, *main()*, *putenv()*, *sigaction()*, *signal()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *system()*, *wait()*, *waitpid()*

exit()

Exit the calling program

Synopsis:

```
#include <stdlib.h>

void exit( int status );
```

Arguments:

status The exit status to use for the program.

Library:

libc

Description:

The *exit()* function causes the calling program to exit normally. When a program exits normally:

1. All functions registered with the *atexit()* function are called.
2. All open file streams (those opened by *fopen()*, *fdopen()*, *freopen()*, or *popen()*) are flushed and closed.
3. All temporary files created by the *tmpfile()* function are removed.
4. The return *status* is made available to the parent process; *status* is typically set to EXIT_SUCCESS to indicate successful termination and set to EXIT_FAILURE or some other value to indicate an error.

Returns:

The *exit()* function doesn't return.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char *argv[] )
{
    FILE *fp;

    if( argc <= 1 ) {
        fprintf( stderr, "Missing argument\n" );
        exit( EXIT_FAILURE );
    }

    fp = fopen( argv[1], "r" );
    if( fp == NULL ) {
        fprintf( stderr, "Unable to open '%s'\n", argv[1] );
        exit( EXIT_FAILURE );
    }
    fclose( fp );
    exit( EXIT_SUCCESS );

    /*
     You'll never get here; this prevents compiler
     warnings about "function has no return value".
    */
    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abort(), atexit(), _exit(), main()

exp(), expf()

Compute the exponential function of a number

Synopsis:

```
#include <math.h>

double exp( double x );

float expf( float x );
```

Arguments:

x The number for which you want to calculate the exponential.

Library:

libm

Description:

The *exp()* function computes the exponential function of *x* (e^x).

A range error occurs if the magnitude of *x* is too large.

Returns:

The exponential value of *x*.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", exp(.5) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
1.648721
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The value of *expm1*(*x*) may be more accurate than *exp*(*x*) - `1.0` for small values of *x*.

See also:

errno, *expm1*, *log()*

expm1(), expm1f()

Compute the exponential of a number, then subtract 1

Synopsis:

```
#include <math.h>

double expm1 ( double x );

float expm1f ( float x );
```

Arguments:

x The number for which you want to calculate the exponential minus one.

Library:

libm

Description:

The *expm1()* and *expm1f()* functions compute the exponential of *x*, minus 1 (e^x - 1).

A range error occurs if the magnitude of *x* is too large.

The value of *expm1*(*x*) may be more accurate than *exp*(*x*) `- 1.0` for small values of *x*.

The *expm1()* and *log1p()* functions are useful for financial calculations of `(((1+`*x*`)**`*n*`)-1)/`*x*, namely:

```
expm1(n * log1p(x))/x
```

when *x* is very small (for example, when performing calculations with a small daily interest rate). These functions also simplify writing accurate inverse hyperbolic functions.

Returns:

The exponential value of *x*, minus 1.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>


int main(int argc, char** argv)
{
    double a, b;

    a = 2;
    b = expm1(a);
    printf("(e ^ %f) -1  is %f \n", a, b);

    return(0);
}
```

produces the output:

```
(e ^ 2.000000) -1  is 6.389056
```

Classification:

expm1() is standard Unix; *expm1f()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

exp(), log1p()

fabs(), fabsf()

Compute the absolute value of a double number

Synopsis:

```
#include <math.h>

double fabs( double x );

float fabsf( float x );
```

Arguments:

x The number you want the absolute value of.

Library:

libm

Description:

These functions compute the absolute value of *x*.

Returns:

The absolute value of *x*.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f %f\n", fabs(.5), fabs(-.5) );
    return EXIT_SUCCESS;
}
```

produces the output:

```
0.500000 0.500000
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abs(), cabs(), labs()

fcfgopen()

Open a configuration file

Synopsis:

```
#include <cfgopen.h>

FILE * fcfgopen( const char * path,
                 const char * mode,
                 int location,
                 const char * historical,
                 char * namebuf,
                 int nblen );
```

Arguments:

path	The name of the configuration file that you want to open.
mode	A string that describes the mode to open in; see *fopen()*.
location	Flags that describe how the path is constructed. See "Search condition flags" in the documentation for *cfgopen()*.
historical	A optional file to open as a last resort if none of the criteria for finding the path is met. This string works like a path search order, and lets you search more than one location. You can also specify **%H** to substitute the hostname value into the string. Specify NULL to ignore this option.
namebuf	A buffer to save the pathname in. Specify NULL to ignore this option.
nblen	The length of the buffer pointed to by *namebuf*. Specify 0 to ignore this option.

Library:

libc

Description:

The *fcfgopen()* function is similar to *cfgopen()* with these exceptions:

- The CFGFILE_NOFD flag isn't valid.
- The values for *flags* described in *open()* aren't valid.

Returns:

A valid *fd* if CFGFILE_NOFD isn't specified, a nonnegative value if CFGFILE_NOFD is specified, or -1 if an error occurs.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

cfgopen(), *confstr()*

mib.txt, **snmpd.conf** in the *Utilities Reference*

fchmod()

Change the permissions for a file

Synopsis:

```
#include <sys/types.h>
#include <sys/stat.h>

int fchmod( int fd,
            mode_t mode );
```

Arguments:

fd A file descriptor for the file whose permissions you want to change.

mode The new permissions for the file. For more information, see "Access permissions" in the documentation for *stat()*.

Library:

libc

Description:

The *fchmod()* function changes the permissions for a file referred to by *fd* to be the settings in the mode given by *mode*.

If the effective user ID of the calling process is equal to the file owner, or the calling process has appropriate privileges (for example, the superuser), *fchmod()* sets the S_ISUID, S_ISGID and the file permission bits, defined in the **<sys/stat.h>** header file, from the corresponding bits in the *mode* argument. These bits define access permissions for the user associated with the file, the group associated with the file, and all others.

For a regular file, if the calling process doesn't have appropriate privileges, and if the group ID of the file doesn't match the effective group ID, the S_ISGID (set-group-ID on execution) bit in the file's mode is cleared upon successful return from *fchmod()*.

Changing the permissions has no any effect on any file descriptors for files that are already open.

If *fchmod()* succeeds, the **st_ctime** field of the file is marked for update.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid file descriptor.

ENOSYS The *fchmod()* function isn't implemented for the filesystem specified by *fd*.

EPERM The effective user ID doesn't match the owner of the file, and the calling process doesn't have appropriate privileges.

EROFS The referenced file resides on a read-only filesystem.

Examples:

```
/*
 * Change the permissions of a list of files
 * to be read/write by the owner only
 */
#include <stdio.h>
#include <fcntl.h>
#include <sys/types.h>
#include <sys/stat.h>

int main( int argc, char **argv )
  {
    int i;
    int ecode = 0;
    int fd;

    for( i = 1; i < argc; i++ ) {
      if( ( fd = open( argv[i], O_RDONLY ) ) == -1 ) {
        perror( argv[i] );
        ecode++;
      }
      else if( fchmod( fd, S_IRUSR | S_IWUSR ) == -1 ) {
```

```
            perror( argv[i] );
            ecode++;
          }

          close( fd );
        }
        return ecode;
      }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chmod(), chown(), errno, fchown(), fstat(), open(), stat()

fchown()

Change the user ID and group ID of a file

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

int fchown( int fd,
            uid_t owner,
            gid_t group );
```

Arguments:

fd	A file descriptor for the file whose ownership you want to change.
owner	The user ID of the new owner.
group	The group ID of the new owner.

Library:

libc

Description:

The *fchown()* function changes the user ID and group ID of the file referenced by *fd* to be the numeric values contained in *owner* and *group*, respectively.

Only processes with an effective user ID equal to the user ID of the file, or with appropriate privileges (for example, the superuser) may change the ownership of a file.

The _POSIX_CHOWN_RESTRICTED flag is enforced. This means that only the superuser may change the ownership of a file. The group of a file may be changed by the superuser, or also by a process with the effective user ID equal to the user ID of the file, if (and only if) *owner* is equal to the user ID of the file and *group* is equal to the effective group ID of the calling process.

If the *fd* argument refers to a regular file, the set-user-ID (S_ISUID) and set-group-ID (S_ISGID) bits of the file mode are cleared if the function is successful.

If *fchown()* succeeds, the **st_ctime** field of the file is marked for update.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid file descriptor.

EPERM The effective user ID doesn't match the owner of the file, or the calling process doesn't have appropriate privileges.

EROFS The named file resides on a read-only filesystem.

Examples:

```
/*
 * Change the ownership of a list of files
 * to the current user/group
 */
#include <stdio.h>
#include <fcntl.h>
#include <sys/types.h>
#include <unistd.h>

int main( int argc, char **argv )
  {
    int i;
    int ecode = 0;
    int fd;

    for( i = 1; i < argc; i++ ) {
      if( ( fd = open( argv[i], O_RDONLY ) ) == -1 ) {
        perror( argv[i] );
        ecode++;
      }
      else if( fchown( fd, getuid(), getgid() ) == -1 ) {
        perror( argv[i] );
        ecode++;
      }

      close( fd );
```

```
    }
    return ecode;
}
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chmod(), chown(), errno, fchmod(), fstat(), lchown(), open(), stat()

fclose()

Close a stream

Synopsis:

```
#include <stdio.h>

int fclose( FILE* fp );
```

Arguments:

fp The stream you want to close.

Library:

libc

Description:

The *fclose()* function closes the stream specified by *fp*. Any unwritten, buffered data is flushed before the file is closed. Any unread, buffered data is discarded.

If the associated buffer was automatically allocated, it's deallocated.

Returns:

0 for success, or EOF if an error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;

    fp = fopen( "stdio.h", "r" );
    if( fp != NULL ) {
        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fcloseall(), fdopen(), fopen(), freopen()

fcloseall()

Close all open stream files

Synopsis:

```
#include <stdio.h>

int fcloseall( void );
```

Library:

libc

Description:

The *fcloseall()* function closes all open streams, except *stdin*, *stdout* and *stderr*. This includes streams created (and not yet closed) by *fdopen()*, *fopen()* and *freopen()*.

Returns:

0

Errors:

If an error occurs, *errno* is set.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    printf( "The number of files closed is %d\n", fcloseall() );
    return EXIT_SUCCESS;
}
```

Classification:

QNX 4

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fclose(), fdopen(), fopen(), freopen()

fcntl()

Provide control over an open file

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>
#include <fcntl.h>

int fcntl( int fildes,
           int cmd,
           ... );
```

Arguments:

fildes The descriptor for the file you want to control.

cmd The command to execute; see below.

Library:

libc

Description:

The *fcntl()* function provides control over the open file referenced by file descriptor *fildes*. To establish a lock with this function, open with write-only permission (O_WRONLY) or with read/write permission (O_RDWR).

The type of control is specified by the *cmd* argument, which may require a third data argument (*arg*). The *cmd* argument is defined in **<fcntl.h>**, and includes at least the following values:

F_ALLOCSP If the size of the file is less than the number of bytes specified by the extra *arg* argument, extend the file with NUL characters.

F_DUPFD Allocate and return a new file descriptor that's the lowest numbered available (i.e. not already open) file descriptor greater than or equal to the third argument, *arg*, taken as an **int**. The new file

descriptor refers to the same file as *fildes*, and shares any locks.

F_FREESP — Truncate the file to the size (in bytes) specified by the extra argument, *arg*.

F_GETFD — Get the file descriptor flags associated with the file descriptor *fildes*. File descriptor flags are associated with a single file descriptor, and don't affect other file descriptors referring to the same file.

F_GETFL — Get the file status flags and the file access modes associated with *fildes*. The flags and modes are defined in **<fcntl.h>**.

The file status flags (see *open()* for more detailed information) are:

- O_APPEND — Set append mode.
- O_NONBLOCK — No delay.

The file access modes are:

- O_RDONLY — Open for reading only.
- O_RDWR — Open for reading and writing.
- O_WRONLY — Open for writing only.

F_GETLK — Get the first lock that blocks the lock description pointed to by the third argument, *arg*, taken as a pointer to type **struct flock** (defined in **<fcntl.h>**). For more information, see the **flock** structure section below. The information returned overwrites the information passed to *fcntl()* in the structure pointed to by *arg*.

If no lock is found that prevents this lock from being created, the structure is left unchanged, except for the lock type, which is set to F_UNLCK. If a lock is found, the *l_pid* member of the structure pointed to by *arg* is set to the process ID of the process holding the blocking lock and *l_whence* is set to SEEK_SET.

F_SETFD — Set the file descriptor flags associated with *fildes* to the third argument, *arg*, taken as type **int**. See the above discussion for more details.

The only defined file descriptor flag is:

- FD_CLOEXEC — When this flag is clear, the file remains open across *spawn*()* or *exec*()* calls; else the file is closed.

F_SETFL — Set the file status flags, as shown above, for the open file description associated with *fildes* from the corresponding bits in the third argument, *arg*, taken as type **int**. You can't use this function to change the file access mode. All bits set in *arg*, other than the file status bits, are ignored.

F_SETLK — Set or clear a file segment lock, according to the lock description pointed to by the third argument, *arg*, taken as a pointer to type **struct flock**, as defined in the header file **<fcntl.h>**, and documented below. This command is used to create the following locks (defined in **<fcntl.h>**):

- F_RDLCK — Shared or read locks.
- F_UNLCK — Remove either type of lock.
- F_WRLCK — Exclusive or write locks.

If a lock can't be set, *fcntl()* returns immediately.

F_SETLKW — This command is the same as F_SETLK, except that when a lock is blocked by other locks, the process waits until the request can be satisfied. If a signal that's to be caught is received while *fcntl()* is waiting for a region, the call is interrupted without performing the lock operation, and *fcntl()* returns -1 with *errno* set to EINTR.

`flock` structure

The **`flock`** structure contains at least the following members:

`short` *l_type* — One of F_RDLCK, F_WRLCK or F_UNLCK.

`short` *l_whence*

One of the following flags that specify where the relative offset, *l_start*, is measured from:

SEEK_CUR	Current seek position.
SEEK_END	End of file.
SEEK_SET	Start of file.

`off_t` *l_start* — Relative offset in bytes.

`off_t` *l_len* — Consecutive bytes to lock; if 0, then until EOF; if negative, the preceding bytes up to, but not including, the start byte.

`pid_t` *l_pid* — Process ID of the process holding the lock, returned when *cmd* is F_GETLK.

When a shared lock is set on a segment of a file, other processes can set shared locks on the same segment, or a portion of it. A shared lock prevents other processes from setting exclusive locks on any portion of the protected area. A request for a shared lock fails if the file was opened write-only.

An exclusive lock prevents any other process from setting a shared or an exclusive lock on a portion of the protected area. A request for an exclusive lock fails if the file was opened read-only.

Locks may start and extend beyond the current end of file, but may not start or extend before the beginning of the file; to attempt to do so is an error. A lock extends to “infinity” (the largest possible value for the file offset) if *l_len* is set to zero. If *l_whence* and *l_start* point to the beginning of the file, and *l_len* is zero, the entire file is locked.

The calling process may have only one type of lock set for each byte of a file. Before successfully returning from an F_SETLK or F_SETLKW request, the previous lock type (if any) for each byte in the specified lock region is replaced by the new lock type. All locks associated with a file for a given process are removed when a file descriptor for that file is closed by the process, or the process holding the file descriptor terminates. Locks aren't inherited by a child process using the *fork()* function. However, locks are inherited across *exec*()* or *spawn*()* calls.

A potential for deadlock occurs if a process controlling a locked region is put to sleep by attempting to lock another process's locked region. If the system detects that sleeping until a locked region is unlocked would cause a deadlock, *fcntl()* fails with EDEADLK. However, the system can't always detect deadlocks in the network case, and care should be exercised in the design of your application for this possibility.

☞

Locking is a protocol designed for updating a file shared among concurrently running applications. Locks are only advisory, that is, they don't prevent an errant or poorly-designed application from overwriting a locked region of a shared file. An application should use locks to indicate regions of a file that are to be updated by the application, and it should respect the locks of other applications.

The following functions ignore locks:

- *chsize()*
- *ltrunc()*
- *open()*
- *read()*
- *sopen()*
- *write()*

Returns:

-1 if an error occurred (*errno* is set). The successful return value(s) depend on the request type specified by *arg*, as shown in the following table:

F_DUPFD	A new file descriptor.
F_GETFD	Value of the file descriptor flags (never a negative value).
F_GETFL	Value of the file status flags and access modes as shown above (never a negative value).
F_GETLK	Value other than -1.
F_SETFD	Value other than -1.
F_SETFL	Value other than -1.

F_SETLK	Value other than -1.
F_SETLKW	Value other than -1.

Errors:

EAGAIN	The argument *cmd* is F_SETLK, the type of lock (*l_type*) is a shared lock (F_RDLCK), and the segment of a file to be locked is already exclusive-locked by another process, or the type is an exclusive lock and some portion of the segment of a file to be locked is already shared-locked or exclusive-locked by another process.
EBADF	The *fildes* argument isn't a valid file descriptor. The argument *cmd* is F_SETLK or F_SETLKW, the type of lock (*l_type*) is a shared lock (F_RDLCK), and *fildes* isn't a valid file descriptor open for reading. The argument *cmd* is F_SETLK or F_SETLKW, the type of lock (*l_type*) is an exclusive lock (F_WRLCK), and *fildes* isn't a valid file descriptor open for writing.
EDEADLK	The argument *cmd* is F_SETLKW, and a deadlock condition was detected.
EINTR	The argument *cmd* is F_SETLKW, and the function was interrupted by a signal.
EINVAL	The argument *cmd* is F_DUPFD, and the third argument is negative, or greater than the configured number of maximum open file descriptors per process. The argument *cmd* is F_GETLK, F_SETLK or F_SETLKW, and the data *arg* isn't valid, or *fildes* refers to a file that doesn't support locking.

EMFILE	The argument *cmd* is F_DUPFD, and the process has no unused file descriptors, or no file descriptors greater than or equal to *arg* are available.
ENOLCK	The argument *cmd* is F_SETLK or F_SETLKW, and satisfying the lock or unlock request causes the number of lock regions in the system to exceed the system-imposed limit.
EOVERFLOW	One of the values to be returned can't be represented correctly.

Examples:

```
/*
 * This program makes "stdout" synchronous
 * to guarantee the data is recoverable
 * (if it's redirected to a file).
 */
#include <unistd.h>
#include <fcntl.h>
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    int flags, retval;

    flags = fcntl( STDOUT_FILENO, F_GETFL );

    flags |= O_DSYNC;

    retval = fcntl( STDOUT_FILENO, F_SETFL, flags );
    if( retval == -1 ) {
        printf( "error setting stdout flags\n" );
        return EXIT_FAILURE;
    }

    printf( "hello QNX world\n" );

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *fcntl()* function may be a cancellation point in the case of F_DUPFD (when dupping across the network), F_GETFD, and F_SETFD.

See also:

close(), *dup()*, *dup2()*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *open()*

fdatasync()

Synchronize file data

Synopsis:

```
#include <unistd.h>

int fdatasync( int filedes );
```

Arguments:

filedes The descriptor of the file that you want to synchronize.

Library:

libc

Description:

The *fdatasync()* function forces all queued I/O operations for the file specified by the *filedes* file descriptor to finish, synchronizing the file's data.

This function is similar to *fsync()*, except that *fsync()* also guarantees the integrity of file information, such as access and modification times.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF The specified *filedes* isn't a valid file descriptor open for writing.

EINVAL The implementation doesn't support synchronized I/O for the given file.

ENOSYS The *fdatasync()* function isn't supported for the filesystem specified by *filedes*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

aio_fsync(), close(), fcntl(), fsync(), open(), read(), sync(), write()

fdopen()

Associate a stream with a file descriptor

Synopsis:

```
#include <stdio.h>

FILE* fdopen( int filedes,
              const char* mode );
```

Arguments:

filedes	The file descriptor that you want to associate with a stream.
mode	The mode specified when *filedes* was originally opened. For information, see *fopen()*, except modes begining with **w** don't cause truncation of the file.

Library:

libc

Description:

The *fdopen()* function associates a stream with the file descriptor *filedes*, which represents an opened file or device.

The *filedes* argument is a file descriptor that was returned by one of *accept()*, *creat()*, *dup()*, *dup2()*, *fcntl()*, *open()*, *pipe()*, or *sopen()*.

The *fdopen()* function preserves the offset maximum previously set for the open file description corresponding to *filedes*.

Returns:

A file stream for success, or NULL if an error occurs (*errno* is set).

Errors:

EBADF	The *filedes* argument is not a valid file descriptor.
EINVAL	The *mode* argument is not a valid mode.
EMFILE	Too many file descriptors are currently in use by this process.

ENOMEM There is no memory for FILE structure.

Examples:

```
#include <stdio.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
{
    int filedes ;
    FILE *fp;

    filedes = open( "file", O_RDONLY );
    if( filedes != -1 ) {
        fp = fdopen( filedes , "r" );
        if( fp != NULL ) {
            /* Also closes the underlying FD, filedes. */
            fclose( fp );
        }
    }
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

creat(), dup(), dup2(), errno, fcntl(), fopen(), freopen(), open(), pipe(), sopen()

feof()

Test a stream's end-of-file flag

Synopsis:

```
#include <stdio.h>

int feof( FILE* fp );
```

Arguments:

fp The stream you want to test.

Library:

libc

Description:

The *feof()* function tests the end-of-file flag for the stream specified by *fp*.

Because the end-of-file flag is set when an input operation attempts to read past the end-of-file, the *feof()* function detects the end-of-file only after an attempt is made to read beyond the end-of-file. Thus, if a file contains 10 lines, the *feof()* won't detect the end-of-file after the tenth line is read; it will detect the end-of-file on the next read operation.

Returns:

0 if the end-of-file flag isn't set, or nonzero if the end-of-file flag is set.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

void process_record( char *buf )
{
    printf( "%s\n", buf );
}

int main( void )
{
    FILE *fp;
    char buffer[100];
```

```
    fp = fopen( "file", "r" );
    fgets( buffer, sizeof( buffer ), fp );
    while( ! feof( fp ) ) {
        process_record( buffer );
        fgets( buffer, sizeof( buffer ), fp );
    }
    fclose( fp );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

clearerr(), *ferror()*, *fgetc()*, *fgetchar()*, *fgets()*, *fgetwc()*, *fgetws()*, *fopen()*, *freopen()*, *getc()*, *getc_unlocked()*, *getchar()*, *getchar_unlocked()*, *gets()*, *getw()*, *getwc()*, *getwchar()*, *perror()*, *read()*

ferror()

Test a stream's error flag

Synopsis:

```
#include <stdio.h>

int ferror( FILE* fp );
```

Arguments:

fp The stream whose error flag you want to test.

Library:

libc

Description:

The *ferror()* function tests the error flag for the stream specified by *fp*.

Returns:

0 if the error flag isn't set, or nonzero if the error flag is set.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    int c;

    fp = fopen( "file", "r" );
    if( fp != NULL ) {
        c = fgetc( fp );
        if( ferror( fp ) ) {
            printf( "Error reading file\n" );
        }
    }
    fclose( fp );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

clearerr(), feof(), fgetc(), fgetchar(), fgets(), fgetwc(), fgetws(), getc(), getc_unlocked(), getchar(), getchar_unlocked(), gets(), getw(), getwc(), getwchar(), perror(), strerror()

fflush()

Flush the buffers for a stream

Synopsis:

```
#include <stdio.h>

int fflush( FILE* fp );
```

Arguments:

fp NULL, or the stream whose buffers you want to flush.

Library:

libc

Description:

If the stream specified by *fp* is open for output or update, the *fflush()* function causes any buffered (see *setvbuf()*) but unwritten data to be written to the file descriptor associated with the stream (see *fileno()*).

If the file specified by *fp* is open for input or update, the *fflush()* function undoes the effect of any preceding **ungetc** operation on the stream.

If *fp* is NULL, all open streams are flushed.

Returns:

0 for success, or EOF if an error occurs (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    printf( "Press Enter to continue..." );
    fflush( stdout );
    getchar();

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fgetc(), fgets(), fileno(), flushall(), fopen(), getc(), gets(), setbuf(), setvbuf(), ungetc()

Find the first bit set in a bit string

Synopsis:

```
#include <strings.h>

int ffs( int value );
```

Arguments:

value The bit string.

Library:

libc

Description:

The *ffs()* function finds the first bit set in *value* and returns the index of that bit. Bits are numbered starting from 1, starting at the rightmost bit.

Returns:

The index of the first bit set, or 0 if *value* is zero.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

fgetc()

Read a character from a stream

Synopsis:

```
#include <stdio.h>

int fgetc( FILE* fp );
```

Arguments:

fp The stream from which you want to read a character.

Library:

libc

Description:

The *fgetc()* function reads the next character from the stream specified by *fp*.

Returns:

The next character from *fp*, cast as **(int)(unsigned char)**, or EOF if end-of-file has been reached or if an error occurs (*errno* is set).

☞ Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    int c;

    fp = fopen( "file", "r" );
    if( fp != NULL ) {
        while( (c = fgetc( fp )) != EOF ) {
            fputc( c, stdout );
        }
```

```
        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *feof()*, *ferror()*, *fgetchar()*, *fgets()*, *fopen()*, *fputc()*, *getc()*, *gets()*, *ungetc()*

fgetchar()

Read a character from stdin

Synopsis:

```
#include <stdio.h>

int fgetchar( void );
```

Library:

libc

Description:

The *fgetchar()* function is the same as *fgetc()* with an argument of *stdin*.

Returns:

The next character from *stdin*, cast as **(int)(unsigned char)**, EOF if end-of-file has been reached on *stdin* or if an error occurs (*errno* is set).

☞ Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    int c;

    fp = freopen( "file", "r", stdin );
    if( fp != NULL ) {
        while( (c = fgetchar()) != EOF ) {
            fputchar(c);
        }
        fclose( fp );

        return EXIT_SUCCESS;
    }
```

```
    return EXIT_FAILURE;
}
```

Classification:

QNX 4

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *feof()*, *ferror()*, *fgetc()*, *fputchar()*, *getc()*, *getchar()*

fgetpos()

Get the current position of a stream

Synopsis:

```
#include <stdio.h>

int fgetpos( FILE* fp,
             fpos_t* pos );
```

Arguments:

fp The stream whose position you want to determine.

pos A pointer to a **fpos_t** object where the function can store the position.

Library:

libc

Description:

The *fgetpos()* function stores the current position of the stream *fp* in the **fpos_t** object specified by *pos*.

You can use the value stored in *pos* in a call to *fsetpos()* if you want to reposition the file to the position at the time of the *fgetpos()* call.

Returns:

0 for success, or nonzero if an error occurs (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    fpos_t position;
    char buffer[80];

    fp = fopen( "file", "r" );
    if( fp != NULL ) {
```

```
        fgetpos( fp, &position ); /* get position     */
        fgets( buffer, 80, fp );      /* read record      */
        fsetpos( fp, &position ); /* set position     */
        fgets( buffer, 80, fp );      /* read same record */
        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *fopen()*, *fseek()*, *fsetpos()*, *ftell()*

fgets()

Read a string of characters from a stream

Synopsis:

```
#include <stdio.h>

char* fgets( char* buf,
             size_t n,
             FILE* fp );
```

Arguments:

buf	A pointer to a buffer in which *fgets()* can store the characters that it reads.
n	The maximum number of characters to read.
fp	The stream from which to read the characters.

Library:

libc

Description:

The *fgets()* function reads a string of characters from the stream specified by *fp*, and stores them in the array specified by *buf*.

It stops reading characters when:

- the end-of-file is reached

  Or:

- a newline (**'\n'**) character is read

  Or:

- *n*-1 characters have been read.

The newline character isn't discarded. A null character is placed immediately after the last character read into the array.

☞ Don't assume that there's a newline character in every string that you read with *fgets()*. A newline character isn't present if there are more than *n*-1 characters before the newline.

Also, a newline character might not appear as the last character in a file when the end-of-file is reached.

Returns:

The same pointer as *buf*, or NULL if the stream is at the end-of-file or an error occurs (*errno* is set).

☞ Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    char buffer[80];

    fp = fopen( "file", "r" );
    if( fp != NULL ) {
        while( fgets( buffer, 80, fp ) != NULL ) {
            fputs( buffer, stdout );
        }
        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, feof(), ferror(), fopen(), fputs(), getc(), gets(), fgetc()

fgetspent()

Get an entry from the shadow password database

Synopsis:

```
#include <sys/types.h>
#include <shadow.h>

struct spwd* fgetspent( FILE* f );
```

Arguments:

f The stream from which to read the shadow password database.

Library:

libc

Description:

The *fgetspent()* works like the *getspent()* function but it assumes that it's reading from a file formatted like a shadow password database file. This function uses a static buffer that's overwritten by each call.

The *fgetspent()*, *getspent()*, and *getspnam()* functions share the same static buffer.

Returns:

A pointer to an object of type **struct spwd** containing the next entry from the password database. For more information about this structure, see *putspent()*.

Errors:

The *fgetspent()* function uses the following functions, and as a result *errno* can be set to an error for any of these calls:

- *fclose()*
- *fgets()*

- *fopen()*
- *fseek()*
- *rewind()*

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <pwd.h>
#include <shadow.h>

/*
 * This program loops, reading a entries from a file
 * (which is formatted in the shadow password way)
 * reading the next shadow password entry.
 * For example this_file /etc/shadow
 */

int main( int argc, char** argv )
{
        FILE*    fp;
    struct spwd* sp;

        if (argc < 2) {
                printf("%s filename \n", argv[0]);
                return(EXIT_FAILURE);
        }

        if (!(fp = fopen(argv[1], "r"))) {
                fprintf(stderr, "Can't open file %s \n", argv[1]);
                return(EXIT_FAILURE);
        }

    while( (sp = fgetspent(fp)) != (struct spwd *) 0 ) {
                printf( "Username: %s\n", sp->sp_namp );
                printf( "Password: %s\n", sp->sp_pwdp );
    }

        fclose(fp);
    return( EXIT_SUCCESS );
}
```

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

errno, *getgrent()*, *getlogin()*, *getpwnam()*, *getpwuid()*, *getspent()*, *getspnam()*, *putspent()*

fgetwc()

Read a wide character from a stream

Synopsis:

```
#include <wchar.h>

wint_t fgetwc( FILE * fp );
```

Arguments:

fp The stream from which you want to read a character.

Library:

libc

Description:

The *fgetwc()* function reads the next wide character from the stream specified by *fp*.

Returns:

The next character from *fp*, cast as **(wint_t)(wchar_t)**, or WEOF if end-of-file has been reached or if an error occurs (*errno* is set).

☞ Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Errors:

EAGAIN	The O_NONBLOCK flag is set for *fp* and would have been blocked by this operation.
EBADF	The file descriptor for *fp* isn't valid for reading.
EINTR	A signal terminated the read operation; no data was transferred.
EIO	Either a physical I/O error has occurred, or the process is in the background and is being ignored or blocked.

EOVERFLOW	Cannot read at or beyond the offset maximum for this stream.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, feof(), ferror(), fputwc()

"Stream I/O functions" and "Wide-character functions" in the summary of functions chapter

fgetws()

Read a string of wide characters from a stream

Synopsis:

```
#include <wchar.h>

wchar_t * fgetws( wchar_t * buf,
                  int n,
                  FILE * fp );
```

Arguments:

buf	A pointer to a buffer in which *fgetws()* can store the wide characters that it reads.
n	The maximum number of characters to read.
fp	The stream from which to read the characters.

Library:

libc

Description:

The *fgetws()* function reads a string of wide characters from the stream specified by *fp*, and stores them in the array specified by *buf*.

It stops reading wide characters when one of the following occurs:

- The end-of-file is reached.
- A newline (**'\n'**) character is read.
- *n*-1 characters have been read.

The *fgetws()* function places a NUL at the end of the string.

☞ Don't assume all strings have newline characters. A newline character isn't present when more than *n*-1 characters occur before the newline.

Also, a newline character might not appear as the last character in a file when the end-of-file is reached.

Returns:

NULL	Failure; the stream is at the end-of-file or an error occurred (*errno* is set).
buf	Success.

☞ Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Errors:

EAGAIN	The O_NONBLOCK flag is set for *fp* and would have been blocked by this operation.
EBADF	The file descriptor for *fp* isn't valid for reading.
EINTR	A signal terminated the read operation; no data was transferred.
EIO	Either a physical I/O error has occurred, or the process is in the background and is being ignored or blocked.
EOVERFLOW	Cannot read at or beyond the offset maximum for this stream.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, feof(), ferror(), fputws()

"Stream I/O functions" and "Wide-character functions" in the summary of functions chapter.

fileno()

Return the file descriptor for a stream

Synopsis:

```
#include <stdio.h>

int fileno( FILE * stream );
```

Arguments:

stream The stream whose file descriptor you want to find.

Library:

libc

Description:

The *fileno()* function returns the file descriptor for the specified file *stream*. This file descriptor can be used in POSIX input/output calls anywhere the value returned by *open()* can be used.

To associate a stream with a file descriptor, call *fdopen()*.

In QNX Neutrino, the file descriptor is also the connection ID (*coid*) used by various Neutrino-specific functions.

The following symbolic values in **<unistd.h>** define the file descriptors associated with the C language *stdin*, *stdout*, and *stderr* streams:

STDIN_FILENO

Standard input file number, *stdin* (0)

STDOUT_FILENO

Standard output file number, *stdout* (1)

STDERR_FILENO

Standard error file number, *stderr* (2)

Returns:

A file descriptor, or -1 if an error occurs (*errno* is set).

Examples:

```
#include <stdlib.h>
#include <stdio.h>

int main( void )
{
    FILE *stream;

    stream = fopen( "file", "r" );
    if( stream != NULL ) {
        printf( "File number is %d.\n", fileno( stream ) );
        fclose( stream );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Produces output similar to:

```
File number is 7.
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *fdopen()*, *fopen()*, *open()*

finite(), *finitef()*

Determine if a number is finite

Synopsis:

```
#include <math.h>

int finite ( double x );

int finitef ( float x);
```

Arguments:

x The number you want to test.

Library:

libm

Description:

The *finite()* and *finitef()* functions determine if *x* is finite.

Returns:

True (1)	The value of *x* is finite.
False (≠ 1)	The value of *x* is infinity or NAN.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv)
{
  double a, b, c, d;

  a = 2;
  b = -0.5;
  c = NAN;
  fp_exception_mask(_FP_EXC_DIVZERO, 1);
  d = 1.0/0.0;
  printf("%f is %s \n", a, (finite(a)) ? "finite" : "not-finite");
```

```
  printf("%f is %s \n", b, (finite(b)) ? "finite" : "not-finite");
  printf("%f is %s \n", c, (finite(c)) ? "finite" : "not-finite");
  printf("%f is %s \n", d, (finite(d)) ? "finite" : "not-finite");

  return(0);
}
```

produces the output:

```
2.000000 is finite
-0.500000 is finite
NAN is not-finite
Inf is not-finite
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

isnan()

Synopsis:

```
#include <unistd.h>

int flink( int fd,
           const char *path );
```

Arguments:

fd	The file descriptor.
path	The path you want to associate with the file descriptor.

Library:

libc

Description:

The *flink()* function assigns the pathname, *path*, to the file associated with the file descriptor, *fd*.

Returns:

0	Success.
-1	An error occurred; *errno* is set.

Errors:

EACCES	A component of either path prefix denies search permission, or the link named by *path* is in a directory with a mode that denies write permission.
EBADF	The file descriptor *fd* is invalid.
EEXIST	The link named by *path* already exists.
ELOOP	Too many levels of symbolic links or prefixes.

EMLINK — The number of links to the file would exceed LINK_MAX.

ENAMETOOLONG — The length of the *path* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT — This error code can mean the following:

- A component of either path prefix doesn't exist.
- The *path* points to an empty string.

ENOSPC — The directory that would contain the link can't be extended.

ENOSYS — The *flink()* function isn't implemented for the filesystem specified in *path*.

ENOTDIR — A component of either path prefix isn't a directory.

EROFS — The requested link requires writing in a directory on a read-only file system.

EXDEV — The link named by *path* is on a different logical disk.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

link()

flock()

Apply or remove an advisory lock on an open file

Synopsis:

```
#include <fcntl.h>

int flock( int filedes,
           int operation );
```

Arguments:

filedes	The file descriptor of an open file.
operation	What you want to do to the file; see below.

Library:

libc

Description:

The *flock()* function applies or removes an advisory lock on the file associated with the open file descriptor *filedes*. To establish a lock with this function, open with write-only permission (O_WRONLY) or with read/write permission (O_RDWR).

A lock is applied by specifying one of the following values for *operation*:

LOCK_EX	Exclusive lock.
LOCK_NB	Don't block when locking. This may be ORed with LOCK_EX or LOCK_SH to give nonblocking behavior.
LOCK_SH	Shared lock.
LOCK_UN	Unlock an existing lock operation.

Advisory locks allow cooperating processes to perform consistent operations on files, but they don't guarantee consistency.

The locking mechanism allows two types of locks: *shared* and *exclusive*. At any time, multiple shared locks may be applied to a file,

but at no time are multiple exclusive, or both shared and exclusive, locks allowed simultaneously on a file.

A shared lock may be upgraded to an exclusive lock, and vice versa, by specifying the appropriate lock type. The previous lock is released and a new lock is applied (possibly after other processes have gained and released the lock).

Requesting a lock on an object that's already locked causes the caller to be blocked until the lock may be acquired. If you don't want the caller to be blocked, you can specify LOCK_NB in the operation to fail the call (*errno* is set to EWOULDBLOCK).

Locks are applied to files, not file descriptors. That is, file descriptors duplicated through *dup()* or *fork()* don't result in multiple instances of a lock, but rather multiple references to a single lock. If a process holding a lock on a file forks and the child explicitly unlocks the file, the parent loses its lock.

Processes blocked awaiting a lock may be awakened by signals.

Returns:

0 The operation was successful.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid descriptor, *filedes*.

EINVAL The argument operation doesn't include one of LOCK_EX, LOCK_SH, or LOCK_UN.

ENOMEM The system can't allocate sufficient memory to store lock resources.

EOPNOTSUPP

The *filedes* argument refers to an object other than a file.

EWOULDBLOCK

The file is locked and LOCK_NB was specified.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

fcntl(), lockf(), open()

flockfile()

Acquire ownership of a file

Synopsis:

```
#include <stdio.h>

void flockfile( FILE* file );
```

Arguments:

file A pointer to the **FILE** object for the file you want to lock.

Library:

libc

Description:

The *flockfile()* function provides for explicit application-level locking of *stdio* (**FILE**) objects. This function can be used by a thread to delineate a sequence of I/O statements that are to be executed as a unit.

The *flockfile()* function is used by a thread to acquire ownership of a **FILE**.

The implementation acts as if there is a lock count associated with each **FILE**. This count is implicitly initialized to zero when the **FILE** is created. The **FILE** object is unlocked when the count is zero. When the count is positive, a single thread owns the **FILE**. When the *flockfile()* function is called, if the count is zero or if the count is positive and the caller owns the **FILE**, the count is incremented. Otherwise, the calling thread is suspended, waiting for the count to return to zero.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getc_unlocked(), *getchar_unlocked()*, *putc_unlocked()*, *putchar_unlocked()*

floor(), floorf()

Round down a value to the next integer

Synopsis:

```
#include <math.h>

double floor( double x );

float floorf( float x );
```

Arguments:

x The value you want to round.

Library:

libm

Description:

These functions compute the largest integer ≤ *x* (rounding towards the "floor").

Returns:

The largest integer ≤ *x*.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", floor( -3.14 ) );
    printf( "%f\n", floor( -3. ) );
    printf( "%f\n", floor( 0. ) );
```

```
    printf( "%f\n", floor( 3.14 ) );
    printf( "%f\n", floor( 3. ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
-4.000000
-3.000000
0.000000
3.000000
3.000000
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ceil(), *fmod()*

flushall()

Flush all input/output buffers

Synopsis:

```
#include <stdio.h>

int flushall( void );
```

Library:

libc

Description:

The *flushall()* function flushes all buffers associated with open input/output streams. A subsequent read operation on an input stream reads new data from the associated stream.

Calling the *flushall()* function is equivalent to calling *fflush()* for all open streams.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Classification:

QNX 4

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The QNX 4 version of this function returns the number of streams flushed.

See also:

errno, *fopen()*, *fflush()*

fmod(), fmodf()

Compute a residue, using floating-point modular arithmetic

Synopsis:

```
#include <math.h>

double fmod( double x,
             double y );


float fmodf( float x,
             float y );
```

Arguments:

x An arbitrary number.

y The modulus.

Library:

libm

Description:

The *fmod()* and *fmodf()* functions compute the floating-point residue of *x* (mod *y*), which is the remainder of $x \div y$, even if the quotient $x \div y$ isn't representable.

Returns:

The residue, $x - (i \times y)$, for some integer *i* such that, if *y* is nonzero, the result has the same sign as *x* and a magnitude less than the magnitude of *y*.

If *y* is zero, the function returns 0.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
{
    printf( "%f\n", fmod(  4.5,  2.0 ) );
    printf( "%f\n", fmod( -4.5,  2.0 ) );
    printf( "%f\n", fmod(  4.5, -2.0 ) );
    printf( "%f\n", fmod( -4.5, -2.0 ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
0.500000
-0.500000
0.500000
-0.500000
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ceil(), *div()*, *fabs()*, *floor()*

fnmatch()

Check to see if a file or path name matches a pattern

Synopsis:

```
#include <fnmatch.h>

int fnmatch( const char* pat,
             const char* str,
             int flags );
```

Arguments:

pat The pattern to match; see "Pattern Matching Special Characters," below.

str The string to match against the pattern.

flags Flags that modify interpretation of *pat* and *str*; a bitwise inclusive OR of these bits:

FNM_PATHNAME
: If this is set, a slash character in *str* is explicitly matched by a slash in *pat*; it isn't matched by either the asterisk or question mark special characters, or by a bracket expression.

FNM_PERIOD
: If this is set, a leading period in *str* matches a period in *pat*, where the definition of "leading" depends on FNM_PATHNAME:

- If FNM_PATHNAME is set, a period is leading if it's the first character in *str*, or if it immediately follows a slash.
- If FNM_PATHNAME isn't set, a period is leading only if it's the first character in *str*.

FNM_QUOTE
: If this isn't set, a backslash (\) in *pat* followed by another character matches that second character. If FNM_QUOTE is set, a backslash is treated as an ordinary character.

Library:

libc

Description:

The *fnmatch()* function checks the file or path name specified by the *str* argument to see if it matches the pattern specified by the *pat* argument.

Pattern Matching Special Characters

A pattern-matching special character that is quoted is a pattern that matches the special character itself. When not quoted, such special characters have special meaning in the specification of patterns. The pattern-matching special characters and the contexts in which they have their special meaning are as follows:

? Matches any printable or nonprintable collating element except **<**newline**>**.

***** Matches any string, including the null string.

[*bracket_expr***]**

Matches a single collating element as per Regular Expression Bracket Expressions (1003.2 2.9.1.2) except that:

- The exclamation point character (**!**) replaces the circumflex character (**^**) in its role as a nonmatching list in the regular expression notation.
- The backslash is used as an escape character within bracket expressions.

The **?**, ***** and **[** characters aren't special when used inside a bracket expression.

The concatenation of patterns matching a single character is a valid pattern that matches the concatenation of the single characters or collating elements matched by each of the concatenated patterns. For example, the pattern **a[bc]** matches the strings **ab** and **ac**.

The concatenation of one or more patterns matching a single character with one or more asterisks (*) is a valid pattern. In such patterns, each asterisk matches a string of zero or more characters, up to the first character that matches the character following the asterisk in the pattern. For example, the pattern **a*d** matches the strings **ad**, **abd**, and **abcd**, but not the string **abc**.

When an asterisk is the first or last character in a pattern, it matches zero or more characters that precede or follow the characters matched by the remainder of the pattern. For example, the pattern **a*d*** matches the strings **ad**, **abcd**, **abcdef**, **aaaad** and **adddd**; the pattern ***a*d** matches the strings **ad**, **abcd**, **efabcd**, **aaaad** and **adddd**.

Returns:

0	The *str* argument matches the pattern specified by *pat*.
Nonzero	The *str* argument doesn't match the pattern specified by *pat*.

Examples:

```
/*
 * The following example accepts a set of patterns
 * for filenames as argv[1..argc].  It reads lines
 * from standard input, and outputs the lines that
 * match any of the patterns.
 */
#include <stdio.h>
#include <fnmatch.h>
#include <stdlib.h>
#include <limits.h>

int main( int argc, char **argv )
  {
    int  i;
    char buffer[PATH_MAX+1];

    while( gets( buffer ) ) {
      for( i = 0; i < argc; i++ ) {
        if( fnmatch( argv[i], buffer, 0 ) == 0 ) {
          puts( buffer );
          break;
        }
      }
```

```
    }
    exit( EXIT_SUCCESS );
}
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

regcomp()

fopen(), *fopen64()*

Open a file stream

Synopsis:

```
#include <stdio.h>

FILE * fopen( const char * filename,
              const char * mode );

FILE * fopen64( const char * filename,
              const char * mode );
```

Arguments:

filename	The name of the file that you want to open.
mode	The access mode; see below.

Library:

libc

Description:

The *fopen()* and *fopen64()* functions open a file stream for the file specified by *filename*. The *mode* string begins with one of the following sequences:

a	Append: create a new file or open the file for writing at its end.
a+	Append: open the file or create it for update, writing at end-of-file; use the default file translation.
r	Open the file for reading.
r+	Open the file for update (reading and/or writing); use the default file translation.
w	Create the file for writing, or truncate it to zero length.
w+	Create the file for update, or truncate it to zero length; use the default file translation.

You can add the letter **b** to the end of any of the above sequences to indicate that the file is (or must be) a binary file (this is an ANSI requirement for portability to systems that make a distinction between text and binary files, such as DOS). Under QNX Neutrino, there's no difference between text files and binary files.

- Opening a file in read mode (**r** in the *mode*) fails if the file doesn't exist or can't be read.
- Opening a file in append mode (**a** in the *mode*) causes all subsequent writes to the file to be forced to the current end-of-file, regardless of previous calls to the *fseek()* function.
- When a file is opened with update mode (**+** in the *mode*), both input and output may be performed on the associated stream.

When using a stream in update mode, writing can't be followed by reading without an intervening call to *fflush()*, or to a file-positioning function (*fseek()*, *fsetpos()* or *rewind()*). Similarly, reading can't be followed by writing without an intervening call to a file-positioning function, unless the read resulted in end-of-file.

The largest value that can be represented correctly in an object of type **off_t** shall be established as the offset maximum in the open file description.

Returns:

A pointer to a file stream for success, or NULL if an error occurs (*errno* is set).

Errors:

EACCES	Search permission is denied on a component of the *filename* prefix, or the file exists and the permissions specified by *mode* are denied, or the file doesn't exist and write permission is denied for the parent directory of the file to be created.

EBADFSYS	While attempting to open the named file, either the file itself or a component of the *filename* prefix was found to be corrupted. A system failure — from which no automatic recovery is possible — occurred while the file was being written to, or while the directory was being updated. You'll need to invoke appropriate systems-administration procedures to correct this situation before proceeding.
EBUSY	File access was denied due to a conflicting open (see *sopen()*).
EINTR	The *fopen()* operation was interrupted by a signal.
EINVAL	The value of the *mode* argument is not valid.
EISDIR	The named file is a directory, and the *mode* argument specifies write-only or read/write access.
ELOOP	Too many levels of symbolic links or prefixes.
EMFILE	Too many file descriptors are currently in use by this process.
ENAMETOOLONG	The length of the *filename* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.
ENFILE	Too many files are currently open in the system.
ENOENT	Either the named file or the *filename* prefix doesn't exist, or the *filename* argument points to an empty string.
ENOMEM	There is no memory for FILE structure.
ENOSPC	The directory or filesystem that would contain the new file can't be extended.

ENOSYS	The *fopen()* function isn't implemented for the filesystem specified in *filename*.
ENOTDIR	A component of the *filename* prefix isn't a directory.
ENXIO	The media associated with the file has been removed (e.g. CD, floppy).
EOVERFLOW	The named file is a regular file and the size of the file can't be represented correctly in an object of type **off_t**.
EROFS	The named file resides on a read-only filesystem.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;

    fp = fopen( "report.dat", "r" );
    if( fp != NULL ) {
        /* rest of code goes here */
        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

fopen() is ANSI, *fopen64()* is for large-file support

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fclose(), fcloseall(), fdopen(), freopen(), freopen64()

Synopsis:

```
#include <sys/types.h>
#include <process.h>

pid_t fork( void );
```

Library:

libc

Description:

The *fork()* function creates a new process. The new process (child process) is an exact copy of the calling process (parent process), except for the following:

- The child process has a unique process ID.
- The child process has a different parent process ID (which is the process ID of the calling process).
- The child process has its own copy of the parent's file descriptors. Each of the child's file descriptors refers to the same open file description with the corresponding file descriptor of the parent.
- The child process has its own copy of the parent's open directory streams.
- The child process's values of *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* are set to zero.
- File locks previously set by the parent aren't inherited by the child.
- Pending alarms are cleared for the child process.
- The set of signals pending for the child process is initialized to the empty set.

Returns:

A value of zero to the child process; and the process ID of the child process to the parent process. Both processes continue to execute from the *fork()* function. If an error occurs, *fork()* returns -1 to the parent and sets *errno*.

Errors:

EAGAIN	Insufficient resources are available to create the child process.
ENOMEM	The process requires more memory than the system is able to supply.
ENOSYS	The *fork()* function isn't implemented for this memory protection model. See also "Caveats," below.

Examples:

```
/*
 * This program executes the program and arguments
 * specified by argv[1..argc].  The standard input
 * of the executed program is converted to upper
 * case.
 */

#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <ctype.h>
#include <process.h>
#include <sys/wait.h>

int main( int argc, char **argv )
  {
    pid_t pid;
    pid_t wpid;
    int   fd[2];
    char  buffer[80];
    int   i, len;
    int   status;

    if( pipe( fd ) == -1 ) {
       perror( "pipe" );
       return EXIT_FAILURE;
    }
```

```
  if( ( pid = fork() ) == -1 ) {
     perror( "fork" );
     return EXIT_FAILURE;
  }

  if( pid == 0 ) {
    /* This is the child process.
     * Move read end of the pipe to stdin ( 0 ),
     * close any extraneous file descriptors,
     * then use exec to 'become' the command.
     */
    dup2( fd[0], 0 );
    close( fd[1] );
    execvp( argv[1], argv+1 );

/* This can only happen if exec fails; print message
 * and exit.
 */
    perror( argv[1] );
    return EXIT_FAILURE;
  } else {
    /* This is the parent process.
     * Remove extraneous file descriptors,
     * read descriptor 0, write into pipe,
     * close pipe, and wait for child to die.
     */
    close( fd[0] );
    while( ( len = read( 0, buffer, sizeof( buffer ) )
        ) > 0 ) {
      for( i = 0; i < len; i++ ) {
        if( isupper( buffer[i] ) )
          buffer[i] = tolower( buffer[i] );
      }
      write( fd[1], buffer, len );
    }
    close( fd[1] );
    do {
      wpid = waitpid( pid, &status, 0 );
    } while( WIFEXITED( status ) == 0 );
    return WEXITSTATUS( status );
  }
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Currently, *fork()* is supported only in single-threaded applications. If you create a thread and then call *fork()*, the function returns -1 and sets *errno* to ENOSYS.

See also:

errno, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *wait()*

forkpty()

Create a new process operating in a pseudo-tty

Synopsis:

```
#include <unix.h>

pid_t forkpty( int *amaster,
               char *name,
               struct termios *termp,
               struct winsize *winp );
```

Arguments:

amaster	A pointer to a location where *forkpty()* can store the file descriptor of the master side of the pseudo-tty.
name	NULL, or a pointer to a buffer where *forkpty()* can store the filename of the slave side of the pseudo-tty.
termp	NULL, or a pointer to a **termios** structure that describes the terminal's control attributes to apply to the slave side of the pseudo-tty.
winp	A pointer to a **winsize** structure that defines the window size to use for the slave side of the pseudo-tty.

Library:

libc

Description:

The *forkpty()* function combines *openpty()*, *fork()*, and *login_tty()* to create a new process operating in a pseudo-tty.

This function fails if either *openpty()* or *fork()* fails.

Returns:

0 to the child process, the child's process ID to the parent, or -1 if an error occurred.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

fork(), *login_tty()*, *openpty()*, **termios**

fp_exception_mask()

Get or set the current exception mask

Synopsis:

```
#include <fpstatus.h>

int fp_exception_mask ( int new_mask,
                        int set );
```

Arguments:

new_mask The new mask to apply. The bits include:

- _FP_EXC_INVALID
- _FP_EXC_DIVZERO
- _FP_EXC_OVERFLOW
- _FP_EXC_UNDERFLOW
- _FP_EXC_INEXACT
- _FP_EXC_DENORMAL

set A value that indicates what you want the function to do:

- If *set* < 0, return the current mask. The *new_mask* argument is ignored.
- If *set* = 0, disable the bits in the exception mask that correspond to the bits set in *new_mask*.
- If *set* > 0, enable the bits in the exception mask that correspond to the bits set in *new_mask*.

Library:

libm

Description:

The *fp_exception_mask()* function gets or sets the current exception mask, depending on the value of the *set* argument.

Returns:

If *set* < 0 The current exception mask.

If *set* ≥ 0 The previous mask.

This function doesn't return a special value to indicate that an error occurred. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again.

Examples:

```
#include <fpstatus.h>

int main(int argc, char** argv)
{
   int ret;

   if ((ret = fp_exception_mask(0, -1)) < 0)
      printf("*** Problem retrieving exceptions \n");
   printf("Exceptions Enabled: \n\t");
   if (ret & _FP_EXC_INEXACT)
      printf("Inexact ");
   if (ret & _FP_EXC_DIVZERO)
      printf("DivZero ");
   if (ret & _FP_EXC_UNDERFLOW)
      printf("Underflow ");
   if (ret & _FP_EXC_OVERFLOW)
      printf("Overflow ");
   if (ret & _FP_EXC_INVALID)
      printf("Invalid ");
   printf("\n");


   /* Set the exception mask to enable division by zero errors */
   if ((ret = fp_exception_mask(_FP_EXC_DIVZERO, 1)) < 0)
      printf("*** Problem setting exceptions \n");
   if ((ret = fp_exception_mask(0, -1)) < 0)
      printf("*** Problem retrieving exceptions \n");
   printf("Exceptions Enabled: \n\t");
   if (ret & _FP_EXC_INEXACT)
      printf("Inexact ");
   if (ret & _FP_EXC_DIVZERO)
      printf("DivZero ");
   if (ret & _FP_EXC_UNDERFLOW)
      printf("Underflow ");
   if (ret & _FP_EXC_OVERFLOW)
```

```
        printf("Overflow ");
    if (ret & _FP_EXC_INVALID)
        printf("Invalid ");
    printf("\n");

    return(0);
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fp_exception_value(), *fp_precision()*, *fp_rounding()*

fp_exception_value()

Get the value of the current exception registers

Synopsis:

```
#include <fpstatus.h>

int fp_exception_value( int mask );
```

Arguments:

mask A mask whose bits indicate which registers you want the value of. The bits include:

- _FP_EXC_INVALID
- _FP_EXC_DIVZERO
- _FP_EXC_OVERFLOW
- _FP_EXC_UNDERFLOW
- _FP_EXC_INEXACT
- _FP_EXC_DENORMAL

Library:

libm

Description:

The *fp_exception_value()* function gets the value of the current exception registers. Set bits indicate that the exception has signaled, unset bits indicate that the exception hasn't signaled.

Returns:

The value of the current exception registers based on the values from **<fpstatus.h>**.

☞ This function doesn't return a special value to indicate that an error occurred. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again.

Examples:

```
#include <fpstatus.h>

int main(int argc, char** argv)
{
   int ret;

/* Test to see if an operation has set (but not necessarily
 * signaled depending on the exception mask) the
 * division by zero bit:
 */

   if (fp_exception_value(_FP_EXC_DIVZERO) & _FP_EXC_DIVZERO)
      printf("Division by zero has occurred \n");
   else
      printf("Division by zero has not occurred \n");

   return(0);

}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fp_precision(), fp_rounding(), fp_exception_mask()

fp_precision()

Set or get the current precision

Synopsis:

```
#include <fpstatus.h>

int fp_precision( int newprecision );
```

Arguments:

newprecision The new precision; one of:

- < 0 — return the current setting.
- _FP_PREC_FLOAT
- _FP_PREC_DOUBLE
- _FP_PREC_EXTENDED
- _FP_PREC_DOUBLE_EXTENDED

Library:

libm

Description:

The *fp_precision()* function sets or gets the current floating-point precision, depending on the value of *newprecision*.

Returns:

If *newprecision* is less than 0, the current precision; otherwise, the previous precision.

This function doesn't return a special value to indicate that an error occurred. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again.

Examples:

```
#include <fpstatus.h>

int main(int argc, char** argv)
{
   int ret;

   ret = fp_precision(-1);
   printf("Precision: ");
   if (ret == _FP_PREC_FLOAT)
      printf("Float \n");
   else if (ret == _FP_PREC_DOUBLE)
      printf("Double \n");
   else if (ret == _FP_PREC_EXTENDED)
      printf("Extended \n");
   else if (ret == _FP_PREC_DOUBLE_EXTENDED)
      printf("128 Bit \n");
   else if (ret == _FP_PREC_EXTENDED)
      printf("Extended \n");
   else if (ret == _FP_PREC_DOUBLE_EXTENDED)
      printf("128 Bit \n");
   else
      printf("Error \n");

   return(0);
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fp_exception_mask(), fp_exception_value(), fp_rounding()

fp_rounding()

Set or get the current rounding

Synopsis:

```
#include <fpstatus.h>

int fp_rounding( int newrounding );
```

Arguments:

newrounding The new rounding; one of:

- < 0 — return the current setting.
- _FP_ROUND_NEAREST
- _FP_ROUND_ZERO
- _FP_ROUND_POSITIVE
- _FP_ROUND_NEGATIVE

Library:

libm

Description:

The *fp_rounding()* function sets or gets the current rounding mode, depending on the value of *newrounding*.

Returns:

If *newrounding* is less than 0, the current rounding mode; otherwise, the previous mode.

This function doesn't return a special value to indicate that an error occurred. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again.

Examples:

```
#include <fpstatus.h>
#include <stdlib.h>
#include <stdio.h>

int main(int argc, char** argv)
{
   int ret;

   ret = fp_rounding(-1);
   printf("Rounding mode: ");
   if (ret == _FP_ROUND_NEAREST)
      printf("Nearest \n");
   else if (ret == _FP_ROUND_POSITIVE)
      printf("Positive \n");
   else if (ret == _FP_ROUND_NEGATIVE)
      printf("Negative \n");
   else if (ret == _FP_ROUND_ZERO)
      printf("To Zero \n");
   else
      printf("Error \n");

   return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fp_exception_mask(), *fp_exception_value()*, *fp_precision()*

fpathconf()

Return the value of a configurable limit associated with a file

Synopsis:

```
#include <unistd.h>

long fpathconf( int filedes,
                int name );
```

Arguments:

filedes A file descriptor for the file whose limit you want to check.

name The name of the configurable limit; see below.

Library:

libc

Description:

The *fpathconf()* function returns a value of a configurable limit indicated by *name* that's associated with the file indicated by *filedes*.

Configurable limits are defined in **<confname.h>**, and include at least the following values:

_PC_LINK_MAX

Maximum value of a file's link count.

_PC_MAX_CANON

Maximum number of bytes in a terminal's canonical input buffer (edit buffer).

_PC_MAX_INPUT

Maximum number of bytes in a terminal's raw input buffer.

_PC_NAME_MAX

Maximum number of bytes in a file name (not including the terminating null).

_PC_PATH_MAX

Maximum number of bytes in a pathname (not including the terminating null).

_PC_PIPE_BUF

Maximum number of bytes that can be written atomically when writing to a pipe.

_PC_CHOWN_RESTRICTED

If defined (not -1), indicates that the use of the *chown()* function is restricted to a process with appropriate privileges, and to changing the group ID of a file to the effective group ID of the process or to one of its supplementary group IDs.

_PC_NO_TRUNC

If defined (not -1), indicates that the use of pathname components longer than the value given by _PC_NAME_MAX generates an error.

_PC_VDISABLE

If defined (not -1), this is the character value that can be used to individually disable special control characters in the **termios** control structure.

Returns:

The requested configurable limit, or -1 if an error occurred (*errno* is set).

Errors:

EINVAL The *name* argument is invalid, or the indicated limit isn't supported for this *filedes*.

EBADF The argument *filedes* is invalid.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main()
  {
    long value;

    value = fpathconf( 0, _PC_MAX_INPUT );
    printf( "Input buffer size is %ld bytes\n",
        value );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

confstr(), *pathconf()*, *sysconf()*, **termios**

fprintf()

Write output to a stream

Synopsis:

```
#include <stdio.h>

int fprintf( FILE* fp,
             const char* format,
             ... );
```

Arguments:

fp	The stream to which you want to send the output.
format	A string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.

Library:

```
libc
```

Description:

The *fprintf()* function writes output to the stream specified by *fp*, under control of the *format* specifier.

Returns:

The number of characters written, or a negative value if an output error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

char *weekday = { "Saturday" };
char *month = { "April" };

int main( void )
{
    fprintf( stdout, "%s, %s %d, %d\n",
        weekday, month, 10, 1999 );
```

```
    return EXIT_SUCCESS;
}
```

Produces:

```
Saturday, April 10, 1999
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *fwprintf()*, *printf()*, *snprintf()*, *sprintf()*, *swprintf()*, *vfprintf()*, *vfwprintf()*, *vprintf()*, *vsnprintf()*, *vsprintf()*, *vswprintf()*, *vwprintf()*, *wprintf()*

fputc()

Write a character to a stream

Synopsis:

```
#include <stdio.h>

int fputc( int c,
           FILE* fp );
```

Arguments:

c The character you want to write.

fp The stream you want to write the character to.

Library:

libc

Description:

The *fputc()* function writes the character specified by *c*, cast as **(int)(unsigned char)**, to the stream specified by *fp*.

Returns:

The character written, cast as **(int)(unsigned char)**, or EOF if an error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    int c;

    fp = fopen( "file", "r" );
    if( fp != NULL ) {
        while( (c = fgetc( fp )) != EOF ) {
            fputc( c, stdout );
        }
        fclose( fp );
```

```
        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *c* is negative, the value returned by this function isn't equal to *c* — unless *c* is -1 and an error occurred :-)

See also:

errno, fgetc(), fopen(), fprintf(), fputchar(), fputs(), putc(), putchar(), puts()

fputchar()

Write a character to stdout

Synopsis:

```
#include <stdio.h>

int fputchar( int c );
```

Arguments:

c The character you want to write.

Library:

libc

Description:

The *fputchar()* function writes the character specified by *c*, cast as **(int)(unsigned char)**, to *stdout*. It's equivalent to *putchar()* and to:

```
fputc( c, stdout );
```

Returns:

The character written, cast as **(int)(unsigned char)**, or EOF if an error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    int c;

    fp = fopen( "file", "r" );
    if( fp != NULL ) {
        c = fgetc( fp );
        while( c != EOF ) {
```

```
            fputchar( c );
            c = fgetc( fp );
        }
        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

QNX 4

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *c* is negative, the value returned by this function isn't equal to *c* — unless *c* is -1 and an error occurred :-)

See also:

errno, fgetc(), fgetchar(), fprintf(), fputc(), fputs(), putc(), putchar()

fputs()

Write a string to an output stream

Synopsis:

```
#include <stdio.h>

int fputs( const char* buf,
           FILE* fp );
```

Arguments:

buf The string you want to write.

fp The stream you want to write the string to.

Library:

libc

Description:

The *fputs()* function writes the character string specified by *buf* to the output stream specified by *fp*.

The terminating NUL character isn't written.

Returns:

A nonnegative value for success, or EOF if an error occurs (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp_in, *fp_out;
    char buffer[80];

    fp_in = fopen( "file", "r" );
    fp_out = fopen( "outfile", "w" );
    if( fp_in != NULL && fp_out != NULL) {
```

```
        while( fgets( buffer, 80, fp_in ) != NULL ) {
            fputs( buffer, fp_out );
        }
        fclose( fp_in );
        fclose( fp_out );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fgets(), fopen(), fprintf(), fputc(), putc(), puts()

fputwc()

Write a wide character to a stream

Synopsis:

```
#include <wchar.h>

wint_t fputwc( wchar_t wc,
               FILE * fp );
```

Arguments:

wc	The wide character you want to write.
fp	The stream you want to write the character to.

Library:

libc

Description:

The *fputwc()* function writes the wide character specified by *wc*, cast as **(wint_t)(wchar_t)**, to the stream specified by *fp*.

Returns:

The wide character written, cast as **(wint_t)(wchar_t)**, or WEOF if an error occurred (*errno* is set).

☞ If *wc* exceeds the valid wide-character range, the value returned is the wide character written, not *wc*.

Errors:

EAGAIN	The O_NONBLOCK flag is set for *fp* and would have been blocked by this operation.
EBADF	The stream specified by *fp* isn't valid for writing.
EFBIG	The file exceeds the maximum file size, the process's file size limit, or the function can't write at or beyond the offset maximum.

EINTR	A signal terminated the write operation; no data was transferred.
EIO	A physical I/O error has occurred or all of the following conditions were met: • The process is in the background. • TOSTOP is set. • The process is blocking/ignoring SIGTTOU. • The process group is orphaned.
EPIPE	Can't write to pipe or FIFO because it's closed; a SIGPIPE signal is also sent to the thread.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fgetwc(), fputws()

"Stream I/O functions" and "Wide-character functions" in the summary of functions chapter.

fputws()

Write a wide-character string to an output stream

Synopsis:

```
#include <wchar.h>

int fputws( const wchar_t * ws,
            FILE * fp );
```

Arguments:

buf The wide-character string you want to write.

fp The stream you want to write the string to.

Library:

libc

Description:

The *fputws()* function writes the wide-character string specified by *ws* to the output stream specified by *fp*.

The terminating NUL wide character isn't written.

Returns:

A nonnegative value for success, or WEOF if an error occurs (*errno* is set).

Errors:

EAGAIN The O_NONBLOCK flag is set for *fp* and would have been blocked by this operation.

EBADF The stream specified by *fp* isn't valid for writing.

EFBIG The file exceeds the maximum file size, the process's file size limit, or the function can't write at or beyond the offset maximum.

EINTR	A signal terminated the write operation; no data was transferred.
EIO	A physical I/O error has occurred or all of the following conditions were met: • The process is in the background. • TOSTOP is set. • The process is blocking/ignoring SIGTTOU. • The process group is orphaned.
EPIPE	Can't write to pipe or FIFO because it's closed; a SIGPIPE signal is also sent to the thread.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fgetws(), fputwc()

"Stream I/O functions" and "Wide-character functions" in the summary of functions chapter.

fread()

Read elements of a given size from a stream

Synopsis:

```
#include <stdio.h>

size_t fread( void* buf,
              size_t size,
              size_t num,
              FILE* fp );
```

Arguments:

buf	A pointer to a buffer where the function can store the elements that it reads.
size	The size of each element to read.
num	The number of elements to read.
fp	The stream from which to read the elements.

Library:

libc

Description:

The *fread()* function reads *num* elements of *size* bytes each from the stream specified by *fp* into the buffer specified by *buf*.

Returns:

The number of complete elements successfully read; this value may be less than the requested number of elements.

Use the *feof()* and *ferror()* functions to determine whether the end of the file was encountered or if an input/output error has occurred.

Errors:

If an error occurs, *errno* is set to indicate the type of error.

Examples:

The following example reads a simple student record containing binary data. The student record is described by the **struct student_data** declaration.

```
#include <stdio.h>
#include <stdlib.h>

struct student_data {
    int  student_id;
    unsigned char marks[10];
};

size_t read_data( FILE *fp, struct student_data *p )
{
    return( fread( p, sizeof( struct student_data ), 1, fp ) );
}

int main( void )
{
    FILE *fp;
    struct student_data std;
    int i;

    fp = fopen( "file", "r" );
    if( fp != NULL ) {
        while( read_data( fp, &std ) != 0 ) {
            printf( "id=%d ", std.student_id );

            for( i = 0; i < 10; i++ ) {
                printf( "%3d ", std.marks[ i ] );
            }

            printf( "\n" );
        }

        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *fopen()*, *feof()*, *ferror()*

free()

Deallocate a block of memory

Synopsis:

```
#include <stdlib.h>

void free( void* ptr );
```

Arguments:

ptr A pointer to the block of memory that you want to free. It's safe to call *free()* with a NULL pointer.

Library:

libc

Description:

The *free()* function deallocates the memory block specified by *ptr*, which was previously returned by a call to *calloc()*, *malloc()* or *realloc()*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <malloc.h>

int main( void )
{
    char *buffer;

    buffer = (char *)malloc( 80 );
    if( buffer == NULL ) {
        printf( "Unable to allocate memory\n" );
        return EXIT_FAILURE;
    } else {
        /* rest of code goes here */

        free( buffer );  /* deallocate buffer */
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

Calling *free()* on a pointer already deallocated by a call to *free()* or *realloc()* could corrupt the memory allocator's data structures.

See also:

alloca(), *calloc()*, *malloc()*, *realloc()*, *sbrk()*

freeaddrinfo()

Free a list of address information structures

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>
#include <netdb.h>

void freeaddrinfo( struct addrinfo * ai );
```

Arguments:

ai A pointer to the **addrinfo** structure that's at the beginning of the list to be freed.

Library:

libsocket

Description:

The *freeaddrinfo()* function frees the given list of **addrinfo** structures and the dynamic storage associated with each item in the list.

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

addrinfo, *gai_strerror()*, *getaddrinfo()*

freeifaddrs()

Free a network interface address

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>
#include <ifaddrs.h>

void freeifaddrs( struct ifaddrs * ifap );
```

Arguments:

ifap A pointer to the linked list of **ifaddrs** structures to be freed.

Library:

libsocket

Description:

The *freeifaddrs()* function frees the dynamically allocated data returned by *getifaddrs()*.

Returns:

0 for success, or -1 if an error occurs (*errno* is set).

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *getifaddrs()*, **`ifaddrs`**, *ioctl()*, *malloc()*, *socket()*, *sysctl()*

freopen(), freopen64()

Reopen a stream

Synopsis:

```
#include <stdio.h>

FILE* freopen( const char* filename,
               const char* mode,
               FILE* fp );

FILE* freopen64( const char* filename,
               const char* mode,
               FILE* fp );
```

Arguments:

filename	The name of the file to open.
mode	The mode to use when opening the file. For more information, see *fopen()*.
fp	The stream to associate with the file.

Library:

libc

Description:

The *freopen()* and *freopen64()* functions close the open stream *fp*, open the file specified by *filename*, and associate its stream with *fp*.

The largest value that can be represented correctly in an object of type **off_t** shall be established as the offset maximum in the open file description.

Returns:

A pointer to the newly opened stream, or NULL if an error occurs (*errno* is set).

Errors:

EACCES	Search permission is denied on a component of the *filename* prefix, or the file exists and the permissions specified by *mode* are denied, or the file doesn't exist and write permission is denied for the parent directory of the file to be created.
EBADFSYS	While attempting to open the named file, either the file itself or a component of the *filename* prefix was found to be corrupted. A system failure — from which no automatic recovery is possible — occurred while the file was being written to, or while the directory was being updated. You'll need to invoke appropriate systems-administration procedures to correct this situation before proceeding.
EBUSY	File access was denied due to a conflicting open (see *sopen()*).
EINTR	The *freopen()* operation was interrupted by a signal.
EINVAL	The value of the *mode* argument is not valid.
EISDIR	The named file is a directory, and the *mode* argument specifies write-only or read/write access.
ELOOP	Too many levels of symbolic links or prefixes.
EMFILE	Too many file descriptors are currently in use by this process.
ENAMETOOLONG	The length of the *filename* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.
ENFILE	Too many files are currently open in the system.

ENOENT	Either the named file or the *filename* prefix doesn't exist, or the *filename* argument points to an empty string.
ENOMEM	There is no memory for FILE structure.
ENOSPC	The directory or filesystem that would contain the new file can't be extended.
ENOSYS	The *freopen()* function isn't implemented for the filesystem specified in *filename*.
ENOTDIR	A component of the *filename* prefix isn't a directory.
ENXIO	The media associated with the file has been removed (e.g. CD, floppy).
EOVERFLOW	The named file is a regular file and the size of the file can't be represented correctly in an object of type **off_t**.
EROFS	The named file resides on a read-only filesystem.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE* fp;
    int c;

    /* Reopen the stdin stream so it's reading
     * from "file" instead of standard input.
     */
    fp = freopen( "file", "r", stdin );

    if( fp != NULL ) {
        /* Now we can read from "file" using the
         * stdin functions like fgetchar()...
         */
        while( ( c = fgetchar() ) != EOF ) {
            fputchar( c );
```

```
        }

        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

freopen() is ANSI, *freopen64()* is for large-file support

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *fclose()*, *fcloseall()*, *fdopen()*, *fopen()*, *fopen64()*

frexp(), frexpf()

Break a floating-point number into a normalized fraction and an integral power of 2

Synopsis:

```
#include <math.h>

double frexp( double value,
              int* exp );

float frexpf( float value,
              int* exp );
```

Arguments:

value	The value you want to break into a normalized fraction.
exp	A pointer to a location where the function can store the integral power of 2.

Library:

libm

Description:

These functions break a floating-point number into a normalized fraction and an integral power of 2. It stores the integral power of 2 in the **int** pointed to by *exp*.

Returns:

x, such that *x* is a **double** with magnitude in the interval [0.5, 1] or 0, and *value* equals *x* times 2 raised to the power *exp*. If *value* is 0, then both parts of the result are 0.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

int main( void )
{
    int expon;
```

```
    double value;

    value = frexp(  4.25, &expon );
    printf( "%f %d\n", value, expon );
    value = frexp( -4.25, &expon );
    printf( "%f %d\n", value, expon );

    return EXIT_SUCCESS;
}
```

produces the output:

```
0.531250 3
-0.531250 3
```

Classification:

frexp() is ANSI; *frexpf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ldexp(), *modf()*

fscanf()

Scan input from a stream

Synopsis:

```
#include <stdio.h>

int fscanf( FILE* fp,
            const char* format,
            ... );
```

Arguments:

fp	The stream that you want to read from.
format	A string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.

Library:

libc

Description:

The *fscanf()* function scans input from the stream specified by *fp*, under control of the argument *format*.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF if the scanning reached the end of the input stream before storing any values (*errno* is set).

Examples:

Scan a date in the form “Friday March 26 1999”:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    int day;
```

```
    int year;
    char weekday[10];
    char month[10];
    FILE *in_data;

    in_data = fopen( "file", "r" );
    if( in_data != NULL ) {
        fscanf( in_data, "%s %s %d %d",
                weekday, month, &day, &year );

        printf( "Weekday=%s Month=%s Day=%d Year=%d\n",
                weekday, month, day, year );

        fclose( in_data );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *fwscanf()*, *scanf()*, *sscanf()*, *swscanf()*, *vfscanf()*, *vfwscanf()*, *vscanf()*, *vsscanf()*, *vswscanf()*, *vwscanf()*, *wscanf()*

fseek(), fseeko()

Change the current position of a stream

Synopsis:

```
#include <stdio.h>

int fseek( FILE* fp,
           long offset,
           int whence );

int fseeko( FILE* fp,
            off_t offset,
            int whence );
```

Arguments:

fp A **FILE** pointer returned by *fopen()* or *freopen()*.

offset The position to seek to, relative to one of the positions specified by *whence*.

whence The position from which to apply the offset; one of:

SEEK_SET	Compute the new file position relative to the start of the file. The value of *offset* must not be negative.
SEEK_CUR	Compute the new file position relative to the current file position. The value of *offset* may be positive, negative or zero. A SEEK_CUR with a 0 *offset* is necessary when you want to switch from reading to writing on a stream opened for updates.
SEEK_END	Compute the new file position relative to the end of the file.

Library:

libc

Description:

The *fseek()* function changes the current position of the stream specified by *fp*. This position defines the character that will be read or written by the next I/O operation on the file.

The *fseek()* function clears the end-of-file indicator, and undoes any effects of the *ungetc()* function on the stream.

You can use *ftell()* to get the current position of the stream before changing it. You can restore the position by using the value returned by *ftell()* in a subsequent call to *fseek()* with the *whence* parameter set to SEEK_SET.

Returns:

0 for success, or nonzero if an error occurs.

Errors:

If an error occurs, *errno* is set to indicate the type of error.

Examples:

Determine the size of a file, by saving and restoring the current position of the file:

```
#include <stdio.h>
#include <stdlib.h>

long filesize( FILE *fp )
{
    long int save_pos;
    long size_of_file;

    /* Save the current position. */
    save_pos = ftell( fp );

    /* Jump to the end of the file. */
    fseek( fp, 0L, SEEK_END );

    /* Get the end position. */
    size_of_file = ftell( fp );

    /* Jump back to the original position. */
```

```
    fseek( fp, save_pos, SEEK_SET );

    return( size_of_file );
}

int main( void )
{
    FILE *fp;

    fp = fopen( "file", "r" );

    if( fp != NULL ) {
        printf( "File size=%ld\n", filesize( fp ) );
        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

fseek() is ANSI; *fseeko()* is standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *fgetpos()*, *fopen()*, *fsetpos()*, *ftell()*

fsetpos()

Set the current position of a file

Synopsis:

```
#include <stdio.h>

int fsetpos( FILE* fp,
             const fpos_t* pos );
```

Arguments:

fp The stream whose position you want to set.

pos A pointer to a **fpos_t** object that specifies the new position for the stream. You must have initialized the value pointed to by *pos* by calling *fgetpos()* on the same file.

Library:

libc

Description:

The *fsetpos()* function sets the current position of the stream specified by *fp* according to the value of the **fpos_t** object pointed to by *pos*.

Returns:

0 for success, or nonzero if an error occurs (*errno* is set).

Examples:

See *fgetpos()*.

Classification:

ANSI

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, fgetpos(), fopen(), fseek(), ftell()

fstat(), fstat64()

Get file information, given a file description

Synopsis:

```
#include <sys/types.h>
#include <sys/stat.h>

int fstat( int filedes,
           struct stat* buf );

int fstat64( int filedes,
             struct stat64* buf );
```

Arguments:

filedes The descriptor of the file that you want to get information about.

buf A pointer to a buffer where the function can store the information about the file.

Library:

libc

Description:

The *fstat()* and *fstat64()* functions get information from the file specified by *filedes* and stores it in the structure pointed to by *buf*.

The file **<sys/stat.h>** contains definitions for **struct stat**, as well as following macros:

S_ISBLK(*m*) Test for block special file.

S_ISCHR(*m*) Test for character special file.

S_ISDIR(*m*) Test for directory.

S_ISFIFO(*m*) Test for FIFO.

S_ISLNK(*m*) Test for symbolic link.

S_ISREG(*m*) Test for regular file.

S_TYPEISMQ(*buf*)
Test for message queue.

S_TYPEISSEM(*buf*)
Test for semaphore.

S_TYPEISSHM(*buf*)
Test for shared memory object.

The arguments to the macros are:

m The value of *st_mode* in a **stat** structure.

buf A pointer to a **stat** structure.

The macros evaluate to nonzero if the test is true, and zero if the test is false.

Access permissions are specified as a combination of bits in the *st_mode* field of the **stat** structure. These bits are defined in **<sys/stat.h>**. For more information, see "Access permissions" in the documentation for *stat()*.

The *st_mode* field also encodes the following bits:

S_ISUID Set user ID on execution. The process's effective user ID (EUID) is set to that of the owner of the file when the file is run as a program. On a regular file, this bit may be cleared for security reasons on any write.

S_ISGID Set group ID on execution. Set effective group ID (EGID) on the process to the file's group when the file is run as a program. On a regular file, this bit bit may be cleared for security reasons on any write.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF	The *filedes* argument isn't a valid file descriptor.
ENOSYS	The *fstat()* function isn't implemented for the filesystem specified by *filedes*.
EOVERFLOW	The file size in bytes or the number of blocks allocated to the file or the file serial number can't be represented correctly in the structure pointed to by *buf*.

Examples:

```
#include <stdio.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
{
    int filedes;
    int rc;
    struct stat buf;

    filedes = open( "file", O_RDONLY );
    if( filedes != -1 ) {
        rc = fstat( filedes , &buf );
        if( rc != -1 ) {
            printf( "File size = %d\n", buf.st_size );
        }

        close( filedes );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

fstat() is POSIX 1003.1; *fstat64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

creat(), dup(), dup2(), errno, fcntl(), lstat(), open(), pipe(), sopen(), stat()

fstatvfs(), *fstatvfs64()*

Get filesystem information, given a file descriptor

Synopsis:

```
#include <sys/statvfs.h>

int fstatvfs( int fildes,
              struct statvfs *buf );

int fstatvfs64( int fildes,
                struct statvfs64 *buf );
```

Arguments:

fildes The descriptor for a file that resides on the filesystem that you want to get information about.

buf A pointer to a buffer where the function can store information about the filesystem; see below.

Library:

libc

Description:

The *fstatvfs()* function returns a "generic superblock" describing a filesystem; you can use it to get information about mounted filesystems. The *fstatvfs64()* function is a 64-bit version of *fstatvfs()*.

The *fildes* argument is an open file descriptor, obtained from a successful call to *open()*, *creat()*, *dup()*, *fcntl()*, or *pipe()*, for a file that resides on that filesystem. The filesystem type is known to the operating system. Read, write, or execute permission for the named file isn't required.

The *buf* argument is a pointer to a **statvfs** or **statvfs64** structure that's filled by the function. It contains at least:

unsigned long *f_bsize*

The preferred filesystem blocksize.

unsigned long *f_frsize*

The fundamental filesystem blocksize (if supported)

fsblkcnt_t *f_blocks*

The total number of blocks on the filesystem, in units of *f_frsize*.

fsblkcnt_t *f_bfree*

The total number of free blocks.

fsblkcnt_t *f_bavail*

The number of free blocks available to a nonsuperuser.

fsfilcnt_t *f_files*

The total number of file nodes (inodes).

fsfilcnt_t *f_ffree*

The total number of free file nodes.

fsfilcnt_t *f_favail*

The number of inodes available to a nonsuperuser.

unsigned long *f_fsid*

The filesystem ID (dev for now).

char *f_basetype*[16]

The type of the target filesystem, as a null-terminated string.

unsigned long *f_flag*

A bitmask of flags; the function can set these flags:

- ST_RDONLY — read-only filesystem.
- ST_NOSUID — the filesystem doesn't support **setuid**/**setgid** semantics.

unsigned long *f_namemax*

The maximum filename length.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF	The *fildes* argument isn't an open file descriptor.
EFAULT	The *buf* argument points to an illegal address.
EINTR	A signal was caught during execution.
EIO	An I/O error occurred while reading the filesystem.
EOVERFLOW	One of the values to be returned can't be represented correctly in the structure pointed to by *buf*.

Classification:

fstatvfs() is standard Unix; *fstatvfs64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The values returned for *f_files*, *f_ffree*, and *f_favail* might not be valid for NFS-mounted filesystems.

See also:

chmod(), chown(), creat(), dup(), fcntl(), link(), mknod(), open(), pipe(), read(), statvfs(), statvfs64(), time(), unlink(), utime(), write()

fsync()

Synchronize the file state

Synopsis:

```
#include <unistd.h>

int fsync( int filedes );
```

Arguments:

filedes The descriptor for the file that you want to synchronize.

Library:

libc

Description:

The *fsync()* function forces all queued I/O operations for the file specified by the *filedes* file descriptor to finish, synchronizing the file's state.

Although similar to *fdatasync()*, *fsync()* also guarantees the integrity of file information such as access and modification times.

Returns:

0 for success, or -1 if an error occurs (*errno* is set).

Errors:

EBADF The *filedes* argument isn't a valid file descriptor open for writing.

EINVAL The implementation doesn't support synchronized I/O for the given file.

ENOSYS The *fsync()* function isn't supported for the filesystem specified by *filedes*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

aio_fsync(), close(), fcntl(), fdatasync(), open(), read(), sync(), write()

ftell(), *ftello()*

Return the current position of a stream

Synopsis:

```
#include <stdio.h>

long int ftell( FILE* fp );

off_t ftello( FILE* fp );
```

Arguments:

fp The stream that you want to get the current position of.

Library:

libc

Description:

The *ftell()* function returns the current position of the stream specified by *fp*. This position defines the character that will be read or written by the next I/O operation on the file. You can use the value returned by *ftell()* in a subsequent call to *fseek()* to restore the file position to a previous value.

The *ftello()* function is similar to *ftell()*, except that the position is returned as an **off_t**.

Returns:

The current position of the file or **-1L** if an error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

long filesize( FILE *fp )
{
    long int save_pos;
    long size_of_file;
```

```
    /* Save the current position. */
    save_pos = ftell( fp );

    /* Jump to the end of the file. */
    fseek( fp, 0L, SEEK_END );

    /* Get the end position. */
    size_of_file = ftell( fp );

    /* Jump back to the original position. */
    fseek( fp, save_pos, SEEK_SET );

    return( size_of_file );
}

int main( void )
{
    FILE *fp;

    fp = fopen( "file", "r" );

    if( fp != NULL ) {
        printf( "File size=%ld\n", filesize( fp ) );
        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ftell() is ANSI; *ftello()* is standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fgetpos(), fopen(), fsetpos(), fseek()

ftime()

Get the current time

Synopsis:

```
#include <sys/timeb.h>

int ftime( struct timeb * timeptr );
```

Arguments:

timeptr A pointer to a **timeb** structure where the function can store the current time; see below.

Library:

libc

Description:

The *ftime()* function stores the current time in the *timeptr* structure. The **timeb** structure contains the following fields:

time_t *time* Time, in seconds, since the Unix Epoch, 00:00:00 January 1, 1970 Coordinated Universal Time (UTC).

unsigned short *millitm*
Milliseconds.

short *timezone* Difference in minutes of the timezone from UTC.

short *dstflag* Nonzero if in daylight savings time.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <time.h>
#include <sys/timeb.h>
#include <stdlib.h>

int main( void )
{
    struct timeb timebuf;
    char *now;

    ftime( &timebuf );
    now = ctime( &timebuf.time );

    /* Note that we're cutting "now" off
     * after 19 characters to avoid the
     * \n that ctime() appends to the
     * formatted time string.
     */

    printf( "The time is %.19s.%hu\n",
            now, timebuf.millitm );

    return EXIT_SUCCESS;
}
```

Produces output similar to the following:

```
The time is Mon Jul 05 15:58:42.870
```

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

asctime(), clock(), ctime(), difftime(), gmtime(), localtime(), mktime(), strftime(), time(), tzset()

ftruncate(), *ftruncate64()*

Truncate a file

Synopsis:

```
#include <unistd.h>

int ftruncate( int fildes,
               off_t length );

int ftruncate64( int fildes,
                 off64_t length );
```

Arguments:

fildes The descriptor for the file that you want to truncate.

length The length that you want the file to be, in bytes.

Library:

libc

Description:

These functions cause the file referenced by *fildes* to have a size of *length* bytes. If the size of the file previously exceeded *length*, the extra data is discarded (this is similar to using the F_FREESP option with *fcntl()*). If the size of the file was previously shorter than *length*, the file size is extended with NUL characters (similar to the F_ALLOCSP option to *fcntl()*).

The value of the seek pointer isn't modified by a call to *ftruncate()*.

Upon successful completion, the *ftruncate()* function marks the *st_ctime* and *st_mtime* fields of the file for update. If the *ftruncate()* function is unsuccessful, the file is unaffected.

Returns:

Zero for success, or -1 if an error occurred (*errno* is set).

Errors:

EBADF	The *fildes* argument isn't a valid file descriptor.
EFBIG	The file is a regular file and *length* is greater than the offset maximum associated with the file.
EINTR	A signal was caught during the call to *ftruncate()*.
EINVAL	The *fildes* argument doesn't refer to a file on which this operation is possible, the *filedes* argument isn't open for writing or the *length* argument is less than the minimum file size for the specified filesystem.
EIO	An I/O error occurred while reading from or writing to the filesystem.
ENOSYS	The *ftruncate()* function isn't implemented for the filesystem specified by *filedes*.
ENOTSUP	The *ftruncate()* function is implemented for the specified filesystem, but the specific operation (F_ALLOCSP or F_FREESP; see *fcntl()*) isn't supported.
EROFS	The file resides on a read-only filesystem.

Classification:

ftruncate() is POSIX 1003.1; *ftruncate64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mmap(), open(), shm_open(), truncate()

ftrylockfile()

Acquire ownership of a file, without blocking

Synopsis:

```
#include <stdio.h>

int ftrylockfile( FILE* file );
```

Arguments:

file A pointer to the **FILE** object for the file you want to lock.

Library:

libc

Description:

The *ftrylockfile()* function is used by a thread to acquire ownership of a **FILE** if the object is available; *ftrylockfile()* is a nonblocking version of *flockfile()*.

Returns:

0	Success.
Nonzero	The lock can't be acquired.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

flockfile(), *getc_unlocked()*, *getchar_unlocked()*, *putc_unlocked()*, *putchar_unlocked()*

Synopsis:

```
#include <ftw.h>

int ftw( const char *path,
         int (*fn)( const char *fname,
                    const struct stat *sbuf,
                    int flags),
         int depth );
```

Arguments:

path The path of the directory whose file tree you want to walk.

fn A pointer to a function that you want to call for each file; see below.

depth The maximum number of file descriptors that *ftw()* can use. The *ftw()* function uses one file descriptor for each level in the tree.

If *depth* is zero or negative, the effect is the same as if it were 1. The *depth* must not be greater than the number of file descriptors currently available for use. The *ftw()* function is faster if *depth* is at least as large as the number of levels in the tree.

Library:

libc

Description:

The *ftw()* function recursively descends the directory hierarchy identified by *path*. For each object in the hierarchy, *ftw()* calls the user-defined function *fn()*, passing to it:

- a pointer to a NULL-terminated character string containing the name of the object

- a pointer to a **stat** structure (see *stat()*) containing information about the object
- an integer. Possible values of the integer, defined in the **<ftw.h>** header, are:

FTW_F	The object is a file.
FTW_D	The object is a directory.
FTW_DNR	The object is a directory that can't be read. Descendents of the directory aren't processed.
FTW_NS	The *stat()* failed on the object because the permissions weren't appropriate, or the object is a symbolic link that points to a nonexistent file. The **stat** buffer passed to *fn()* is undefined.

The *ftw()* function visits a directory before visiting any of its descendents.

The tree traversal continues until the tree is exhausted, an invocation of *fn()* returns a nonzero value, or some error is detected within *ftw()* (such as an I/O error). If the tree is exhausted, *ftw()* returns zero. If *fn()* returns a nonzero value, *ftw()* stops its tree traversal and returns whatever value was returned by *fn()*.

When *ftw()* returns, it closes any file descriptors it opened; it doesn't close any file descriptors that may have been opened by *fn()*.

Returns:

0	Success.
-1	An error (other than EACCESS) occurred (*errno* is set).

Classification:

Standard Unix, *ftw64()* is for large-file support

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Because *ftw()* is recursive, it might terminate with a memory fault when applied to very deep file structures.

This function uses *malloc()* to allocate dynamic storage during its operation. If *ftw()* is forcibly terminated, for example if *longjmp()* is executed by *fn()* or an interrupt routine, *ftw()* doesn't have a chance to free that storage, so it remains permanently allocated. A safe way to handle interrupts is to store the fact that an interrupt has occurred, and arrange to have *fn()* return a nonzero value at its next invocation.

See also:

longjmp(), *malloc()*, *nftw()*, *stat()*

funlockfile()

Release ownership of a file

Synopsis:

```
#include <stdio.h>

void funlockfile( FILE* file );
```

Arguments:

file A pointer to the **FILE** object for the file you want to unlock.

Library:

libc

Description:

The *funlockfile()* function is used to release ownership of *file* granted to the thread. The behavior is undefined if a thread other than the current owner calls the *funlockfile()* function.

For more information, see *flockfile()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

flockfile(), *ftrylockfile()*, *getc_unlocked()*, *getchar_unlocked()*, *putc_unlocked()*, *putchar_unlocked()*

futime()

Record the modification time for a file

Synopsis:

```
#include <utime.h>

int futime( int fildes,
            const struct utimbuf *times );

struct utimbuf {
    time_t   actime;    /* access time */
    time_t   modtime;   /* modification time */
};
```

Arguments:

fildes The descriptor for the file whose modification time you want to get or set.

times NULL, or a pointer to a **utimbuf** structure where the function can store the modification time.

Library:

libc

Description:

The *futime()* function records the modification time for the file or directory with the descriptor, *fildes*.

If the *times* argument is NULL, the access and modification times of the file or directory are set to the current time. The effective user ID of the process must match the owner of the file or directory, or the process must have write permission to the file or directory, or appropriate privileges in order to use the *futime()* function in this way.

If the *times* argument isn't NULL, it's interpreted as a pointer to a **utimbuf** structure, and the access and modification times of the file or directory are set to the values contained in the *actime* and *modtime* fields in this structure. Only the owner of the file or directory, and processes with appropriate privileges are permitted to use the *futime()* function in this way.

Returns:

0 Success.

-1 An error occurred (*errno*) is set.

Errors:

EACCES Search permission is denied for a component of *path*, or the *times* argument is NULL, and the effective user ID of the process doesn't match the owner of the file, and write access is denied.

ENAMETOOLONG
The argument *path* exceeds PATH_MAX in length, or a pathname component is longer than NAME_MAX.

ENOENT The specified *path* doesn't exist, or *path* is an empty string.

ENOTDIR A component of *path* isn't a directory.

EPERM The *times* argument isn't NULL, and the calling process's effective user ID has write access to the file but doesn't match the owner of the file, and the calling process doesn't have the appropriate privileges.

EROFS The named file resides on a read-only filesystem.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *utime()*

fwide()

Set or get the stream orientation

Synopsis:

```
#include <wchar.h>

int fwide( FILE * fp,
           int mode  );
```

Arguments:

fp The stream whose orientation you want to set.

mode The orientation mode:

- If *mode* is greater than zero and the stream orientation hasn't been set, *fwide()* flags the stream as wide-oriented.
- If *mode* is less than zero, *fwide()* behaves similarly, but flags the stream as byte-oriented.
- If *mode* is zero, *fwide()* returns the stream type without altering the stream.

Library:

libc

Description:

The *fwide()* function sets or determines the orientation of the stream *fp*.

Returns:

> 0 The stream is (now) wide-oriented.

0 The stream is unbound.

< 0 The stream is (now) byte-oriented.

Errors:

EBADF The *fp* argument isn't valid.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

"Stream I/O functions" and "Wide-character functions" in the summary of functions chapter.

fwprintf()

Write wide-character output to a stream

Synopsis:

```
#include <wchar.h>

int fwprintf( FILE * fp,
              const wchar_t * format,
              ... );
```

Arguments:

fp	The stream to which you want to send the output.
format	A wide-character string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.

Library:

libc

Description:

The *fwprintf()* function writes output to the stream specified by *fp*, under control of the *format* specifier.

The *fwprintf()* function is the wide-character version of *fprintf()*.

Returns:

The number of wide characters written, excluding the terminating **NUL**, or a negative number if an error occurred (*errno* is set).

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fprintf(), printf(), snprintf(), sprintf(), swprintf(), vfprintf(), vfwprintf(), vprintf(), vsnprintf(), vsprintf(), vswprintf(), vwprintf(), wprintf()

fwrite()

Write elements to a file

Synopsis:

```
#include <stdio.h>

size_t fwrite( const void* buf,
               size_t size,
               size_t num,
               FILE* fp );
```

Arguments:

buf	A pointer to a buffer that contains the elements that you want to write.
size	The size of each element to write.
num	The number of elements to write.
fp	The stream to which to write the elements.

Library:

libc

Description:

The *fwrite()* function writes *num* elements of *size* bytes each to the stream specified by *fp*.

Returns:

The number of complete elements successfully written; if an error occurs, this is less than *num*.

Errors:

If an error occurs, *errno* is set to indicate the type of error.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

struct student_data {
    int student_id;
    unsigned char marks[10];
};

int main( void )
{
    FILE *fp;
    struct student_data std;
    int i;

    fp = fopen( "file", "w" );
    if( fp != NULL ) {
        std.student_id = 1001;

        for( i = 0; i < 10; i++ ) {
            std.marks[i] = (unsigned char)(85 + i);
        }

        /* write student record with marks */
        i = fwrite( &std, sizeof( struct student_data ), 1, fp );
        printf( "Successfully wrote %d records\n", i );

        fclose( fp );

        if( i == 1 ) {
            return EXIT_SUCCESS;
        }
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, ferror(), fopen()

fwscanf()

Scan wide-character input from a stream

Synopsis:

```
#include <wchar.h>

int fwscanf( FILE * fp,
             const wchar_t * format,
             ... );
```

Arguments:

fp	The stream that you want to read from.
format	A wide-character string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.

Library:

libc

Description:

The *fwscanf()* function scans input from the stream specified by *fp*, under control of the argument *format*. Following the format string is a list of addresses to receive values.

The *fwscanf()* function is the wide-character version of *fscanf()*.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF if the scanning reached the end of the input stream before storing any values.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *fscanf()*, *scanf()*, *sscanf()*, *swscanf()*, *vfscanf()*, *vfwscanf()*, *vscanf()*, *vsscanf()*, *vswscanf()*, *vwscanf()*, *wscanf()*

gai_strerror()

Return the string associated with a getaddrinfo() error code

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>
#include <netdb.h>

const char * gai_strerror( int ecode );
```

Arguments:

ecode The error code number from the *getaddrinfo()* function.

Library:

libsocket

Description:

The *gai_strerror()* function returns a string describing the error code from the *getaddrinfo()* function. Nonzero error codes are defined in **<netdb.h>** as follows:

EAI_ADDRFAMILY
: The address family for *nodename* isn't supported.

EAI_AGAIN
: There was a temporary failure in name resolution.

EAI_BADFLAGS
: Invalid value for *ai_flags*.

EAI_FAIL
: Nonrecoverable failure in name resolution.

EAI_FAMILY
: The *ai_family* isn't supported.

EAI_MEMORY
: Memory allocation failure.

EAI_NODATA
: No address associated with the *nodename*.

EAI_NONAME
: Either the *nodename* or the *servname* argument wasn't provided or isn't known.

EAI_SERVICE	The *servname* argument isn't supported for *ai_socktype*.
EAI_SOCKTYPE	The *ai_socktype* isn't supported.
EAI_SYSTEM	System error returned in *errno*.

Returns:

If called with a proper *ecode* argument, a pointer to a string describing the given error code. If the argument isn't one of the EAI_* values, a pointer to a string whose contents indicate an unknown error.

☞ Don't modify the strings that this function returns.

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

addrinfo, *freeaddrinfo()*, *getaddrinfo()*

Log gamma function

Synopsis:

```
#include <math.h>

double gamma( double x );

double gamma_r( double x,
                int* signgam);

float gammaf( float x );

float gammaf_r( float x,
                int* signgam);
```

Arguments:

x	An arbitrary number.
signgam	(*gamma_r()*, *gammaf_r()* only) A pointer to a location where the function can store the sign of Γ(*x*).

Library:

libm

Description:

The *gamma()* and *gamma_r()* functions return the natural log (**ln**) of the *gamma()* function and are equivalent to *lgamma()*. These functions return **ln**|Γ(*x*)|, where Γ(*x*) is defined as follows:

For $x > 0$: $\int_0^\infty e^{-t}\, t^{x-1} dt$

For $x < 1$: n / (Γ(1-*x*) * *sin*(n*x*))

The results converge when *x* is between 0 and 1. The Γ function has the property:

$\Gamma(N) = \Gamma(N-1) \times N$

The *gamma** functions compute the log because the Γ function grows very quickly.

The *gamma()* and *gammaf()* functions use the external integer *signgam* to return the sign of Γ(*x*), while *gamma_r()* and *gammaf_r()* use the user-allocated space addressed by *signgamp*.

☞ The *signgam* variable isn't set until *gamma()* or *gammaf()* returns. For example, don't use the expression:

```
g = signgam * exp( gamma( x ));
```

to compute $g = \Gamma(x)'$. Instead, compute *gamma()* first:

```
lg = gamma(x);
g = signgam * exp( lg );
```

Note that Γ(*x*) must overflow when *x* is large enough, underflow when -*x* is large enough, and generate a division by 0 exception at the singularities *x* a nonpositive integer.

Returns:

$\ln|\Gamma(x)|$

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

lgamma()

getaddrinfo()

Get socket address information

Synopsis:

```
#include <sys/socket.h>
#include <netdb.h>

int getaddrinfo( const char * nodename,
                 const char * servname,
                 const struct addrinfo * hints,
                 struct addrinfo ** res );
```

Arguments:

nodename	The node name. A non-NULL *nodename* may be either a node name or a numeric host address string (i.e. a dotted-decimal IPv4 address or an IPv6 hex address.)
servname	The server name. A non-NULL *servname* may be either a server name or a decimal port number.
hints	A pointer to an **addrinfo** structure that provides hints about the type of socket you're supporting. See "Using the *hints* argument" for more information.
res	The address of a location where the function can store a pointer to a linked list of one or more **addrinfo** structures.

Library:

libsocket

Description:

The *getaddrinfo()* function performs the functionality of *gethostbyname()* and *getservbyname()* but in a more sophisticated manner.

The *nodename* and *servname* arguments are either pointers to null-terminated strings or NULL. One or both of these two arguments

must be a non-NULL pointer. Normally, a client scenario specifies both *nodename* and *servname*.

On success, the *getaddrinfo()* function stores, in the location pointed to by *res*, a pointer to a linked list of one or more **addrinfo** structures. You can process each **addrinfo** structure in this list by following the *ai_next* pointer until reaching a NULL pointer. Each **addrinfo** structure contains the corresponding *ai_family*, *ai_socktype*, and *ai_protocol* arguments for a call to the *socket()* function. The *ai_addr* argument of the **addrinfo** structure points to a filled-in socket address structure with a length specified by the *ai_addrlen* argument.

Using the *hints* argument

You can optionally pass an **addrinfo** structure, pointed to by the *hints* argument, that provides hints concerning the type of socket that your application supports.

In this structure, all members — except *ai_flags*, *ai_family*, *ai_socktype*, and *ai_protocol* — must be zero or a NULL pointer. The **addrinfo** structure of the *hints* argument can accept various types of sockets:

To accept:	Set:	To:
Any protocol family	*ai_family*	PF_UNSPEC
Any socket type	*ai_socktype*	0
Any protocol	*ai_protocol*	0
All of the above (as well as setting *ai_flags* to 0)	*hints*	NULL

The *hints* argument defaults to all possibilities, but you can also use it to limit choices:

- If the application handles only TCP but not UDP, you could set the *ai_socktype* member of the *hints* structure to SOCK_STREAM.
- If the application handles only IPv4 but not IPv6, you could set the *ai_family* member of the *hints* structure to PF_INET.

Using the *ai_flags* argument in the *hints* structure

You can set the *ai_flags* argument to further configure the *hints* structure. Settings for *ai_flags* include:

AI_PASSIVE
: Set this bit if you plan to use the returned **addrinfo** structure in a call to *bind()*. In this call, if the *nodename* argument is a NULL pointer, then the IP address portion of the socket address structure *ai_addr* is set to INADDR_ANY for an IPv4 address or IN6ADDR_ANY_INIT for an IPv6 address.

  If you don't set the AI_PASSIVE flag, you can use the returned **addrinfo** structure in a call to:

  - *connect()* — connectionless or connection-oriented protocol
  - *sendto()* — connectionless protocol
  - *sendmsg()* — connectionless protocol

  In this case, if the *nodename* argument is a NULL pointer, then the IP address portion of the socket address structure *ai_addr* is set to the loopback address.

AI_CANONNAME
: Set this bit if you want the *ai_canonname* argument of the first **addrinfo** structure to point to a null-terminated string containing the canonical name of the specified *nodename*.

AI_NUMERICHOST
: Set this bit if you want to prevent any type of name resolution service (such as DNS) from being used.

A non-NULL *nodename* string must be a numeric host address string; otherwise, *getaddrinfo()* returns EAI_NONAME.

Pitfalls

The arguments to *getaddrinfo()* must be sufficiently consistent and unambiguous or this function will return an error. Here are some problems you may encounter:

- Inconsistent *hints* — for Internet address families, specifying SOCK_STREAM for *ai_socktype* while specifying IPPROTO_UDP for *ai_protocol*.
- Inconsistent *servname* — specifying a *servname* that's defined only for certain *ai_socktype* values, such as the TFTP service (a datagram service SOCK_DGRAM) on SOCK_STREAM.
- Undefined service names — specifying a *servname* while specifying SOCK_RAW for *ai_socktype*. (Service names aren't defined for the internet SOCK_RAW space.)
- Incomplete specifications — specifying a numeric *servname* while leaving *ai_socktype* and *ai_protocol* unspecified. The *getaddrinfo()* function isn't allowed to *glob()* the argument when a numeric *servname* doesn't have a specified socket type.

☞ The *getaddrinfo()* function dynamically allocates space for the following:

- *addrinfo* structures
- socket address structures
- canonical node name strings pointed to by the *addrinfo* structures.

Use *freeaddrinfo()* to free the *addrinfo* structures, and *gai_strerror()* to decipher error codes.

Returns:

Zero for success, or nonzero if an error occurs.

Errors:

To get an explanation of any error code, use *gai_strerror()*.

Examples:

The following code tries to connect to **www.kame.net** service HTTP using a stream socket. It loops through all the addresses available, regardless of the address family. If the destination resolves to an IPv4 address, it uses a AF_INET socket. Similarly, it uses an AF_INET6 socket if it resolves to IPv6. Note that there aren't any hardcoded references to any particular address family; the code works even if *getaddrinfo()* returns addresses that aren't IPv4/v6.

```
struct addrinfo hints, *res, *res0;
int error;
int s;
const char *cause = NULL;

memset(&hints, 0, sizeof(hints));
hints.ai_family = PF_UNSPEC;
hints.ai_socktype = SOCK_STREAM;
error = getaddrinfo("www.kame.net", "http", &hints, &res0);
if (error) {
    err1(1, "%s", gai_strerror(error));
    /*NOTREACHED*/
```

```
}
s = -1;
for (res = res0; res; res = res->ai_next) {
    s = socket(res->ai_family, res->ai_socktype,
        res->ai_protocol);
    if (s < 0) {
        cause = "socket";
        continue;
    }

    if (connect(s, res->ai_addr, res->ai_addrlen) < 0) {
        cause = "connect";
        close(s);
        s = -1;
        continue;
    }

    break;  /* okay we got one */
}
if (s < 0) {
    err(1, cause);
    /*NOTREACHED*/
}
freeaddrinfo(res0);
```

The following example tries to open a wildcard-listening socket onto the HTTP service for all of the available address families:

```
struct addrinfo hints, *res, *res0;
int error;
int s[MAXSOCK];
int nsock;
const char *cause = NULL;

memset(&hints, 0, sizeof(hints));
hints.ai_family = PF_UNSPEC;
hints.ai_socktype = SOCK_STREAM;
hints.ai_flags = AI_PASSIVE;
error = getaddrinfo(NULL, "http", &hints, &res0);
if (error) {
    err1(1, "%s", gai_strerror(error));
    /*NOTREACHED*/
}
nsock = 0;
for (res = res0; res && nsock < MAXSOCK; res = res->ai_next) {
    s[nsock] = socket(res->ai_family, res->ai_socktype,
        res->ai_protocol);
    if (s[nsock] < 0) {
        cause = "socket";
```

```
            continue;
        }

        if (connect(s[nsock], res->ai_addr, res->ai_addrlen) < 0) {
            cause = "connect";
            close(s[nsock]);
            continue;
        }

        nsock++;
    }
    if (nsock == 0) {
        err(1, cause);
        /*NOTREACHED*/
    }
    freeaddrinfo(res0);
```

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

addrinfo, *freeaddrinfo()*, *gai_strerror()*

getc()

Get the next character from a file

Synopsis:

```
#include <stdio.h>

int getc( FILE* fp );
```

Arguments:

fp The stream you want to get the character from.

Library:

libc

Description:

The *getc()* macro gets the next character from the stream designated by *fp*. The character is returned as an **int** value.

Returns:

The next character from the stream *fp*, cast as **(int)(unsigned char)**, or EOF if an end-of-file or error condition occurs (*errno* is set).

Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE* fp;
    int c;

    fp = fopen( "file", "r" );
    if( fp != NULL ) {
        while( (c = getc( fp )) != EOF ) {
            putchar(c);
```

```
        }

        fclose( fp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

getc() is a macro.

See also:

errno, *feof()*, *ferror()*, *fgetc()*, *fgetchar()*, *fgets()*, *fopen()*, *getchar()*, *gets()*, *putc()*, *putc_unlocked()*, *putchar()*, *putchar_unlocked()*, *ungetc()*

getc_unlocked()

Get the next character from a file

Synopsis:

```
#include <stdio.h>

int getc_unlocked( FILE *fp );
```

Arguments:

fp The stream you want to get the character from.

Library:

libc

Description:

The *getc_unlocked()* function is a thread-unsafe version of *getc()*. You can use it safely only when the invoking thread has locked *fp* using *flockfile()* (or *ftrylockfile()*) and *funlockfile()*.

Returns:

The next character from the input stream pointed to by *fp*, or EOF if an end-of-file or error condition occurs (*errno* is set).

Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	No

See also:

feof(), *ferror()*, *flockfile()*, *getc()*, *getchar()*, *getchar_unlocked()*, *putc()*, *putc_unlocked()*, *putchar()*, *putchar_unlocked()*

getchar()

Get a character from stdin

Synopsis:

```
#include <stdio.h>

int getchar( void );
```

Library:

libc

Description:

The *getchar()* function is equivalent to *getc()* on the *stdin* stream.

Returns:

The next character from the input stream pointed to by *stdin*, cast as **(int)(unsigned char)**, or EOF if an end-of-file or error condition occurs (*errno* is set).

Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    int c;

    /* Get characters from "file" instead of
     * stdin.
     */
    fp = freopen( "file", "r", stdin );
    while( ( c = getchar() ) != EOF ) {
        putchar(c);
    }

    fclose( fp );
```

```
    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *feof()*, *ferror()*, *fgetc()*, *fgetchar()*, *getc()*, *putc()*, *putc_unlocked()*, *putchar()*, *putchar_unlocked()*

getchar_unlocked()

Get a character from stdin

Synopsis:

```
#include <stdio.h>

int getchar_unlocked( void );
```

Library:

libc

Description:

The *getchar_unlocked()* function is a thread-unsafe version of *getchar()*. You can use it safely only when the invoking thread has locked *stdin* using *flockfile()* (or *ftrylockfile()*) and *funlockfile()*.

Returns:

The next character from the input stream pointed to by *stdin*, cast as **(int)(unsigned char)**, or EOF if an end-of-file or error condition occurs (*errno* is set).

Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

feof(), *ferror()*, *getc()*, *getc_unlocked()*, *getchar()*, *putc()*, *putc_unlocked()*, *putchar()*, *putchar_unlocked()*

getcwd()

Get the name of the current working directory

Synopsis:

```
#include <unistd.h>

char* getcwd( char* buffer,
              size_t size );
```

Arguments:

buffer A pointer to a buffer where the function can store the directory name.

size The size of the buffer, in bytes.

Library:

libc

Description:

The *getcwd()* function returns the name of the current working directory. *buffer* is a pointer to a buffer of at least *size* bytes where the NUL-terminated name of the current working directory will be placed.

The maximum size that might be required for *buffer* is PATH_MAX + 1 bytes. See **<limits.h>**.

Returns:

The address of the string containing the name of the current working directory, or NULL if an error occurs (*errno* is set).

Errors:

EINVAL The argument *size* is negative or 0.

ELOOP Too many levels of symbolic links.

ENOSYS The *getcwd()* function isn't implemented for the filesystem specified in the current working directory.

ERANGE The buffer is too small (as specified by *size*) to contain the name of the current working directory.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <limits.h>

int main( void )
{
    char* cwd;
    char buff[PATH_MAX + 1];

    cwd = getcwd( buff, PATH_MAX + 1 );
    if( cwd != NULL ) {
        printf( "My working directory is %s.\n", cwd );
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
My working directory is /home/bill.
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

There is only one current working directory per *process*. In a multithreaded application, any thread calling *chdir()* will change the current working directory for *all threads* in that process.

See also:

chdir(), *errno*, *mkdir()*, *rmdir()*

getdomainname()

Get the domain name of the current host

Synopsis:

```
#include <unistd.h>

int getdomainname( char * name,
                   size_t namelen );
```

Arguments:

name A buffer where the function can store the domain name.

namelen The size of the name array.

Library:

libsocket

Description:

The *getdomainname()* function gets the standard domain name for the current processor and stores it in the buffer that *name* points to. The name is null-terminated.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EFAULT The *name* or *namelen* parameters gave an invalid address.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

setdomainname()

getdtablesize()

Get the size of the file descriptor table

Synopsis:

```
#include <unistd.h>

int  getdtablesize( void );
```

Library:

libc

Description:

Each process has a fixed size descriptor table, which is guaranteed to have at least 20 slots. The entries in the descriptor table are numbered with small integers starting at 0. The *getdtablesize()* returns the size of this table.

This function is equivalent to *getrlimit()* with the RLIMIT_NOFILE option.

Returns:

The size of the file descriptor table.

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

close(), dup(), getrlimit(), open(), select(), sysconf()

getegid()

Get the effective group ID

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

gid_t getegid( void );
```

Library:

libc

Description:

The *getegid()* function gets the effective group ID for the calling process.

Returns:

The calling process's effective group ID. This function can't fail.

Examples:

```
/*
 * Print the effective group ID of a process
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <unistd.h>

int main( void )
{
  printf( "My effective group ID is %d\n", getegid() );
  return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

geteuid(), getgid(), getuid(), setegid()

getenv()

Get the value of an environment variable

Synopsis:

```
#include <stdlib.h>

char* getenv( const char* name );
```

Arguments:

name The name of the environment variable whose value you want to get.

Library:

libc

Description:

The *getenv()* function searches the environment list for a string in the form *name=value* and returns a pointer to a string containing the *value* for the specified *name*. The matching is case-sensitive.

Returns:

A pointer to the *value* assigned to *name*, or NULL if *name* wasn't found in the environment.

☞ Don't modify the returned string.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char* path;

    path = getenv( "INCLUDE" );
    if( path != NULL ) {
        printf( "INCLUDE=%s\n", path );
        return EXIT_SUCCESS;
    }
```

```
    return EXIT_FAILURE;
}
```

Classification:

ANSI, POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

The *getenv()* function manipulates the environment pointed to by the global *environ* variable.

See also:

clearenv(), *environ*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *putenv()*, *searchenv()*, *setenv()*, *spawn*()* functions, *system()*

geteuid()

Get the effective user ID

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

uid_t geteuid( void );
```

Library:

libc

Description:

The *geteuid()* function gets the effective user ID for the calling process.

Returns:

The calling process's effective user ID.

Examples:

```
/*
 * Print the effective user ID of a process.
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <unistd.h>

int main( void )
{
  printf( "My effective user ID is %d\n", geteuid() );
  return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

getegid(), *getgid()*, *getuid()*, *seteuid()*

getgid()

Get the group ID

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

gid_t getgid( void );
```

Library:

libc

Description:

The *getgid()* function gets the group ID for the calling process.

Returns:

The calling process's group ID. This function can't fail.

Examples:

```
/*
 * Print the group id of a process.
 */

#include <stdlib.h>
#include <stdio.h>
#include <sys/types.h>
#include <unistd.h>

int main( void )
{
    printf( "I belong to group ID %d\n", getgid() );
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

getegid(), *geteuid()*, *getuid()*

getgrent()

Return an entry from the group database

Synopsis:

```
#include <grp.h>

struct group* getgrent( void );
```

Library:

libc

Description:

The *getgrent()* function returns the next entry from the group database, although no particular order is guaranteed. This function uses a static buffer that's overwritten by each call.

The *getgrent()*, *getgrgid()*, and *getgrnam()* function share the same static buffer.

Returns:

The next entry from the group database. When you first call *getgrent()*, the group database is opened. It remains open until either *getgrent()* returns NULL to signify end-of-file, or you call *endgrent()*.

Errors:

The *getgrent()* function uses the following functions, and as a result, *errno* can be set to an error for any of these calls:

- *fclose()*
- *fgets()*
- *fopen()*
- *fseek()*
- *rewind()*

Examples:

```
/*
 * This program loops, reading a group name from
 * standard input and checking to see if it is a valid
 * group. If it isn't valid, the entire contents of the
 * group database are printed.
 */
#include <stdio.h>
#include <stdlib.h>
#include <grp.h>
#include <limits.h>

int main( void )
  {
    struct group* gr;
    char    buf[80];

    setgrent();
    while( gets(buf) != NULL) {
      if( (gr=getgrnam(buf)) != (struct group *)0) {
        printf("Valid group is: %s\n",gr->gr_name);
      } else {
        setgrent();
        while( (gr=getgrent()) != (struct group *)0 )
          printf("%s\n",gr->gr_name);
      }
    }
    endgrent();
    return( EXIT_SUCCESS );
  }
```

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

endgrent(), *errno*, *getgrgid()*, *getgrnam()*, *getpwent()*, *setgrent()*

getgrgid()

Get information about the group with a given ID

Synopsis:

```
#include <sys/types.h>
#include <grp.h>

struct group* getgrgid( gid_t gid );
```

Arguments:

gid The ID of the group you want to get information about.

Library:

libc

Description:

The *getgrgid()* function lets a process gain more knowledge about group *gid*. This function uses a static buffer that's overwritten by each call.

The *getgrent()*, *getgrgid()*, and *getgrnam()* functions share the same static buffer.

Returns:

A pointer to an object of type *struct group* containing an entry from the group database with a matching *gid*. On error or failure to find an entry with a matching *gid*, a NULL pointer is returned.

Examples:

```
/*
 * Print a list of all users in your group
 */
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <sys/types.h>
#include <grp.h>
```

```
int main( void )
  {
    struct group* g;
    char** p;

    if( ( g = getgrgid( getgid() ) ) == NULL ) {
      fprintf( stderr, "getgrgid: NULL pointer\n" );
      return( EXIT_FAILURE );
    }
    printf( "group name:%s\n", g->gr_name );
    for( p = g->gr_mem; *p != NULL; p++ ) {
      printf( "\t%s\n", *p );
    }
    return( EXIT_SUCCESS );
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getgrent(), *getgrgid_r()*, *getgrnam()*

getgrgid_r()

Get information about the group with a given ID

Synopsis:

```
#include <sys/types.h>
#include <grp.h>

int getgrgid_r ( gid_t gid,
                 struct group* grp,
                 char* buffer,
                 size_t bufsize,
                 struct group** result );
```

Arguments:

gid	The ID of the group you want to get information about.
grp	A pointer to a **group** structure where the function can store information about the group.
buffer	A buffer from which to allocate any memory required.
bufsize	The size of the buffer.
result	The address of a pointer that *getgrgid_r()* sets to the same pointer as *grp* on success, or to NULL if the function can't find the group.

Library:

libc

Description:

If _POSIX_THREAD_SAFE_FUNCTIONS is defined, *getgrgid_r()* updates the group structure pointed by *grp* and stores a pointer to that structure at the location pointed by *result*. The structure contains an entry from the group database with a matching *gid*.

This function allocates storage referenced by the group structure from the memory provided with the *buffer* parameter, which is *bufsize* characters in size. You can determine the maximum size needed for

this *buffer* by calling *sysconf()* with an argument of _SC_GETGR_R_SIZE_MAX.

The *getgrgid_r()* stores a NULL pointer at the location pointed by *result* on error or if the requested entry isn't found.

Returns:

Zero for success, or an error number if an error occurred.

Errors:

ERANGE — Insufficient storage was supplied via *buffer* and *bufsize* to contain the resulting *group* structure.

The *getgrgid_r()* function uses the following functions, and as a result, *errno* can be set to an error for any of these calls:

- *fclose()*
- *fgets()*
- *fopen()*
- *fseek()*
- *rewind()*

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getgrgid(), getgrnam(), getgrnam_r(), getlogin(), sysconf()

getgrnam()

Get information about the group with a given name

Synopsis:

```
#include <sys/types.h>
#include <grp.h>

struct group* getgrnam( const char* name );
```

Arguments:

name The name of the group you want to get information about.

Library:

libc

Description:

The *getgrnam()* function lets a process gain more knowledge about the group named *name*. This function uses a static buffer that's overwritten by each call.

☞ The *getgrent()*, *getgrgid()*, and *getgrnam()* functions share the same static buffer.

Returns:

A pointer to an object of type **struct group** containing an entry from the group database with a matching name, or NULL on error or failure to find an entry with a matching name.

Examples:

```
/*
 * Print the name of all users in the group given in
 * argv[1]
 */
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <sys/types.h>
#include <grp.h>
```

```
int main( int argc, char** argv )
  {
    struct group* g;
    char** p;

    if( ( g = getgrnam( argv[1] ) ) == NULL ) {
       fprintf( stderr, "getgrnam: %s failed\n",
            argv[1] );
       return( EXIT_FAILURE );
    }
    printf( "group name:%s\n", g->gr_name );
    for( p = g->gr_mem; *p != NULL; p++ ) {
       printf( "\t%s\n", *p );
    }
    return( EXIT_SUCCESS );
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getgrent(), *getgrgid()*, *getgrnam_r()*

Synopsis:

```
#include <sys/types.h>
#include <grp.h>

int getgrnam_r( const char* name,
                struct group* grp,
                char* buffer,
                size_t bufsize,
                struct group** result );
```

Arguments:

name	The name of the group you want to get information about.
grp	A pointer to a **group** structure where the function can store information about the group.
buffer	A buffer from which to allocate any memory required.
bufsize	The size of the buffer.
result	The address of a pointer that *getgrgid_r()* sets to the same pointer as *grp* on success, or to NULL if the function can't find the group.

Library:

libc

Description:

If _POSIX_THREAD_SAFE_FUNCTIONS is defined, the *getgrnam_r()* function updates the group structure pointed by *grp* and stores a pointer to that structure at the location pointed by *result*. The structure contains an entry from the group database with a matching *name*.

This function allocates storage referenced by the group structure from the memory provided with the *buffer* parameter, which is *bufsize* characters in size. You can determine the maximum size needed for

this *buffer* by calling *sysconf()* with an argument of _SC_GETGR_R_SIZE_MAX.

The *getgrnam_r()* stores a NULL pointer at the location pointed by *result* on error or if the requested entry isn't found.

Returns:

Zero for success, or an error number if an error occurred.

Errors:

ERANGE — Insufficient storage was supplied via *buffer* and *bufsize* to contain the *group* structure.

The *getgrnam_r()* function uses the following functions, and as a result, *errno* can be set to an error for any of these calls:

- *fclose()*
- *fgets()*
- *fopen()*
- *fseek()*
- *rewind()*

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getgrgid(), getgrgid_r(), getgrnam(), getlogin(), sysconf()

getgrouplist()

Determine the group access list for a user

Synopsis:

```
#include <unistd.h>

int getgrouplist( const char *name,
                  gid_t basegid,
                  gid_t *groups,
                  int *ngroups );
```

Arguments:

name	The name of the user.
basegid	The *basegid* is automatically included in the list of groups. Typically this value is given as the group number from the password file.
groups	A pointer to an array where the function can store the group IDs.
ngroups	A pointer to the size of the *groups* array. The function sets the value pointed to by *ngroups* to be the actual number of groups found.

Library:

libc

Description:

The *getgrouplist()* function reads the group file and determines the group access list for the user specified in *name*.

Returns:

-1 if the size of the group list is too small to hold all the user's groups. The group array is filled with as many groups as fit.

Files:

`/etc/group` Group membership list.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *getgrouplist()* function uses the routines based on *getgrent()*. If the invoking program uses any of these routines, the group structure will be overwritten in the call to *getgrouplist()*.

See also:

initgroups(), *setgroups()*

getgroups()

Get the supplementary group IDs of the calling process

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

int getgroups( int gidsetsize,
               gid_t grouplist[] );
```

Arguments:

gidsetsize	The size of the *grouplist* array.
grouplist	An array that the function can fill in with the process's supplementary group IDs.

Library:

libc

Description:

The *getgroups()* function fills the array *grouplist* with the supplementary group IDs of the calling process. The values of array entries with indices greater than or equal to the returned value are undefined.

Returns:

The number of supplementary groups IDs; this value is zero if NGROUPS_MAX is zero. A value of -1 indicates an error (*errno* is set).

Errors:

EINVAL	The *gidsetsize* argument isn't equal to zero, and is less than the number of supplementary group IDs.

Examples:

```
/*
 * Print the supplementary group IDs of
 * the calling process.
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <unistd.h>

int main( void )
  {
    int     gidsize;
    gid_t   *grouplist;
    int     i;

    gidsize = getgroups( 0, NULL );
    grouplist = malloc( gidsize * sizeof( gid_t ) );
    getgroups( gidsize, grouplist );
    for( i = 0; i < gidsize; i++ )
      printf( "%d\n", ( int ) grouplist[i] );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, getegid(), geteuid(), getgid(), getuid(), setgroups()

gethostbyaddr()

Get a network host entry, given an Internet address

Synopsis:

```
#include <netdb.h>

struct hostent * gethostbyaddr( const void * addr,
                                socklen_t len,
                                int type );
```

Arguments:

addr	A pointer to the binary-format (i.e. not NULL-terminated) address in network byte order.
len	The length, in bytes, of *addr*.
type	The type of address. Currently, this must be AF_INET.

Library:

libsocket

Description:

The *gethostbyaddr()* function searches for information associated with a host, which has the address pointed to by *addr* within the address family specified by *type*, opening a connection to the database if necessary.

This function returns a pointer to a structure of type **hostent** that describes an Internet host. This structure contains either the information obtained from a name server, or broken-out fields from a line in **/etc/hosts**.

You can use *sethostent()* to request the use of a connected TCP socket for queries. If the *stayopen* flag is nonzero, all queries to the name server will use TCP and the connection will be retained after each call to *gethostbyaddr()* or *gethostbyname()*. If the *stayopen* flag is zero, queries use UDP datagrams.

Returns:

A pointer to a valid **hostent** structure, or NULL if an error occurs (*h_errno* is set).

Errors:

See *herror()*.

Examples:

Use the *gethostbyaddr()* function to find a host:

```
struct sockaddr_in  client;
struct hostent* host;

int sock, fd, len;

⋮

len = sizeof( client );

fd  = accept( sock, (struct sockaddr*)&client, &len );

if( fd == -1 ) {
    perror( "accept" );
    exit( 1 );
}

host = gethostbyaddr( (const void*)&client.sin_addr,
                      sizeof(struct in_addr),
                      AF_INET );

printf( "Connection from %s: (%s)\n",
        host ? host->h_name : "<unknown>",
        inet_ntoa( client.sin_addr ) );

⋮
```

Files:

/etc/hosts Host database file.

/etc/resolv.conf

Resolver configuration file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data storage; if you need the data for future use, copy it before any subsequent calls overwrite it. Currently, only the Internet address format is understood.

See also:

endhostent(), *gethostbyname()*, *gethostbyaddr_r()*, *gethostent()*, *herror()*, **hostent**, *sethostent()*

/etc/hosts, **/etc/resolv.conf** in the *Utilities Reference*

gethostbyaddr_r()

Get a network host entry, in a thread-safe manner

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <netdb.h>

struct hostent * gethostbyaddr_r(
                    const void * addr,
                    socklen_t length,
                    int type,
                    struct hostent * result,
                    char * buffer,
                    int buflen,
                    int * h_errnop );
```

Arguments:

addr	A pointer to the binary-format (i.e. not NULL-terminated) address in network byte order.
length	The length, in bytes, of *addr*.
type	The type of address. Currently, this must be AF_INET.
result	A pointer to a **struct hostent** where the function can store the host entry.
buffer	A pointer to a buffer that the function can use during the operation to store host database entries; *buffer* should be large enough to hold all of the data associated with the host entry. A 2K buffer is usually more than enough; a 256-byte buffer is safe in most cases.
buflen	The length of the area pointed to by *buffer*.
h_errnop	A pointer to a location where the function can store an *herrno* value if an error occurs.

Library:

libsocket

Description:

The *gethostbyaddr_r()* function is a thread-safe version of *gethostbyaddr()*. This function gets the network host entry for the host specified by *addr*. The *addr* argument is the network address of the specified network family, *type*. The buffer for *addr* is at least *length* bytes.

If you need to convert a text-based address into the format necessary for use as *gethostbyaddr_r()*'s *addr*, see *inet_pton()*.

Returns:

A pointer to *result*, or NULL if an error occurs.

Errors:

If an error occurs, the **int** pointed to by *h_errnop* is set to:

ERANGE — The supplied *buffer* isn't large enough to store the result.

HOST_NOT_FOUND — Authoritative answer: Unknown host.

NO_ADDRESS — No address associated with name; look for an MX record.

NO_DATA — Valid name, but no data record of the requested type. The name is known to the name server, but has no IP address associated with it — this isn't a temporary error. Another type of request to the name server using this domain name will result in an answer (e.g. a mail-forwarder may be registered for this domain).

NO_RECOVERY
: Unknown server error. An unexpected server failure was encountered. This is a nonrecoverable network error.

TRY_AGAIN
: Nonauthoritative answer: Host name lookup failure. This is usually a temporary error and means that the local server didn't receive a response from an authoritative server. A retry at some later time may succeed.

Files:

`/etc/hosts`
: Local host database file.

`/etc/resolv.conf`
: Resolver configuration file.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

gethostbyaddr(), *gethostbyname()*, *gethostbyname_r()*, *inet_ntop()*, *inet_pton()*

`/etc/hosts`, **`/etc/resolv.conf`** in the *Utilities Reference*

gethostbyname(), *gethostbyname2()*

Get a network host entry, given a name

Synopsis:

```
#include <netdb.h>

struct hostent * gethostbyname( const char * name );

struct hostent * gethostbyname2( const char * name,
                                 int af );
```

Arguments:

name The name of the Internet host whose entry you want to find.

af (*gethostbyname2()* only) The address family; one of:

- AF_INET
- AF_INET6

Library:

libsocket

Description:

The *gethostbyname()* routine gets the network host entry for a given name. It returns a pointer to a structure of type **hostent** that describes an Internet host. This structure contains either the information obtained from a name server, or broken-out fields from a line in **/etc/hosts**.

When using the name server, *gethostbyname()* searches for the named host in the current domain and in the domain's parents, unless the name ends in a dot.

If the name doesn't contain a dot, and the environment variable **HOSTALIASES** contains the name of an alias file, the alias file is first searched for an alias matching the input name. This file has the same form as **/etc/hosts**.

You can use *sethostent()* to request the use of a connected TCP socket for queries. If the *stayopen* flag is nonzero, all queries to the name server use TCP and the connection is retained after each call to *gethostbyname()* or *gethostbyaddr()*. If the *stayopen* flag is zero, queries use UDP datagrams.

The *gethostbyname2()* function is an evolution of the *gethostbyname()* function that lets you look up host names in address families other than AF_INET. If you specify an invalid address family, the function returns NULL and sets *h_errno* to NETDB_INTERNAL.

Returns:

A pointer to a valid **hostent** structure, or NULL if an error occurs (*h_errno* is set).

Errors:

See *herror()*.

Files:

/etc/hosts Host database file.

/etc/resolv.conf
Resolver configuration file.

For information about these files, see the *Utilities Reference*.

Environment variables:

HOSTALIASES

Name of the alias file that *gethostbyname()* is to search first when the hostname doesn't contain a dot.

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data storage; if you need the data for future use, copy it before any subsequent calls overwrite it.

See also:

endhostent(), *gethostbyaddr()*, *gethostbyname_r()*, *gethostent()*, *herror()*, **`hostent`**, *sethostent()*

`/etc/hosts`, **`/etc/resolv.conf`** in the *Utilities Reference*

gethostbyname_r()

Get a network host entry by name

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <netdb.h>

struct hostent * gethostbyname_r( const char * name,
                                  struct hostent * result,
                                  char * buffer,
                                  int bufflen,
                                  int * h_errnop );
```

Arguments:

name	The name of the Internet host whose entry you want to find.
result	A pointer to a **struct hostent** where the function can store the host entry.
buffer	A pointer to a buffer that the function can use during the operation to store host database entries; *buffer* should be large enough to hold all of the data associated with the host entry. A 2K buffer is usually more than enough; a 256-byte buffer is safe in most cases.
buflen	The length of the area pointed to by *buffer*.
h_errnop	A pointer to a location where the function can store an *herrno* value if an error occurs.

Library:

libsocket

Description:

The *gethostbyname_r()* function is a thread-safe version of *gethostbyname()*. This function gets the network host entry for the host specified by *name*, and stores the entry in the **`struct hostent`** pointed to by *result*.

Returns:

A pointer to *result*, or NULL if an error occurs.

Errors:

If an error occurs, the **`int`** pointed to by *h_errnop* is set to:

ERANGE	The supplied *buffer* isn't large enough to store the result.
HOST_NOT_FOUND	Authoritative answer: Unknown host.
NO_ADDRESS	No address associated with name; look for an MX record.
NO_DATA	Valid name, but no data record of the requested type. The name is known to the name server, but has no IP address associated with it — this isn't a temporary error. Another type of request to the name server using this domain name will result in an answer (e.g. a mail-forwarder may be registered for this domain).
NO_RECOVERY	Unknown server error. An unexpected server failure was encountered. This is a nonrecoverable network error.
TRY_AGAIN	Nonauthoritative answer: Host name lookup failure. This is usually a temporary error and means that the local server didn't receive a response from an

authoritative server. A retry at some later time may succeed.

Files:

/etc/hosts Local host database file.

/etc/resolv.conf
Resolver configuration file.

For information about these files, see the *Utilities Reference*.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

gethostbyaddr(), gethostbyaddr_r(), gethostbyname()

/etc/hosts, **/etc/resolv.conf** in the *Utilities Reference*

gethostent()

Read the next line of the host database file

Synopsis:

```
#include <netdb.h>

struct hostent * gethostent( void );
```

Library:

libsocket

Description:

The *gethostent()* routine reads the next line in the host database file.

Returns:

A pointer to a valid **hostent** structure, or NULL if an error occurs.

Files:

/etc/hosts Host database file.

/etc/resolv.conf
Resolver configuration file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data storage; if you need the data for future use, copy it before any subsequent calls overwrite it.

Currently, this function understands only the Internet address format.

See also:

endhostent(), *gethostbyaddr()*, *gethostbyname()*, *gethostent_r()*, **`hostent`**, *sethostent()*

`/etc/hosts`, **`/etc/resolv.conf`** in the *Utilities Reference*

gethostent_r()

Read the next line of the host database file

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <netdb.h>

struct hostent * gethostent_r( FILE ** hostf,
                               struct hostent * result,
                               char * buffer,
                               int buflen,
                               int * h_errnop );
```

Arguments:

hostf	NULL, or the address of the **FILE *** pointer associated with the host database file.
result	A pointer to a **struct hostent** where the function can store the host entry.
buffer	A pointer to a buffer that the function can use during the operation to store host database entries; *buffer* should be large enough to hold all of the data associated with the host entry. A 2K buffer is usually more than enough; a 256-byte buffer is safe in most cases.
buflen	The length of the area pointed to by *buffer*.
h_errnop	A pointer to a location where the function can store an *herrno* value if an error occurs.

Library:

libsocket

Description:

The *gethostent_r()* function is a thread-safe version of the *gethostent()* function. This function gets the local host's entry. If the pointer pointed to by *hostf* is NULL, *gethostent_r()* opens **/etc/hosts** and returns its file pointer in *hostf* for later use. It's the calling process's responsibility to close the host file with *fclose()*.

☞ The first time that you call *gethostent_r()*, pass NULL in the pointer pointed to by *hostf*.

Returns:

A pointer to *result*, or NULL if an error occurs.

Errors:

If an error occurs, the **int** pointed to by *h_errnop* is set to:

ERANGE — The supplied *buffer* isn't large enough to store the result.

HOST_NOT_FOUND — Authoritative answer: Unknown host.

NO_ADDRESS — No address associated with name, look for an MX record.

NO_DATA — Valid name, no data record of the requested type. The name is known to the name server, but has no IP address associated with it — this isn't a temporary error. Another type of request to the name server using this domain name will result in an answer (e.g. a mail-forwarder may be registered for this domain).

NO_RECOVERY — Unknown server error. An unexpected server failure was encountered. This is a nonrecoverable network error.

TRY_AGAIN	Nonauthoritative answer: Host name lookup failure. This is usually a temporary error and means that the local server didn't receive a response from an authoritative server. A retry at some later time may succeed.

Files:

`/etc/hosts`	Local host database file.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

endhostent(), *gethostent()*, *sethostent()*

`/etc/hosts` in the *Utilities Reference*

gethostname()

Get the name of the current host

Synopsis:

```
#include <unistd.h>

int gethostname( char * name,
                 size_t namelen );
```

Arguments:

name	A buffer where the function can store the host name.
namelen	The size of the buffer.

Library:

libc

Description:

The *gethostname()* function stores in *name* the standard hostname for the current processor, as previously set by *sethostname()*. The parameter *namelen* specifies the size of the *name* array. The returned name is NULL-terminated unless insufficient space is provided.

This function gets the value of the **_CS_HOSTNAME** configuration string, not that of the **HOSTNAME** environment variable.

Returns:

0	Success.
-1	An error occurred (*errno* **isn't** set).

Classification:

Standard Unix, POSIX 1003.1g (draft)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Hostnames are limited to MAXHOSTNAMELEN characters (defined in **<sys/param.h>**).

See also:

sethostname()

getifaddrs()

Get a network interface address

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>
#include <ifaddrs.h>

int getifaddrs( struct ifaddrs ** ifap );
```

Arguments:

ifap The address of a location where the function can store a pointer to a linked list of **ifaddrs** structures that contain the data related to the network interfaces on the local machine.

Library:

libsocket

Description:

The *getifaddrs()* function stores a reference to a linked list of the network interfaces on the local machine in the memory referenced by *ifap*.

The data returned by *getifaddrs()* is dynamically allocated; you should free it by calling *freeifaddrs()* when you no longer need it.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

The *getifaddrs()* function may fail and set *errno* for any of the errors specified by:

- *ioctl()*
- *malloc()*

- *socket()*
- *sysctl()*

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *freeifaddrs()*, **`ifaddrs`**, *ioctl()*, *malloc()*, *socket()*, *sysctl()*

GETIOVBASE()

Get the base member of an **iov_t** *structure*

Synopsis:

```
#include <unistd.h>

#define GETIOVBASE( _iov ) ...
```

Arguments:

_iov The **iov_t** structure from which you want to get the base member.

Library:

libc

Description:

This macro evaluates to the *iov_base* member of the given **iov_t** structure.

Returns:

The *iov_base* member of the **iov_t** structure, which is of type **void ***.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

GETIOVLEN(), SETIOV()

GETIOVLEN()

Get the length member of an **iov_t** *structure*

Synopsis:

```
#include <unistd.h>

#define GETIOVLEN( _iov ) ...
```

Arguments:

_iov The **iov_t** structure from which you want to get the length member.

Library:

libc

Description:

This macro evaluates to the *iov_len* member of the given **iov_t** structure.

Returns:

The *iov_len* member of the **iov_t** structure, which is of type **size_t**.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

GETIOVBASE(), SETIOV()

getitimer()

Get the value of an interval timer

Synopsis:

```
#include <sys/time.h>

int getitimer ( int which,
                struct itimerval *value );
```

Arguments:

which The interval time whose value you want to get. Currently, this must be ITIMER_REAL.

value A pointer to a **itimerval** structure where the function can store the value of the interval timer.

Library:

libc

Description:

The system provides each process with several interval timers, defined in **<sys/time.h>**. The *getitimer()* function stores the current value of the timer specified by *which* into the structure pointed to by *value*.

A timer value is defined by the **itimerval** structure (see *gettimeofday()* for the definition of **timeval**), which includes the following members:

```
struct timeval    it_interval;    /* timer interval */
struct timeval    it_value;       /* current value */
```

The *it_value* member indicates the time to the next timer expiration. The *it_interval* member specifies a value to be used in reloading *it_value* when the timer expires. Setting *it_value* to 0 disables a timer, regardless of the value of *it_interval*. Setting *it_interval* to 0 disables a timer after its next expiration (assuming *it_value* is nonzero).

Time values smaller than the resolution of the system clock are rounded up to the resolution of the system clock.

The interval timers include:

ITIMER_REAL	Decrements in real time. A SIGALRM signal is delivered when this timer expires.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EINVAL	The specified number of seconds is greater than 100,000,000, the number of microseconds is greater than or equal to 1,000,000, or the *which* argument is unrecognized.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

alarm(), gettimeofday(), pthread_attr_setscope(), pthread_sigmask(), setitimer(), sigprocmask(), sleep(), sysconf()

getlogin()

Get the user name associated with the calling process

Synopsis:

```
#include <unistd.h>

char* getlogin( void ) ;
```

Library:

libc

Description:

The *getlogin()* function returns a pointer to a string containing the login name of the user associated with the calling process.

Returns:

A pointer to a string containing the user's login name, or NULL if the user's login name can't be found.

The return value from *getlogin()* may point to static data and, therefore, may be overwritten by each call.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getlogin_r(), *getpwnam()*, *getpwuid()*

getlogin_r()

Get the user name associated with the calling process

Synopsis:

```
#include <unistd.h>

int getlogin_r( char* name,
                size_t namesize );
```

Arguments:

name	A buffer where the function can store the user name.
namesize	The size of the buffer.

Library:

libc

Description:

If _POSIX_THREAD_SAFE_FUNCTIONS is defined, the *getlogin_r()* function puts the login name of the user associated with the calling process in the character array pointed to by *name*. The array is *namesize* characters long and should have space for the name and the terminating NULL character. The maximum size of the login name is _POSIX_LOGIN_NAME_MAX.

If *getlogin_r()* is successful, *name* points to the name the user used at login, even if there are several login names with the same user ID.

Returns:

EOK	Success.
ERANGE	Insufficient storage was supplied via the *name* and *namesize* arguments to contain the user's name.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getlogin(), getpwnam(), getpwnam_r(), getpwuid(), getpwuid_r()

Perform address-to-nodename translation in protocol-independent manner

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>
#include <netdb.h>

int getnameinfo(const struct sockaddr *sa,
                socklen_t salen,
                char *host, size_t hostlen,
                char *serv, size_t servlen,
                int flags);
```

Arguments:

sa Points to either a **sockaddr_in** structure (for IPv4) or a **sockaddr_in6** structure (for IPv6) that holds the IP address and port number.

salen Length of the **sockaddr_in** or **sockaddr_in6** structure.

host Buffer pointer for the host.

hostlen Size of the host buffer.

serv Buffer pointer for the server.

servlen Length of the server buffer.

flags Change the default action of *getnameinfo()*. By default, the fully qualified domain name (FQDN) for the host is looked up in the DNS and returned.

These flags are defined in **<netdb.h>**:

NI_NOFQDN Only the nodename portion of the FQDN is returned for local hosts.

NI_NUMERICHOST

If set, or if the host's name can't be located in the DNS, the numeric form

of the host's address is returned instead of its name (e.g. by calling *inet_ntop()* instead of *getnodebyaddr()*).

NI_NAMEREQD — If set, an error is returned when the host's name can't be located in the DNS.

NI_NUMERICSERV — If set, the numeric form of the service address (instead of its name) is returned e.g. its port number. You may require two NI_NUMERIC*xxx* flags to support the **-n** flag that many commands provide.

NI_DGRAM — Specify that the service is a datagram service. Call *getservbyport()* with a second argument of *udp* instead of its default of *tcp*. This is required for the few ports (512-514) that have different services for UDP and TCP.

Library:

libsocket

Description:

The *getnameinfo()* function defines and performs protocol-independent address-to-nodename translation. You can think of it as implementing the reverse-functionality of *getaddrinfo()* or similar functionality of *gethostbyaddr()* or *getservbypor()*.

This function looks up an IP address and port number provided by the caller in the DNS and system-specific database. For both IP address and port number, the *getnameinfo()* function returns text strings in respective buffers provided by the caller. The function indicates successful completion by a zero return value; a non-zero return value indicates failure.

The *getnameinfo()* function returns the nodename associated with the IP address in the buffer pointed to by the *host* argument. The *hostlen* argument gives the length of this buffer.

The *getnameinfo()* function returns the service name associated with the port number in the buffer pointed to by the *serv* argument. The *servlen* argument gives the length of this buffer.

Specify zero for *hostlen* or *servlen* when the caller chooses not to return either string. Otherwise, the caller must provide buffers large enough to hold the nodename and the service name, including the terminating null characters.

Most systems don't provide constants that specify the maximum size of either a FQDN or a service name. In order to aid your application in allocating buffers, the following constants are defined in **<netdb.h>**:

```
#define NI_MAXHOST  1025
#define NI_MAXSERV    32
```

You may find the first value as the constant MAXDNAME in recent versions of BIND's **<arpa/nameser.h>**; older versions of BIND define this constant to be 256. The second value is a guess based on the services listed in the current Assigned Numbers RFC. BIND (Berkeley Internet Name Domain) is a suite of functionalities that implements Domain Name System (DNS) protocols.

Extension

The implementation allows experimental numeric IPv6 address notation with scope identifier. An IPv6 link-local address appears as string like **fe80::1%ne0**, when the NI_WITHSCOPEID bit is enabled in the *flags* argument. See *getaddrinfo()* for the notation.

Returns:

0 Success.

Non-zero value

An error occurred (see below).

Errors:

EAI_AGAIN	The name couldn't be resolved at this time. Future attempts may succeed.
EAI_BADFLAGS	The flags had invalid values.
EAI_FAIL	A nonrecoverable error occurred.
EAI_FAMILY	The address family wasn't recognized or the address length was invalid for the specified family.
EAI_MEMORY	There was a memory allocation failure.
EAI_NONAME	The name doesn't resolve for the supplied parameters. NI_NAMEREQD is set and the host's name can't be located, or both *node* name and *serv* name were null.
EAI_SYSTEM	A system error occurred. The error code can be found in *errno*.

Examples:

The following code gets the numeric hostname and the service name for a given socket address. There is no hardcoded reference to a particular address family.

```
struct sockaddr *sa;    /* input */
char hbuf[NI_MAXHOST], sbuf[NI_MAXSERV];

if (getnameinfo(sa, sa->sa_len, hbuf, sizeof(hbuf), sbuf,
   sizeof(sbuf), NI_NUMERICHOST | NI_NUMERICSERV)) {
   errx(1, "could not get numeric hostname");
   /*NOTREACHED*/
   }
   printf("host=%s, serv=%s\n", hbuf, sbuf);
```

The following version checks if the socket address has reverse address mapping.

```
struct sockaddr *sa;    /* input */
char hbuf[NI_MAXHOST];
```

```
if (getnameinfo(sa, sa->sa_len, hbuf, sizeof(hbuf), NULL, 0,
   NI_NAMEREQD)) {
   errx(1, "could not resolve hostname"); /*NOTREACHED*/
   }
   printf("host=%s\n", hbuf);
```

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getaddrinfo(), *gethostbyaddr()*, *getservbyport()*, **/etc/hosts**, **/etc/resolv.conf**, **/etc/services**, **named**

getnetbyaddr()

Get a network entry, given an address (Unix)

Synopsis:

```
#include <netdb.h>

struct netent * getnetbyaddr( uint32_t net,
                              int type );
```

Arguments:

net The net address whose network entry you want to find.

type The address type. This must currently be AF_INET.

Library:

libsocket

Description:

The *getnetbyaddr()* function gets an entry for the given address, *net*, from the network database, **/etc/networks**.

This function returns a pointer to a structure of type **netent**, which contains the broken-out fields of a line in the network database.

The *setnetent()* function opens and rewinds the file. If you pass a nonzero *stayopen* argument to *setnetent()*, the network database isn't closed after each call to *getnetbyname()*, or *getnetbyaddr()*.

The *getnetbyname()* and *getnetbyaddr()* functions sequentially search from the beginning of the file until a matching net name or net address and type is found, or until EOF is encountered. Network numbers are supplied in host order.

Returns:

A pointer to a valid **netent** structure, or NULL if an error occurs.

Files:

/etc/networks

Network name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if you need the data for future use, copy it before any subsequent calls overwrite it.

Only Internet network numbers are currently understood.

See also:

endnetent(), *getnetbyname()*, *getnetent()*, **netent**, *setnetent()*

/etc/networks in the *Utilities Reference*

getnetbyname()

Get a network entry, given a name

Synopsis:

```
#include <netdb.h>

struct netent * getnetbyname( const char * name );
```

Arguments:

name The name of the network whose entry you want to find.

Library:

libsocket

Description:

The *getnetbyname()* function gets the network entry for the given name. This function returns a pointer to a structure of type **netent**, which contains the broken-out fields of a line in the network database, **/etc/networks**.

The *setnetent()* function opens and rewinds the file. If you pass a nonzero *stayopen* argument to *setnetent()*, the network database isn't closed after each call to *getnetbyname()* or *getnetbyaddr()*.

The *getnetbyaddr()* and *getnetbyname()* functions sequentially search from the beginning of the file until a matching net name or net address and type is found, or until EOF is encountered. Network numbers are supplied in host order.

Returns:

A pointer to a valid **netent** structure, or NULL if an error occurs.

Files:

/etc/networks

Network name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

endnetent(), *getnetbyaddr()*, *getnetent()*, **`netent`**, *setnetent()*

`/etc/networks` in the *Utilities Reference*

getnetent()

Read the next line of the network name database file

Synopsis:

```
#include <netdb.h>

struct netent * getnetent( void );
```

Library:

libsocket

Description:

The *getnetent()* function reads the next line of the network name database file, opening the file if necessary. It returns a pointer to a structure of type **netent**, which contains the broken-out fields of a line in the network database, **/etc/networks**.

Returns:

A pointer to a valid **netent** structure, or NULL if an error occurs.

Files:

/etc/networks

Network name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

endnetent(), *getnetbyaddr()*, *getnetbyname()*, **`netent`**, *setnetent()*

`/etc/networks` in the *Utilities Reference*

getopt()

Parse options from a command line

Synopsis:

```
#include <unistd.h>

int getopt( int argc,
            char * const argv[],
            const char * optstring );

extern char * optarg;
extern int optind, opterr, optopt;
```

Arguments:

argc	The argument count that was passed to *main()*.
argv	The argument array that was passed to *main()*.
optstring	A string of recognized option letters; if a letter is followed by a colon, the option takes an argument. Valid option characters for *optstring* consist of a single alphanumeric character (i.e. a letter or digit).

Library:

libc

Description:

The *getopt()* function is a command-line parser that can be used by applications that follow the Utility Syntax Guidelines described below.

The *optind* global variable is the index of the next element of the *argv*[] vector to be processed. The system initializes *optind* to 1 when the program is loaded, and *getopt()* updates it when it finishes with each element of *argv*[]. Reset *optind* to 1 if you want to use *getopt()* to process additional argument sets.

The *getopt()* function returns the next option character from *argv* that matches a letter in *optstring*, if there's one that matches. If the option

takes an argument, *getopt()* sets the global variable *optarg* to point to the option argument as follows:

1. If the option is the last letter in the string pointed to by an element of *argv*, then *optarg* contains the next element of *argv*, and *optind* is incremented by 2.
2. Otherwise, *optarg* points to the string following the option letter in that element of *argv*, and *optind* is incremented by 1.

The *getopt()* function returns -1 is returned and doesn't change *optind* if:

- *argv*[*optind*] is NULL
- **argv*[*optind*] isn't the character `'-'`
- *argv*[*optind*] points to the string `"-"`.

This function returns -1 after incrementing *optind*, if:

- *argv*[*optind*] points to the string `"--"`.

If *getopt()* encounters an option character that isn't contained in *optstring*, it returns the `?` character. If it detects a missing option argument, it returns `:` if the first character of *optstring* is a colon, or `?` otherwise. In both cases, *getopt()* sets *optopt* to the option character that caused the error.

The *getopt()* always prints a diagnostic message to *stderr* unless *opterr* is set to 0, or the first character of *optstring* is a `:` character.

Utility Syntax Guidelines

The *getopt()* function may be used by applications that follow these guidelines:

- When describing the syntax of a utility, the options are listed in alphabetical order. There's no implied relationship between the options based upon the order in which they appear, unless otherwise stated in the Options section, or:

- the options are documented as mutually-exclusive and such an option is documented to override any incompatible options preceding it
- when an option has option arguments repeated, the option and option argument combinations are interpreted in the order specified on the command line.

If an option that doesn't have option arguments is repeated, the results depend on the application.

- Names of parameters that require substitution by actual values may be shown with embedded underscores or as **<***parameter name***>**. Angle brackets are used for the symbolic grouping of a phrase representing a single parameter and portable applications shouldn't include them in data submitted to the utility.
- Options may be documented individually, or grouped (if they don't take option arguments):

```
utility_name [-a] [-b] [-c option_argument]
             [-d|-e] [-foption_argument] [operand...]
```

Or:

```
utility_name [-ab] [-c option_argument]
             [-d|-e] [-foption_argument] [operand...]
```

Utilities with very complex arguments may be shown as:

```
utility_name [options] [operand]
```

- Unless specified, whenever an operand or option argument is, or contains, a numeric value:
  - the number is interpreted as a decimal integer
  - numerals in the range 0 to 2,147,483,647 are syntactically recognized as numeric values
  - when the utility description states that it accepts negative numbers as operands or option arguments, numerals in the

range -2,147,483,647 to 2,147,483,647 are syntactically recognized as numeric values

- ranges greater than those listed here are allowed.

All numbers within the allowable range aren't necessarily semantically correct. A standard utility that accepts an option argument or operand that's to be interpreted as a number, and for which a range of values smaller than that shown above is permitted, describes that smaller range along with the description of the option argument or operand. If an error is generated, the utility's diagnostic message indicates that the value is out of the supported range, not that it's syntactically incorrect.

- Arguments or option arguments enclosed in the "[" and "]" notation are optional and can be omitted. Portable applications shouldn't include the "[" and "]" symbols in data submitted to the utility.

- Ellipses (. . .) are used to denote that one or more occurrences of an option or operand are allowed. When an option or an operand followed by ellipses is enclosed in brackets, zero or more options or operands may be specified. The forms:

  utility_name -f *option_argument*...**[***operand*...**]**
  utility_name [-g *option_argument***]...[***operand*...**]**

  indicate that multiple occurrences of the option and its option argument preceding the ellipses are valid, with semantics as indicated in the Options section of the utility. In the first example, each option argument requires a preceding **-f** and at least one **-f***option_argument* must be given.

- When the synopsis is too long to be printed on a single line in the documentation, the indented lines following the initial line are continuation lines. An actual use of the command appears on a single logical line.

Returns:

The next option character specified on the command line; a colon if a missing argument is detected and the first character of *optstring* is a colon; a question mark if an option character is encountered that's not in *optstring* and the first character of *optstring* isn't a colon; otherwise, -1 when all command line options have been parsed.

Examples:

```
#include <unistd.h>
#include <stdlib.h>
#include <stdio.h>

int main( int argc, char* argv[] )
  {
    int c, errflag = 0;

    while( ( c = getopt( argc, argv, "abt:" ) )
      != -1 ) {
      switch( c ) {
        case 'a': printf( "apples\n" );
                  break;
        case 'b': printf( "bananas\n" );
                  break;
        case 't': printf( "tree = %s\n", optarg );
                  break;
        case '?': ++errflag;
                  break;
      }
    }
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	No

See also:

getsubopt(), stderr

Guidelines 3,4,5,6,7,9 and 10 in the *Base Definitions* volume of the IEEE Std.1003.1-2001, Section 12.2, *Utility Syntax Guidelines*.

getpass()

Prompt for and read a password

Synopsis:

```
#include <unistd.h>

char *getpass( const char *prompt );
```

Arguments:

prompt The string you want to display to prompt for the password.

Library:

libc

Description:

The *getpass()* function can be used to get a password. It opens the current terminal, displays the given *prompt*, suppresses echoing, reads up to 32 characters into a static buffer, and restores echoing. This function adds a null character to the end of the string, but ignores additional characters and the newline character.

Returns:

A pointer to the static buffer.

Classification:

Legacy Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function leaves its result in an internal static buffer and returns a pointer to it. Subsequent calls to *getpass()* modify the same buffer. The calling process should zero the password as soon as possible to avoid leaving the clear-text password visible in the process's address space.

See also:

crypt()

getpeername()

Get the name of the peer connected to a socket

Synopsis:

```
#include <sys/socket.h>

int getpeername( int s,
                 struct sockaddr * name,
                 socklen_t * namelen );
```

Arguments:

s	The socket whose connected peer you want to get.
name	A buffer where the function can store the name of the peer.
namelen	A pointer to a **socklen_t** object that initially specifies the size of the buffer. This function stores the actual size of the name, in bytes, in this object.

Library:

libsocket

Description:

The *getpeername()* function returns the name of the peer connected to socket *s*. The name is truncated if the buffer provided is too small.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EBADF	Invalid descriptor *s*.
EFAULT	The *name* parameter points to memory *not* in a valid part of the process address space.

ENOBUFS	Insufficient resources were available in the system to perform the operation.
ENOTCONN	The socket isn't connected.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

accept(), bind(), getsockname(), socket()

getpgid()

Get a process group ID

Synopsis:

```
#include <unistd.h>

pid_t getpgid( pid_t pid );
```

Arguments:

pid The ID of the process whose process group ID you want to get.

Library:

libc

Description:

The *getpgid()* returns the group ID for the process specified by *pid*. If *pid* is 0, *getpgid()* returns the calling process's group ID.

The following definitions are worth mentioning:

Process	An executing instance of a program, identified by a nonnegative integer called a process ID.
Process group	A collection of one or more processes, with a unique process group ID. A process group ID is a positive integer.

Returns:

A process group ID for success, or (**pid_t**)-1 if an error occurs.

Errors:

If an error occurs, *errno* is set to:

ESRCH	The process specified by *pid* doesn't exist.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

getsid(), setpgid(), setsid()

getpgrp()

Get the process group

Synopsis:

```
#include <sys/types.h>
#include <process.h>

pid_t getpgrp( void );
```

Library:

libc

Description:

The *getpgrp()* function gets the ID of the process group to which the calling process belongs.

Returns:

The calling process's process group ID.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <process.h>
#include <sys/types.h>

int main( void )
  {
    printf( "I am in process group %d\n", (int) getpgrp() );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

setpgrp(), setsid()

getpid()

Get the process ID

Synopsis:

```
#include <process.h>

pid_t getpid( void );
```

Library:

libc

Description:

The *getpid()* function gets the process ID for the calling process.

Returns:

The process ID of the calling process.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <process.h>

int main ( void )
{
    printf( "I'm process %d\n", getpid() );
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes

continued...

Safety	
Thread	Yes

See also:

getppid()

getppid()

Get the parent process ID

Synopsis:

```
#include <sys/types.h>
#include <process.h>

pid_t getppid( void );
```

Library:

libc

Description:

The *getppid()* function gets the process ID of the parent of the calling process.

Returns:

The calling process's parent's process ID.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <process.h>

int main( void )
  {
    printf( "My parent is %d\n", getppid() );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

getpid()

getprio()

Get the priority of a given process

Synopsis:

```
#include <sched.h>

int getprio( pid_t pid );
```

Arguments:

pid The process ID of the process whose priority you want to get.

Library:

libc

Description:

The *getprio()* function returns the current priority of thread 1 in process *pid*. If *pid* is zero, the priority of the calling thread is returned.

Returns:

The priority, or -1 if an error occurred (*errno* is set).

Errors:

ESRCH The process *pid* doesn't exist.

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *getprio()* and *setprio()* functions are included in the QNX Neutrino libraries for porting QNX 4 applications. For new programs, use *sched_getparam()* or *pthread_getschedparam()*.

See also:

errno, *pthread_getschedparam()*, *pthread_setschedparam()*, *sched_get_priority_max()*, *sched_get_priority_min()*, *sched_getparam()*, *sched_getscheduler()*, *sched_setscheduler()*, *sched_yield()*, *setprio()*

getprotobyname()

Get a protocol entry, given a name

Synopsis:

```
#include <netdb.h>

struct protoent * getprotobyname( const char * name );
```

Arguments:

name The name of the protocol whose entry you want to get.

Library:

libsocket

Description:

The *getprotobyname()* function gets the entry for the given name from the protocol database, **/etc/protocols**. This function returns a pointer to a structure of type **protoent**, which contains the broken-out fields of a line in the network protocol database.

The *setprotoent()* function opens and rewinds the file. If you pass a nonzero *stayopen* argument to *setprotoent()*, the protocol database isn't closed after each call to *getprotobyname()* or *getprotobynumber()*.

The *getprotobyname()* and *getprotobynumber()* functions sequentially search from the beginning of the file until a matching protocol name or protocol number is found, or until EOF is encountered.

Returns:

A pointer to a valid **protoent** structure, or NULL if an error occurs.

Files:

/etc/protocols

Protocol name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if you need the data for future use, copy it before any subsequent calls overwrite it.

Currently, only the Internet protocols are understood.

See also:

endprotoent(), *getprotobynumber()*, *getprotoent()*, **`protoent`**, *setprotoent()*

`/etc/protocols` in the *Utilities Reference*

getprotobynumber()

Get a protocol entry, given a number

Synopsis:

```
#include <netdb.h>

struct protoent * getprotobynumber( int proto );
```

Arguments:

proto The protocol number whose entry you want to get.

Library:

libsocket

Description:

The *getprotobynumber()* function gets the protocol entry for the given number. It returns a pointer to structure of type **protoent**, which contains the broken-out fields of a line in the network protocol database, **/etc/protocols**.

The *setprotoent()* function opens and rewinds the file. If you pass a nonzero *stayopen* argument to *setprotoent()*, the protocol database isn't closed after each call to *getprotobyname()* or *getprotobynumber()*.

The *getprotobyname()* and *getprotobynumber()* functions sequentially search from the beginning of the file until a matching protocol name or protocol number is found, or until EOF is encountered.

Returns:

A pointer to a valid **protoent** structure, or NULL if an error occurs.

Files:

/etc/protocols

Protocol name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if you need the data for future use, copy it before any subsequent calls overwrite it.

Currently, only the Internet protocols are understood.

See also:

endprotoent(), *getprotobyname()*, *getprotoent()*, **`protoent`**, *setprotoent()*

`/etc/protocols` in the *Utilities Reference*

getprotoent()

Read the next line of the protocol name database file

Synopsis:

```
#include <netdb.h>

struct protoent * getprotoent( void );
```

Library:

libsocket

Description:

The *getprotoent()* function reads the next line of the protocol name database file, opening the file if necessary. It returns a pointer to a structure of type **protoent**, which contains the broken-out fields of a line in the network protocol database, **/etc/protocols**.

Returns:

A pointer to a valid **protoent** structure, or NULL if an error occurs.

Files:

/etc/protocols

Protocol name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if you need the data for future use, copy it before any subsequent calls overwrite it.

Currently, only the Internet protocols are understood.

See also:

endprotoent(), *getprotobyname()*, *getprotobynumber()*, **protoent**, *setprotoent()*

/etc/protocols in the *Utilities Reference*

getpwent()

Get an entry from the password database

Synopsis:

```
#include <sys/types.h>
#include <pwd.h>

struct passwd* getpwent( void );
```

Library:

libc

Description:

The *getpwent()* function returns the next entry from the password database. This function uses a static buffer that's overwritten by each call.

The *getpwent()*, *getpwnam()*, and *getpwuid()*, functions share the same static buffer.

Returns:

A pointer to an object of type **struct passwd** containing the next entry from the password database. When *getpwent()* is first called, the password database is opened, and remains open until either a NULL is returned to signify end-of-file, or *endpwent()* is called.

Errors:

The *getpwent()* function uses the following functions, and as a result, *errno* can be set to an error for any of these calls:

- *fclose()*
- *fgets()*
- *fopen()*
- *fseek()*
- *rewind()*

Examples:

```
/*
 * This program loops, reading a login name from standard
 * input and checking to see if it is a valid name. If it
 * is not valid, the entire contents of the name in the
 * password database are printed.
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <pwd.h>

int main( void )
  {
    struct passwd* pw;
    char    buf[80];

    setpwent( );
    while( gets( buf ) != NULL ) {
      if( ( pw = getpwnam( buf ) ) != ( struct passwd * )0 ) {
        printf( "Valid login name is: %s\n", pw->pw_name );
      } else {
        setpwent( );
        while( ( pw=getpwent( ) ) != ( struct passwd * )0 )
          printf( "%s\n", pw->pw_name );
      }
    }
    endpwent();
    return( EXIT_SUCCESS );
  }
```

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

endpwent(), errno, getgrent(), getlogin(), getpwnam(), getpwuid(), setpwent()

getpwnam()

Get information about the user with a given name

Synopsis:

```
#include <sys/types.h>
#include <pwd.h>

struct passwd* getpwnam( const char* name );
```

Arguments:

name The name of the user whose entry you want to find.

Library:

libc

Description:

The *getpwnam()* function gets information about the user with the given *name*. It uses a static buffer that's overwritten by each call.

The *getpwent()*, *getpwnam()*, and *getpwuid()* functions share the same static buffer.

The *getpwnam_r()* function is a reentrant version of *getpwnam()*.

Returns:

A pointer to an object of type **struct passwd** containing an entry from the group database with a matching *name*. A NULL pointer is returned on error or failure to find a entry with a matching *name*.

Examples:

```
/*
 * Print information from the password entry
 * about the user name given as argv[1].
 */
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <sys/types.h>
```

```
#include <pwd.h>

int main( int argc, char* *argv )
  {
    struct passwd* pw;

    if( ( pw = getpwnam( argv[1] ) ) == NULL ) {
      fprintf( stderr, "getpwnam: unknown %s\n",
        argv[1] );
      return( EXIT_FAILURE );
    }
    printf( "login name  %s\n", pw->pw_name );
    printf( "user id     %d\n", pw->pw_uid );
    printf( "group id    %d\n", pw->pw_gid );
    printf( "home dir    %s\n", pw->pw_dir );
    printf( "login shell %s\n", pw->pw_shell );
    return( EXIT_SUCCESS );
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getlogin(), getpwent(), getpwnam_r() getpwuid()

getpwnam_r()

Get information about the user with a given name

Synopsis:

```
#include <sys/types.h>
#include <pwd.h>

int getpwnam_r( const char* name,
                struct passwd* pwd,
                char* buffer,
                size_t bufsize,
                struct passwd* result );
```

Arguments:

name	The name of the user whose entry you want to find.
pwd	A pointer to a **passwd** structure where the function can store the entry.
buffer	A block of memory that the function can use to allocate storage referenced by the **passwd** structure. You can determine the maximum size needed for this buffer by calling *sysconf()* with an argument of _SC_GETPW_R_SIZE_MAX.
bufsize	The size of the block that *buffer* points to, in characters.
result	The address of a pointer to a **passwd** structure. If *getpwnam_r()* finds the entry, it stores a pointer to *pwd* in the location indicated by *result*; otherwise the function stores a NULL pointer there.

Library:

libc

Description:

The *getpwnam_r()* function is a reentrant version of *getpwnam()*. It gets information about the user with the given *name*.

If _POSIX_THREAD_SAFE_FUNCTIONS is defined, the *getpwnam_r()* function updates the **passwd** structure pointed to by *pwd* and stores a pointer to that structure at the location pointed by *result*. The structure contains an entry from the user database with the given *name*.

The function stores a NULL pointer at the location pointed by *result* on error or if it can't find the requested entry.

Returns:

Zero for success, or an error number.

Errors:

ERANGE — Insufficient storage was supplied via *buffer* and *bufsize* to contain the resulting *passwd* structure.

The *getpwnam_r()* function uses the following functions, and as a result, *errno* can be set to an error for any of these calls:

- *fclose()*
- *fgets()*
- *fopen()*
- *fseek()*
- *rewind()*

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getlogin(), *getpwent()*, *getpwnam()*, *getpwuid()*, *getpwuid_r()*

getpwuid()

Get information about the user with a given ID

Synopsis:

```
#include <sys/types.h>
#include <pwd.h>

struct passwd* getpwuid( uid_t uid );
```

Arguments:

uid The userid whose entry you want to find.

Library:

libc

Description:

The *getpwuid()* function gets information about user *uid*. This function uses a static buffer that's overwritten by each call.

The *getpwent()*, *getpwnam()*, and *getpwuid()* functions share the same static buffer.

Returns:

A pointer to an object of type **struct passwd** containing an entry from the group database with a matching *uid*, or NULL if an error occurred or the function couldn't find a matching entry.

Examples:

```
/*
 * Print password info on the current user.
 */
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <sys/types.h>
#include <pwd.h>

int main( void )
```

```
{
  struct passwd* pw;

  if( ( pw = getpwuid( getuid() ) ) == NULL ) {
     fprintf( stderr,
        "getpwuid: no password entry\n" );
     return( EXIT_FAILURE );
  }
  printf( "login name  %s\n", pw->pw_name );
  printf( "user id     %d\n", pw->pw_uid );
  printf( "group id    %d\n", pw->pw_gid );
  printf( "home dir    %s\n", pw->pw_dir );
  printf( "login shell %s\n", pw->pw_shell );
  return( EXIT_SUCCESS );
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getlogin(), getpwent(), getpwnam()

getpwuid_r()

Get information about the user with a given ID

Synopsis:

```
#include <sys/types.h>
#include <pwd.h>

int getpwuid_r( uid_t uid,
                struct passwd* pwd,
                char* buffer,
                size_t bufsize,
                struct passwd** result );
```

Arguments:

uid	The userid whose entry you want to find.
pwd	A pointer to a **passwd** structure where the function can store the entry.
buffer	A block of memory that the function can use to allocate storage referenced by the **passwd** structure. You can determine the maximum size needed for this buffer by calling *sysconf()* with an argument of _SC_GETPW_R_SIZE_MAX.
bufsize	The size of the block that *buffer* points to, in characters.
result	The address of a pointer to a **passwd** structure. If *getpwnam_r()* finds the entry, it stores a pointer to *pwd* in the location indicated by *result*; otherwise the function stores a NULL pointer there.

Library:

libc

Description:

The *getpwuid_r()* function is a reentrant version of *getpwuid()*. It lets a process gain more knowledge about user with the given *uid*.

If _POSIX_THREAD_SAFE_FUNCTIONS is defined, the *getpwuid_r()* function updates the **passwd** structure pointed to by *pwd* and stores a pointer to that structure at the location pointed by *result*. The structure contains an entry from the user database with a matching *uid*.

The function stores a NULL pointer at the location pointed by *result* on error or if it can't find the requested entry.

Returns:

Zero for success, or an error number.

Errors:

ERANGE — Insufficient storage was supplied via *buffer* and *bufsize* to contain the resulting *passwd* structure.

The *getpwuid_r()* function uses the following functions, and as a result, *errno* can be set to an error for any of these calls:

- *fclose()*
- *fgets()*
- *fopen()*
- *fseek()*
- *rewind()*

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getlogin(), *getpwnam()*, *getpwnam_r()*, *getpwuid()*

getrlimit(), getrlimit64()

Get the limit on a system resource

Synopsis:

```
#include <sys/resource.h>

int getrlimit( int resource,
               struct rlimit * rlp );

int getrlimit64( int resource,
                 struct rlimit64 * rlp );
```

Arguments:

resource The resource whose limit you want to get. For a list of the possible resources, their descriptions, and the actions taken when the current limit is exceeded, see *setrlimit()*.

rlp A pointer to a **rlimit** or **rlimit64** structure where the function can store the limit on the resource. The **rlimit** and **rlimit64** structures include at least the following members:

```
rlim_t rlim_cur; /* current (soft) limit */
rlim_t rlim_max; /* hard limit */
```

The **rlim_t** type is an arithmetic data type to which you can cast objects of type **int**, **size_t**, and **off_t** without loss of information.

Library:

libc

Description:

The *getrlimit()* function gets the limits on the consumption of a variety of system resources by a process and each process it creates. The *getrlimit64()* function is a 64-bit version of *getrlimit()*.

Each call to *getrlimit()* identifies a specific resource to be operated upon as well as a resource limit. A resource limit is a pair of values:

- the current (soft) limit
- a maximum (hard) limit.

A process can change soft limits to any value that's less than or equal to the hard limit. A process may (irreversibly) lower its hard limit to any value that's greater than or equal to the soft limit. Only a process with an effective user ID of **root** can raise a hard limit. Both hard and soft limits can be changed in a single call to *setrlimit()* subject to the constraints described above. Limits may have an "infinite" value of RLIM_INFINITY.

Because limit information is stored in the per-process information, the shell builtin **ulimit** command must directly execute this system call if it's to affect all future processes created by the shell.

The values of the current limit of the following resources affect these parameters:

Resource	Parameter
RLIMIT_FSIZE	FCHR_MAX
RLIMIT_NOFILE	OPEN_MAX

When using *getrlimit()*, if a resource limit can be represented correctly in an object of type **rlim_t**, then its representation is returned; otherwise, if the value of the resource limit is equal to that of the corresponding saved hard limit, the value returned is RLIM_SAVED_MAX; otherwise, the value returned is RLIM_SAVED_CUR.

A limit whose value is greater than RLIM_INFINITY is permitted.

The *exec** family of functions also causes resource limits to be saved.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EFAULT The *rlp* argument points to an illegal address.

EINVAL An invalid resource was specified.

EPERM The limit specified to *setrlimit()* would've raised the maximum limit value, and the effective user of the calling process isn't the superuser.

Classification:

getrlimit() is standard Unix; *getrlimit64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

brk(), execl(), execle(), execlp(), execlpe(), execv(), execve(), execvp(), execvpe(), fork(), getdtablesize(), malloc(), open(), setrlimit(), setrlimit64(), signal(), sysconf()

getrusage()

Get information about resource utilization

Synopsis:

```
#include <sys/resource.h>

int getrusage( int who,
               struct rusage * r_usage );
```

Arguments:

who Which process to get the usage for:

- RUSAGE_CHILDREN — get information about resources used by the terminated and waited-for children of the current process. If the child is never waited for (e.g if the parent has SA_NOCLDWAIT set, or sets SIGCHLD to SIG_IGN), the resource information for the child process is discarded and isn't included.
- RUSAGE_SELF — get information about resources used by the current process.

r_usage A pointer to an object of type **`struct rusage`** in which the function can store the resource information; see below.

Library:

`libc`

Description:

The *getrusage()* function provides measures of the resources used by the current process or its terminated and waited-for child processes, depending on the value of the *who* argument.

The **`rusage`** structure is defined as:

```
struct timeval  ru_utime;    /* user time used */
struct timeval  ru_stime;    /* system time used */
long            ru_maxrss;   /* max resident set size */
```

```
long            ru_ixrss;    /* integral shared memory size */
long            ru_idrss;    /* integral unshared data " */
long            ru_isrss;    /* integral unshared stack " */
long            ru_minflt;   /* page reclaims */
long            ru_majflt;   /* page faults */
long            ru_nswap;    /* swaps */
long            ru_inblock;  /* block input operations */
long            ru_oublock;  /* block output operations */
long            ru_msgsnd;   /* messages sent */
long            ru_msgrcv;   /* messages received */
long            ru_nsignals; /* signals received */
long            ru_nvcsw;    /* voluntary context switches */
long            ru_nivcsw;   /* involuntary " */
```

The members include:

ru_utime — The total amount of time, in seconds and microseconds, spent executing in user mode.

ru_stime — The total amount of time, in seconds and microseconds, spent executing in system mode.

ru_maxrss — The maximum resident set size, given in pages. See the Caveats section, below.

ru_ixrss — Not currently supported.

ru_idrss — An “integral” value indicating the amount of memory in use by a process while the process is running. This value is the sum of the resident set sizes of the process running when a clock tick occurs. The value is given in pages times clock ticks. It doesn’t take sharing into account. See the Caveats section, below.

ru_isrss — Not currently supported.

ru_minflt — The number of page faults serviced that didn’t require any physical I/O activity. See the Caveats section, below.

ru_majflt — The number of page faults serviced that required physical I/O activity. This could include page ahead

operations by the kernel. See the Caveats section, below

ru_nswap The number of times a process was swapped out of main memory.

ru_inblock The number of times the file system had to perform input in servicing a *read()* request.

ru_oublock The number of times the filesystem had to perform output in servicing a *write()* request.

ru_msgsnd The number of messages sent over sockets.

ru_msgrcv The number of messages received from sockets.

ru_nsignals The number of signals delivered.

ru_nvcsw The number of times a context switch resulted due to a process's voluntarily giving up the processor before its timeslice was completed (usually to await availability of a resource).

ru_nivcsw The number of times a context switch resulted due to a higher priority process's becoming runnable or because the current process exceeded its time slice.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EFAULT The address specified by the *r_usage* argument isn't in a valid portion of the process's address space.

EINVAL Invalid *who* parameter.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Only the **`timeval`** fields of **`struct rusage`** are supported.

The numbers *ru_inblock* and *ru_oublock* account only for real I/O, and are approximate measures at best. Data supplied by the cache mechanism is charged only to the first process to read and the last process to write the data.

The way resident set size is calculated is an approximation, and could misrepresent the true resident set size.

Page faults can be generated from a variety of sources and for a variety of reasons. The customary cause for a page fault is a direct reference by the program to a page that isn't in memory. Now, however, the kernel can generate page faults on behalf of the user, for example, servicing *read()* and *write()* functions. Also, a page fault can be caused by an absent hardware translation to a page, even though the page is in physical memory.

In addition to hardware-detected page faults, the kernel may cause pseudo page faults in order to perform some housekeeping. For example, the kernel may generate page faults, even if the pages exist in physical memory, in order to lock down pages involved in a raw I/O request.

By definition, major page faults require physical I/O, while minor page faults don't. For example, reclaiming the page from the free list would avoid I/O and generate a minor page fault. More commonly, minor page faults occur during process startup as references to pages which are already in memory. For example, if an address space faults on some "hot" executable or shared library, a minor page fault results for the address space. Also, anyone doing a *read()* or *write()* to something that's in the page cache gets a minor page fault(s) as well.

There's no way to obtain information about a child process that hasn't yet terminated.

See also:

gettimeofday(), *read()*, *times()*, *wait()*, *write()*

gets()

Get a string of characters from standard input

Synopsis:

```
#include <stdio.h>

char *gets( char *buf );
```

Arguments:

buf A buffer where the function can store the string.

Library:

libc

Description:

The *gets()* function gets a string of characters from the *stdin* stream, and stores them in the array pointed to by *buf* until end-of-file is encountered or a newline character is read. Any newline character is discarded, and the string is NUL-terminated.

☞ You should use *fgets()* instead of *gets()*; *gets()* happily overflows the *buf* array if a newline character isn't read from *stdin* before the end of the array is reached.

The *gets()* function is similar to *fgets()*, except that *gets()* operates with *stdin*, has no size argument, and replaces a newline character with the NUL character.

Returns:

A pointer to *buf*, or NULL when end-of-file is encountered before reading any characters or a read error occurred (*errno* is set).

Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char buffer[80];

    while( gets( buffer ) != NULL ) {
        puts( buffer );
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *feof()*, *ferror()*, *fopen()*, *getc()*, *fgetc()*, *fgets()*, *puts()*, *ungetc()*

getservbyname()

Get a service entry, given a name

Synopsis:

```
#include <netdb.h>

struct servent * getservbyname( const char * name,
                                const char * proto );
```

Arguments:

name The name of the service whose entry you want to find.

proto NULL, or the protocol for the service.

Library:

libsocket

Description:

The *getservbyname()* function gets the entry for the given name and protocol from the network services database, **/etc/services**. This function returns a pointer of type **servent**, which contains the broken-out fields of a line in the network services database.

The *setservent()* function opens and rewinds the file. If you pass a nonzero *stayopen* argument to *setservent()*, the services database isn't closed after each call to *getservbyname()* or *getservbyport()*.

The *getservbyname()* and *getservbyport()* functions sequentially search from the beginning of the file until a matching protocol name or port number is found, or until EOF is encountered. If a protocol name is also supplied (non-NULL), searches must also match the protocol.

Returns:

A valid pointer to a **servent** structure, or NULL if an error occurs.

Files:

`/etc/services`

Network services database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if you need the data for future use, copy it before any subsequent calls overwrite it.

See also:

endservent(), *getprotoent()*, *getservbyport()*, *getservent()*, **`servent`**, *setservent()*

`/etc/services` in the *Utilities Reference*

getservbyport()

Get a service entry, given a port

Synopsis:

```
#include <netdb.h>

struct servent * getservbyport( int port,
                                const char * proto );
```

Arguments:

port The port number for the service.

proto NULL, or the protocol for the service.

Library:

libsocket

Description:

The *getservbyport()* function gets the entry for the given port from the services database, **/etc/services**. This function returns a pointer to a structure of type **servent**, which contains the broken-out fields of a line in the network services database.

The *setservent()* function opens and rewinds the file. If you pass a nonzero *stayopen* argument to *setservent()*, the services database isn't closed after each call to *getservbyname()* or *getservbyport()*.

The *getservbyport()* function sequentially searches from the beginning of the file until a matching protocol name or port number is found, or until EOF is encountered. If a protocol name is also supplied (non-NULL), searches must also match the protocol.

Returns:

A valid pointer to a **servent** structure, or NULL if an error occurs.

Files:

`/etc/services`

Network services database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if you need the data for future use, copy it before any subsequent calls overwrite it.

See also:

endservent(), *getservbyname()*, *getservent()*, **`servent`**, *setservent()*

`/etc/services` in the *Utilities Reference*

getservent()

Read the next line of network services database file

Synopsis:

```
#include <netdb.h>

struct servent * getservent( void );
```

Library:

libsocket

Description:

The *getservent()* function reads the next line of network services database file, opening the file if necessary. It returns a pointer to a structure of type **servent**, which contains the broken-out fields of a line in the network services database, **/etc/services**.

Returns:

A valid pointer to a **servent** structure, or NULL if an error occurs.

Files:

/etc/services

Network services database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if you need the data for future use, copy it before any subsequent calls overwrite it.

See also:

endservent(), *getservbyname()*, *getservbyport()*, **`servent`**, *setservent()*

`/etc/services` in the *Utilities Reference*

getsid()

Get the session ID of a process

Synopsis:

```
#include <unistd.h>

pid_t getsid( pid_t pid );
```

Arguments:

pid The process ID for the process whose session ID you want to get.

Library:

libc

Description:

The *getsid()* function determines the session ID for the given process ID, *pid*.

Returns:

The session ID, or -1 if an error occurs (*errno* is set).

Errors:

EPERM The process specified by *pid* is not in the same session as the calling process. The implementation doesn't allow access to the process group ID of the session leader from the calling process.

EINVAL There isn't a process with the given ID.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *setsid()*

getsockname()

Get the name of a socket

Synopsis:

```
#include <sys/socket.h>

int getsockname( int s,
                 struct sockaddr * name,
                 socklen_t * namelen );
```

Arguments:

s	The file descriptor of the socket whose name you want to get.
name	A pointer to a **sockaddr** object where the function can store the socket's name.
namelen	A pointer to a **socklen_t** object that initially indicates the amount of space pointed to by *name*. The function updates *namelen* to contain the actual size of the name (in bytes).

Library:

libsocket

Description:

The *getsockname()* function returns the current name for the specified socket.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EBADF	Invalid descriptor *s*.
EFAULT	The *name* parameter points to memory that isn't in a valid part of the process address space.
ENOBUFS	Insufficient resources were available in the system to perform the operation.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getpeername()

getsockopt()

Get options associated with a socket

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

int getsockopt( int s,
                int level,
                int optname,
                void * optval,
                socklen_t * optlen );
```

Arguments:

s	The file descriptor of the socket that the option is to be applied to, as returned by *socket()*.
level	The protocol layer that the option is to be applied to. In most cases, it's a socket-level option and is indicated by SOL_SOCKET.
optname	The option for the socket file descriptor. For a list of options, see "Options," below.
optval	A pointer to the value of the option (in most cases, whether the option is to be turned on or off). If no option value is to be returned, *optval* may be NULL. Most socket-level options use an **int** parameter for *optval*. Others, such as the SO_LINGER, SO_SNDTIMEO, and SO_RCVTIMEO options, use structures that also let you get data associated with the option.
optlen	A pointer to the length of the value of the option. This argument is a value-result parameter; initialize it to indicate the size of the buffer pointed to by *optval*.

Library:

libsocket

Description:

The *getsockopt()* function gets options associated with a socket.

Manipulating socket options

When manipulating a socket option, you must specify the option's name (*optname*) and the level (*level*) at which the option resides.

To manipulate options at the socket-level, specify *level* as SOL_SOCKET. When manipulating options any other level, the value that you specify for *level* is represented by the protocol number of the appropriate protocol controlling the option. You can obtain the value in a variety of ways:

- from the "Options" section below, use the symbolic constant (e.g. IPPROTO_IP, IPPROTO_TCP) that corresponds to the option
- from **/etc/protocols**, specify the protocol number for the appropriate protocol
- call *getprotobyname()* and pass the appropriate protocol (e.g. **getprotobyname(tcp);**) to retrieve the number of the protocol level.

The latter two ways might not work if you have customized **/etc/protocols**.

The *optname* parameter and any specified options are passed uninterpreted to the appropriate protocol module for interpretation. The **<sys/socket.h>** header file contains definitions for the socket-level options. Options at other protocol levels vary in format and name.

☞ Since levels (e.g. SOL_SOCKET, IPPROTO_IP and IPPROTO_TCP) and the options within the levels can vary, you need to ensure the proper headers are included for both. For example, when setting TCP_NODELAY:

```
int on = 1;
setsockopt(s, IPPROTO_TCP, TCP_NODELAY, &on);
```

the level IPPROTO_TCP is defined in **<netinet/in.h>**, whereas the TCP_NODELAY option is defined in **<netinet/tcp.h>**.

Options

Here are some of the more common options and their corresponding *level*.

☞ Except where noted, you can examine the state of the option by calling *getsockopt()*, and set the state by calling *setsockopt()*.

For the list of options that the tiny TCP/IP stack supports, see **npm-ttcpip.so** in the *Utilities Reference*.

IP_HDRINCL *level*: IPPROTO_IP

Get or set the custom IP header that's included with your data. You can use it only for raw sockets. For example:

```
(socket(AF_INET, SOCK_RAW, ...)
```

IP_TOS *level*: IPPROTO_IP

Get or set the type-of-service field in the IP header for SOCK_STREAM and SOCK_DGRAM (not applicable for **npm-ttcpip.so**) sockets.

level: SOL_SOCKET

SO_BINDTODEVICE

Applies to *setsockopt()* only.

Allow packets to be sent or received on this specified interface only. If the interface specified conflicts with the parameters of *bind()*, or with the routing table, an error or undesired behavior may occur.

This option accepts the **ifreq** structure with the *ifr_name* member set to the interface name (e.g. **en0**). Currently, you can use this option only for UDP sockets.

level: SOL_SOCKET

SO_BROADCAST

Enable or disable the permission to transmit broadcast messages. You can use this option only for UDP sockets. For example:

```
(socket(AF_INET, SOCK_DGRAM, ...))
```

"Broadcast" was a privileged operation in earlier versions of the system.

SO_DEBUG

level: SOL_SOCKET

Enable or disable the recording of debug information in the underlying protocol modules.

level: SOL_SOCKET

SO_DONTROUTE

Enable or disable the bypassing of routing tables for outgoing messages. Indicates that outgoing messages should bypass the standard routing facilities. The messages are directed to the appropriate network interface according to the network portion of the destination address.

SO_ERROR

level: SOL_SOCKET

Applies to *getsockopt()* only.

Get any pending error on the socket and clears the error status. You can use it to check for asynchronous errors on connected datagram sockets or for other asynchronous errors.

level: SOL_SOCKET

SO_KEEPALIVE

Enable or disable the periodic (at least every 2 hours) transmission of messages on a connected socket. Should the connected party fail to respond to these messages, the connection is considered broken, and processes that are using the socket are notified via a SIGPIPE signal when they attempt to send data.

SO_LINGER

level: SOL_SOCKET

Controls the action that's taken when unsent messages are queued on socket when a *close()* is performed.

If it's enabled and the socket promises reliable delivery of data, the system blocks the process on the *close()* attempt until it's able to transmit the data or until it decides it can't deliver the information (a timeout period, termed the linger interval, is specified in the *setsockopt()* call when SO_LINGER is requested).

If it's disabled, the system processes the *close()* in a way that lets the process continue as quickly as possible.

The **`struct linger`** parameter (defined in **`<sys/socket.h>`**) specifies the desired state of the option in the **`l_onoff`** field and the linger interval in the **`l_linger`** field, in seconds. A value of 0 causes a reset on the socket when the application closes the socket.

level: SOL_SOCKET

SO_OOBINLINE

For protocols that support out-of-band data, allows or disallows out-of-band data to be placed in the normal data input queue as received. The data is accessible using the *recv()* or *read()* calls without the MSG_OOB flag. Some protocols always behave as if this option is set.

SO_RCVBUF and SO_SNDBUF

level: SOL_SOCKET

Gets or sets the normal buffer sizes allocated for output (SO_SNDBUF) and input (SO_RCVBUF) buffers. You can increase the buffer size for high-volume connections, or decrease it to limit the possible backlog

of incoming data. The system places an absolute limit on these values and defaults them to at least 16K for TCP sockets.

SO_RCVLOWAT

level: SOL_SOCKET

Gets or sets the minimum count for input operations (default is 1). In general, receive calls block until any (nonzero) amount of data is received, and then return with the amount available or the amount requested, whichever is smaller.

If you set the value to be larger than the default, blocking receive calls will wait until they've received the low-water mark value or the requested amount, whichever is smaller. Receive calls may still return less than the low-water mark if: an error occurs, a signal is caught, or if the type of data next in the receive queue differs from that returned.

SO_RCVTIMEO

level: SOL_SOCKET

Gets or sets a timeout value for input operations. It accepts a **`struct timeval`** parameter (defined in **`<sys/time.h>`**) with the number of seconds and microseconds used to limit waits for input operations to complete.

In the current implementation, this timer is restarted each time additional data is received by the protocol, so the limit is in effect an inactivity timer. If a receive operation has been blocked for this much time without receiving additional data, it returns with a short count or, if no data was received, with the error EWOULDBLOCK.

SO_REUSEADDR

level: SOL_SOCKET

Enables or disables the reuse of duplicate addresses and port bindings. Indicates that the rules used in validating addresses supplied in a *bind()* call allows/disallows local addresses to be reused.

SO_REUSEPORT

level: SOL_SOCKET

Enables or disables duplicate address and port bindings. Complete duplicate bindings by multiple processes are allowed when they all set SO_REUSEPORT before binding the port. This option permits multiple instances of a program to each receive UDP/IP multicast or broadcast

datagrams destined for the bound port. See the **reuseport_unicast** option of the **npm-tcpip.so** utility to see how unicast packets are also received on all sockets bound to the same port.

SO_SNDLOWAT

level: SOL_SOCKET

Gets or sets the minimum count for output operations. In BSD, this count is typically 2048, but it is a calculated value in Neutrino. If you require a specific SO_SNDLOWAT, you must specify the count. Most output operations process all of the data supplied by the call, delivering data to the protocol for transmission and blocking as necessary for flow control. Nonblocking output operations will process as much data as permitted (subject to flow control without blocking), but will process no data if flow control doesn't allow the smaller of the low-water mark value or the entire request to be processed.

A *select()* operation that tests the ability to write to a socket returns true only if the low-water mark amount could be processed.

SO_SNDTIMEO

level: SOL_SOCKET

Gets or sets a timeout value for output operations. It accepts a **struct timeval** parameter (defined in **<sys/time.h>**) that includes the number of seconds and microseconds that are used to limit waits for output operations to complete. If a send operation has blocked for this much time, it returns with a partial count or with the error EWOULDBLOCK if data weren't sent.

This timer is restarted each time additional data is delivered to the protocol, implying that the limit applies to output portions ranging in size from the low-water mark to the high-water mark for output. Timeouts are restricted to 32 seconds or under.

SO_TIMESTAMP

level: SOL_SOCKET

Enables or disables the reception of a timestamp with datagrams. If enabled on a SOCK_DGRAM socket, the *recvmsg()* call returns a timestamp corresponding to when the datagram was received. The *msg_control* field in the **msghdr** structure points to a buffer that

contains a **cmsghdr** structure followed by a **struct timeval**. The **cmsghdr** fields have the following values:

```
cmsg_len = sizeof(struct cmsghdr) + sizeof(struct timeval)
cmsg_level = SOL_SOCKET
cmsg_type = SCM_TIMESTAMP
```

SO_TYPE

level: SOL_SOCKET

Applies to *getsockopt()* only.

Gets the type of the socket (e.g. SOCK_STREAM). This information is useful for servers that inherit sockets on startup.

SO_USELOOPBACK

level: SOL_SOCKET

Enables or disables the sending process to receive its own routing messages.

TCP_KEEPALIVE

level: IPPROTO_TCP

Gets or sets the amount of time in seconds between keepalive probes (the default value is 2 hours). It accepts a **struct timeval** parameter with the number of seconds to wait between the keepalive probes.

TCP_NODELAY

level: IPPROTO_TCP

Don't delay sending in order to coalesce packets. Under most circumstances, TCP sends data when it's presented. When outstanding data hasn't yet been acknowledged, TCP gathers small amounts of output to be sent in a single packet once an acknowledgment is received.

☞ For a few clients (such as windowing systems that send a stream of mouse events that receive no replies), this packetization may cause significant delays. Therefore, TCP provides a boolean option, TCP_NODELAY, to defeat this algorithm.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid file descriptor *s*.

EDOM Value was set out of range.

EFAULT The address pointed to by *optval* isn't in a valid part of the process address space. For *getsockopt()*, this error may also be returned if *optlen* isn't in a valid part of the process address space.

EINVAL The *optval* argument can't be NULL; *optlen* can't be 0.

ENOPROTOOPT
The option is unknown at the level indicated.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ICMP, IP, TCP, and UDP protocols

close(), *getprotobyname()*, *ioctl()*, *read()*, *select()*, *setsockopt()*, *socket()*

`/etc/protocols` in the *Utilities Reference*

getspent(), getspent_r()

Get an entry from the shadow password database

Synopsis:

```
#include <sys/types.h>
#include <shadow.h>

struct spwd* getspent( void );

struct spwd* getspent_r( struct spwd* result,
                         char* buffer,
                         int buflen );
```

Arguments:

These arguments apply only to *getspent_r()*:

result A pointer to a **spwd** structure where the function can store the entry. For more information about this structure, see *putspent()*.

buffer A block of memory that the function can use to allocate storage referenced by the **spwd** structure. You can determine the maximum size needed for this buffer by calling *sysconf()* with an argument of _SC_GETPW_R_SIZE_MAX.

bufsize The size of the block that *buffer* points to, in characters.

Library:

libc

Description:

The *getspent()* and *getspent_r()* functions return the next entry from the shadow password database. The *getspent()* function uses a static buffer that's overwritten by each call.

The *fgetspent()*, *getspent()*, *getspnam()*, and functions share the same static buffer.

Returns:

The *getspent()* function returns a pointer to an object of type **struct spwd** containing the next entry from the shadow password database. When *getspent()* is first called, the database is opened, and remains open until either a NULL is returned to signify end-of-file, or *endspent()* is called.

Errors:

The *getspent()* function uses the following functions, and as a result, *errno* can be set to an error for any of these calls:

- *fclose()*
- *fgets()*
- *fopen()*
- *fseek()*
- *rewind()*

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <pwd.h>
#include <shadow.h>

/*
 * This program loops, reading a login name from standard
 * input and checking to see if it is a valid name. If it
 * is not valid, the entire contents of the name in the
 * password database are printed.
 */

int main(int argc, char** argv)
{
   struct spwd* sp;
```

```
    char  buf[80];

    setpwent( );
    while( gets( buf ) != NULL ) {
      if( ( sp = getspnam( buf ) ) != ( struct spwd * )0 ) {
        printf( "Valid login name is: %s\n", sp->sp_namp );
      } else {
        setspent( );
        while( ( sp=getspent( ) ) != ( struct spwd * )0 )
          printf( "%s\n", sp->sp_namp );
      }
    }
    endspent();
    return( EXIT_SUCCESS );
}
```

Classification:

Unix

getspent()

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

getspent_r()

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *fgetspent()*, *getgrent()*, *getlogin()*, *getspnam()*, *getpwuid()*, *putspent()*, *setspent()*

getspnam(), getspnam_r()

Get information about a user with a given name

Synopsis:

```
#include <sys/types.h>
#include <shadow.h>

struct spwd* getspnam( char* name );

struct spwd* getspnam_r( const char* name,
                         struct spwd* result,
                         char* buffer,
                         size_t bufsize );
```

Arguments:

name The name of the user.

result (*getspnam_r()* only) A pointer to a **spwd** structure where the function can store the entry. For more information about this structure, see *putspent()*.

buffer (*getspnam_r()* only) A block of memory that the function can use to allocate storage referenced by the **spwd** structure. You can determine the maximum size needed for this buffer by calling *sysconf()* with an argument of _SC_GETPW_R_SIZE_MAX.

bufsize (*getspnam_r()* only) The size of the block that *buffer* points to, in characters.

Library:

libc

Description:

The *getspnam()* and *getspnam_r()* functions allow a process to gain more knowledge about a user *name*. The *getspnam()* function uses a static buffer that's overwritten by each call.

The *fgetspent()*, *getspent()*, and *getspnam()* functions share the same static buffer.

Returns:

A pointer to an object of type **`struct spwd`** containing an entry from the group database with a matching *name*, or NULL if an error occurred or the function couldn't find a matching entry.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <pwd.h>
#include <shadow.h>

/*
 * Print information from the password entry
 * about the user name given as argv[1].
 */

int main( int argc, char** argv )
{
    struct spwd* sp;

        if (argc < 2) {
                printf("%s username \n", argv[0]);
                return(EXIT_FAILURE);
        }

    if( ( sp = getspnam( argv[1] ) ) == (struct spwd*)0) {
      fprintf( stderr, "getspnam: unknown %s\n",
        argv[1] );
      return( EXIT_FAILURE );
    }
    printf( "login name  %s\n", sp->sp_namp );
    printf( "password    %s\n", sp->sp_pwdp );
    return( EXIT_SUCCESS );
}
```

Classification:

getspnam() is POSIX 1003.1; *getspnam_r()* is Unix

getspnam()

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

getspnam_r()

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fgetspent(), *getlogin()*, *getspent()*, *getpwuid()*, *putspent()*

getsubopt()

Parse suboptions from a string

Synopsis:

```
#include <stdlib.h>

int getsubopt( char** optionp,
               char* const* tokens,
               char** valuep );
```

Arguments:

optionp The address of a pointer to the string of options that you want to parse. The function updates this pointer as it parses the options; see below.

tokens A vector of possible tokens.

valuep The address of a pointer that the function updates to point to the first character of a value that's associated with an option; see below.

Library:

libc

Description:

The *getsubopt()* functions parses suboptions in a flag argument that was initially parsed by *getopt()*. These suboptions are separated by commas and may consist of either a single token or a token-value pair separated by an equal sign. Since commas delimit suboptions in the option string, they aren't allowed to be part of the suboption or the value of a suboption. A command that uses this syntax is **mount**, which allows the user to specify mount parameters with the **-o** option as follows:

```
mount -o rw,hard,bg,wsize=1024 speed:/usr /usr
```

In this example there are four suboptions: **rw**, **hard**, **bg**, and **wsize**, the last of which has an associated value of 1024.

The *getsubopt()* function takes the address of a pointer to the option string, a vector of possible tokens, and the address of a value string pointer. It returns the index of the token that matched the suboption in the input string, or -1 if there was no match. If the option string at *optionp* contains only one suboption, *getsubopt()* updates *optionp* to point to the null character at the end of the string; otherwise, it isolates the suboption by replacing the comma separator with a null character, and updates *optionp* to point to the start of the next suboption. If the suboption has an associated value, *getsubopt()* updates *valuep* to point to the value's first character. Otherwise, it sets *valuep* to NULL.

The token vector is organized as a series of pointers to null strings. The end of the token vector is identified by a NULL pointer.

When *getsubopt()* returns, if *valuep* isn't NULL, the suboption processed included a value. The calling program may use this information to determine if the presence or lack of a value for this suboption is an error.

Additionally, when *getsubopt()* fails to match the suboption with the tokens in the *tokens* array, the calling program should decide if this is an error, or if the unrecognized option should be passed to another program.

Returns:

The *getsubopt()* function returns -1 when the token it's scanning isn't in the *tokens* vector. The variable addressed by *valuep* contains a pointer to the first character of the token that wasn't recognized rather than a pointer to a value for that token.

The variable addressed by *optionp* points to the next option to be parsed, or a null character if there are no more options.

Examples:

The following code fragment shows how to process options to the mount(1M) command using *getsubopt()*:

```
#include <stdlib.h>
```

```
char *myopts[] = {
#define READONLY    0
                "ro",
#define READWRITE   1
                "rw",
#define WRITESIZE   2
                "wsize",
#define READSIZE    3
                "rsize",
                NULL};

main(argc, argv)
     int  argc;
     char **argv;
{
     int sc, c, errflag;
     char *options, *value;
     extern char *optarg;
     extern int optind;
     .
     .
     .
     while((c = getopt(argc, argv, "abf:o:")) != -1) {
          switch (c) {
          case 'a': /* process a option */
               break;
          case 'b': /* process b option */
               break;
          case 'f':
               ofile = optarg;
               break;
          case '?':
               errflag++;
               break;
          case 'o':
               options = optarg;
               while (*options != '\0') {
                    switch(getsubopt(&options,myopts,&value) {
                    case READONLY : /* process ro option */
                         break;
                    case READWRITE : /* process rw option */
                         break;

                    case WRITESIZE : /* process wsize option */
                         if (value == NULL) {
                              error_no_arg();
                              errflag++;
                         } else
                              write_size = atoi(value);
                         break;
```

```
                    case READSIZE : /* process rsize option */
                         if (value == NULL) {
                              error_no_arg();
                              errflag++;
                         } else
                              read_size = atoi(value);
                         break;
                    default :
                         /* process unknown token */
                         error_bad_token(value);
                         errflag++;
                         break;
                    }
               }
               break;
          }
     }
     if (errflag) {
          /* print usage instructions etc. */
     }
     for (; optind < argc; optind++) {
          /* process remaining arguments */
     }
     .
     .
     .
}
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

During parsing, commas in the option input string are changed to null characters. White space in tokens or token-value pairs must be protected from the shell by quotes.

See also:

getopt()

gettimeofday()

Get the current time

Synopsis:

```
#include <sys/time.h>

int gettimeofday( struct timeval * when,
                  void * not_used );
```

Arguments:

when A pointer to a **timeval** structure where the function can store the time. The **struct timeval** contains the following members:

- **long** *tv_sec* — the number of seconds since the start of the Unix Epoch.
- **long** *tv_usec* — the number of microseconds.

not_used This pointer must be NULL or the behavior of *gettimeofday()* is unspecified. This argument is provided only for backwards compatibility.

Library:

libc

Description:

The *gettimeofday()* function returns the current time in *when* in seconds and microseconds, since the Unix Epoch, 00:00:00 January 1, 1970 Coordinated Universal Time (UTC) (formerly known as Greenwich Mean Time (GMT)).

Returns:

0 for success, or -1 if an error occurs (*errno* is set).

Errors:

EFAULT An error occurred while accessing the *when* buffer.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *gettimeofday()* function is provided for porting existing code. You shouldn't use it in new code; use *clock_gettime()* instead.

See also:

asctime(), asctime_r(), clock_gettime(), clock_settime(), ctime(), ctime_r(), difftime(), gmtime(), gmtime_r(), localtime(), localtime_r(), settimeofday(), time()

getuid()

Get the user ID

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

uid_t getuid( void );
```

Library:

libc

Description:

The *getuid()* function gets the user ID for the calling process.

Returns:

The user ID for the calling process.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <unistd.h>

int main( void )
  {
    printf( "My userid is %d\n", getuid() );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

getegid(), *geteuid()*, *getgid()*, *setuid()*

getutent()

Read the next entry from the user-information file

Synopsis:

```
#include <utmp.h>

struct utmp * getutent( void );
```

Library:

libc

Description:

The *getutent()* function reads in the next entry from a user-information file. If the file isn't already open, *getutent()* opens it. If the function reaches the end of the file, it fails.

Returns:

A pointer to a **utmp** structure for the next entry, or NULL if the file couldn't be read or reached the end of file.

Files:

_PATH_UTMP

Specifies the user information file.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The most current entry is saved in a static structure. Copy it before making further accesses.

On each call to either *getutid()* or *getutline()*, the routine examines the static structure before performing more I/O. If the contents of the static structure match what it's searching for, the function looks no further. For this reason, to use *getutline()* to search for multiple occurrences, zero out the static area after each success, or *getutline()* will return the same structure over and over again.

There's one exception to the rule about emptying the structure before further reads are done: the implicit read done by *pututline()* (if it finds that it isn't already at the correct place in the file) doesn't hurt the contents of the static structure returned by the *getutent()*, *getutid()* or *getutline()* routines, if you just modified those contents and passed the pointer back to *pututline()*.

These routines use buffered standard I/O for input, but *pututline()* uses an unbuffered nonstandard write to avoid race conditions between processes trying to modify the **utmp** and **wtmp** files.

See also:

endutent(), *getutid()*, *getutline()*, *pututline()*, *setutent()*, **utmp**, *utmpname()*

login in the *Utilities Reference*

Synopsis:

```
#include <utmp.h>

struct utmp * getutid( struct utmp * id );
```

Arguments:

id A pointer to a **utmp** structure that you want to find in the user-information file.

Library:

libc

Description:

The *getutid()* function searches forward from the current point in the **utmp** file until it finds a matching entry:

- If *id->ut_type* is one of RUN_LVL, BOOT_TIME, OLD_TIME, or NEW_TIME, the function looks for an entry with the same *ut_type*.
- If *id->ut_type* is INIT_PROCESS, LOGIN_PROCESS, USER_PROCESS, or DEAD_PROCESS, *getutid()* looks for the first entry entry with the same *ut_type* and a *ut_id* field that matches *id->ut_id*.

If *getutid()* reaches the end of the file without finding a match, the search fails.

Returns:

A pointer to the **utmp** structure for the matching entry, or NULL if it couldn't be found.

Files:

_PATH_UTMP

Specifies the user information file.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The most current entry is saved in a static structure. Copy it before making further accesses.

On each call to either *getutid()* or *getutline()*, the routine examines the static structure before performing more I/O. If the contents of the static structure match what it's searching for, the function looks no further. For this reason, to use *getutline()* to search for multiple occurrences, zero out the static area after each success, or *getutline()* will return the same structure over and over again.

There's one exception to the rule about emptying the structure before further reads are done: the implicit read done by *pututline()* (if it finds that it isn't already at the correct place in the file) doesn't hurt the contents of the static structure returned by the *getutent()*, *getutid()* or *getutline()* routines, if the user has just modified those contents and passed the pointer back to *pututline()*.

These routines use buffered standard I/O for input, but *pututline()* uses an unbuffered nonstandard write to avoid race conditions between processes trying to modify the **utmp** and **wtmp** files.

See also:

endutent(), *getutent()*, *getutline()*, *pututline()*, *setutent()*, **utmp**, *utmpname()*

login in the *Utilities Reference*

getutline()

Get an entry from the user-information file

Synopsis:

```
#include <utmp.h>

struct utmp * getutline( struct utmp * line );
```

Arguments:

line A pointer to a **utmp** structure that you want to find in the user-information file.

Library:

libc

Description:

The *getutline()* function searches forward from the current point in the **utmp** file until it finds an entry of the type LOGIN_PROCESS or a *ut_line* string that matches *line->ut_line*. If the function reaches the end of the file is reached without finding a match, the function fails.

Returns:

A pointer to the **utmp** structure for the entry found, or NULL if the search failed.

Files:

_PATH_UTMP

Specifies the user information file.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The most current entry is saved in a static structure. Copy it before making further accesses.

On each call to either *getutid()* or *getutline()*, the routine examines the static structure before performing more I/O. If the contents of the static structure match what it's searching for, the function looks no further. For this reason, to use *getutline()* to search for multiple occurrences, zero out the static area after each success, or *getutline()* will return the same structure over and over again.

There's one exception to the rule about emptying the structure before further reads are done: the implicit read done by *pututline()* (if it finds that it isn't already at the correct place in the file) doesn't hurt the contents of the static structure returned by the *getutent()*, *getutid()* or *getutline()* routines, if the user has just modified those contents and passed the pointer back to *pututline()*.

These routines use buffered standard I/O for input, but *pututline()* uses an unbuffered nonstandard write to avoid race conditions between processes trying to modify the **utmp** and **wtmp** files.

See also:

endutent(), *getutent()*, *getutid()*, *pututline()*, *setutent()*, **utmp**, *utmpname()*

login in the *Utilities Reference*

getw()

Get a word from a stream

Synopsis:

```
#include <stdio.h>

int getw( FILE* stream );
```

Arguments:

stream The stream that you want to read a word from.

Library:

libc

Description:

The *getw()* function returns the next word (i.e. integer) from the named input stream. This function increments the associated file pointer, if defined, to point to the next word. The size of a word is the size of an integer, and varies from machine to machine. The *getw()* function assumes no special alignment in the file.

Returns:

The next word, or the constant EOF at the end-of-file or on an error; it sets the EOF or error indicator of the stream.

Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Errors:

EOVERFLOW The file is a regular file, and an attempt was made to read at or beyond the offset maximum associated with the corresponding stream.

Classification:

Legacy Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Because of possible differences in word length and byte ordering, files written using *putw()* are implementation-dependent, and might not be read correctly using *getw()* on a different processor.

See also:

fclose(), *feof()*, *ferror()*, *fgetc()*, *flockfile()*, *fopen()*, *fread()*, *getc()*, *getc_unlocked()*, *getchar()*, *getchar_unlocked()*, *gets()*, *putc()*, *putw()*, *scanf()*, *ungetc()*,

getwc()

Read a wide character from a stream

Synopsis:

```
#include <wchar.h>

wint_t getwc( FILE * fp );
```

Arguments:

fp The stream from which you want to read a wide character.

Library:

libc

Description:

The *getwc()* function reads the next wide character from the specified stream.

Returns:

The next character from the stream, cast as **(wint_t)(wchar_t)**, or WEOF if end-of-file has been reached or if an error occurs (*errno* is set).

Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Errors:

EAGAIN	The O_NONBLOCK flag is set for *fp* and would have been blocked by this operation.
EBADF	The *fp* stream isn't valid for reading.
EINTR	A signal terminated the read operation; no data was transferred.

EIO	Either a physical I/O error has occurred, or the process is in the background and is being ignored or blocked.
EOVERFLOW	Cannot read at or beyond the offset maximum for this stream.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *feof()*, *ferror()*, *putwc()*, *putwchar()*

"Stream I/O functions" and "Wide-character functions" in the summary of functions chapter

getwchar()

Read a character from a stream

Synopsis:

```
#include <wchar.h>

wint_t getwchar( void );
```

Library:

libc

Description:

The *getwchar()* function reads the next wide character from *stdin*.

Returns:

The next character from *stdin*, cast as **(wint_t)(wchar_t)**, or WEOF if the end-of-file has been reached or if an error occurs (*errno* is set).

Use *feof()* or *ferror()* to distinguish an end-of-file condition from an error.

Errors:

EAGAIN	The O_NONBLOCK flag is set for *stdin* and would have been blocked by this operation.
EINTR	A signal terminated the read operation; no data was transferred.
EIO	Either a physical I/O error has occurred, or the process is in the background and is being ignored or blocked.
EOVERFLOW	Cannot read at or beyond the offset maximum for this stream.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, feof(), ferror(), putwc(), putwchar()

"Stream I/O functions" and "Wide-character functions" in the summary of functions chapter

getwd()

Get current working directory pathname

Synopsis:

```
#include <unistd.h>

char* getwd( char *path_name );
```

Arguments:

path_name	A buffer where the function can store the current working directory.

Library:

libc

Description:

The *getwd()* function determines the absolute pathname of the current working directory of the calling process, and copies that pathname into the array pointed to by the *path_name* argument.

If the length of the pathname of the current working directory is greater than ({PATH_MAX} + 1) including the null byte, *getwd()* fails and returns a null pointer.

For portability, use *getcwd()* instead of *getwd()*.

Returns:

A pointer to the string containing the absolute pathname of the current working directory. On error, *getwd()* returns a null pointer and the contents of the array pointed to by *path_name* are undefined.

Classification:

Legacy Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

getcwd()

glob()

Find paths matching a pattern

Synopsis:

```
#include <glob.h>

int glob( const char* pattern,
          int flags,
          int (*errfunc)( const char* epath,
                                      int error ),
          glob_t* pglob );
```

Arguments:

pattern The pattern you want to match. This can include these wildcard characters:

- `*` matches any string, of any length
- `?` matches any single character
- `[`*chars*`]` matches any of the characters found in the string *chars*.

flags Flags that affect the search; see below.

errfunc A pointer to a function that *glob()* calls when it encounters a directory that it can't open or read. For more information, see below.

pglob A pointer to a **glob_t** structure where *glob()* can store the paths found. This structure contains at least the following members:

- **size_t** *gl_pathc* — the number of pathnames matched by *pattern*.
- **char**** *gl_pathv* — a NULL-terminated array of pointers to the pathnames matched by *pattern*.
- **size_t** *gl_offs* — the number of pointers to reserve at the beginning of *gl_pathv*.

You must create the **glob_t** structure before calling *glob()*. The *glob()* function allocates storage as needed for the *gl_pathv* array. Use *globfree()* to free this space.

Library:

libc

Description:

The *glob()* function finds pathnames matching the given pattern.

In order to have access to a pathname, *glob()* must have search permission on every component of the path except the last, and read permission on each directory of every filename component of *pattern* that contains any of the special characters (*****, **?**, **[** and **]**).

The *errfunc* argument is a pointer to an error-handler function with this prototype:

```
int errfunc( const char* epath, int error );
```

The *errfunc* function is called when *glob()* encounters a directory that it can't open or read. The arguments are:

epath A pointer to the path that failed.

error The value of *errno* from the failure. The *error* argument can be set to any of the values returned by *opendir()*, *readdir()*, or *stat()*.

The *errfunc* function should return 0 if *glob()* should continue, or a nonzero value if *glob()* should stop searching.

You can set *errfunc* to NULL to ignore these types of errors.

The *flags* argument can be set to any combination of the following bits:

GLOB_APPEND Append found pathnames to the ones from a previous call from *glob()*.

GLOB_DOOFFS Use the value in *pglob->gl_offs* to specify how many NULL pointers to add at the beginning of *pglob->pathv*. After the call to *glob()*,

pglob->pathv will contain *pglob->gl_offs* NULL pointers, followed by *pglob->gl_pathc* pathnames, followed by a NULL pointer. This can be useful if you're building a command to be applied to the matched files.

GLOB_ERR — Cause *glob()* to return when it encounters a directory that it can't open or read. Otherwise, *glob()* will continue to find matches.

GLOB_MARK — Append a slash to each matching pathname that's a directory.

GLOB_NOCHECK

If *pattern* doesn't match any path names, return only the contents of *pattern*.

GLOB_NOESCAPE

Disable backslash escapes in *pattern*.

GLOB_NOSORT — Don't sort the returned pathnames; their order will be unspecified. The default is to sort the pathnames.

Returns:

Zero for success, or an error value.

Errors:

GLOB_ABEND

The scan was stopped because GLOB_ERR was set, or the *errfunc* function returned nonzero.

GLOB_NOMATCH

The value of *pattern* doesn't match any existing pathname, and GLOB_NOCHECK wasn't set in *flags*.

GLOB_NOSPACE

Unable to allocate memory to store the matched paths.

Examples:

This simple example attempts to find all of the `.c` files in the current directory and print them in the order the filesystem found them.

```
#include <unistd.h>
#include <stdio.h>
#include <glob.h>

int main( void )
{
    glob_t paths;
    int retval;

    paths.gl_pathc = 0;
    paths.gl_pathv = NULL;
    paths.gl_offs = 0;

    retval = glob( "*.c", GLOB_NOCHECK | GLOB_NOSORT,
                   NULL, &paths );
    if( retval == 0 ) {
        int idx;

        for( idx = 0; idx < paths.gl_pathc; idx++ ) {
            printf( "[%d]: %s\n", idx,
                    paths.gl_pathv[idx] );
        }

        globfree( &paths );
    } else {
        puts( "glob() failed" );
    }

    return 0;
}
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

Don't change the values in *pglob* between calling *glob()* and *globfree()*.

See also:

globfree(), *wordexp()*, *wordfree()*

globfree()

Free storage allocated by a call to glob()

Synopsis:

```
#include <glob.h>

void globfree( glob_t* pglob );
```

Arguments:

pglob A pointer to a **glob_t** structure that you passed to *glob()*.

Library:

libc

Description:

The *globfree()* function frees the storage allocated by a call to *glob()*.

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Don't change the values in *pglob* between calling *glob()* and *globfree()*.

See also:

glob(), wordexp(), wordfree()

gmtime()

Convert calendar time to a broken-down time

Synopsis:

```
#include <time.h>

struct tm* gmtime( const time_t* timer );
```

Arguments:

timer A pointer to a **time_t** structure that contains the time that you want to convert.

Library:

libc

Description:

The *gmtime()* function converts the calendar time pointed to by *timer* into a broken-down time, expressed as Coordinated Universal Time (UTC) (formerly known as Greenwich Mean Time or GMT).

The *gmtime()* function places the converted time in a static structure that's reused each time you call *gmtime()*. If you want a thread-safe version of *gmtime()*, use *gmtime_r()*.

You typically use the **date** command to set the computer's internal clock using Coordinated Universal Time (UTC). Use the **TZ** environment variable or **_CS_TIMEZONE** configuration string to establish the local time zone. For more information, see "Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*.

Returns:

A pointer to a **tm** structure that contains the broken-down time.

Classification:

ANSI, POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

asctime(), asctime_r(), clock(), ctime(), difftime(), gmtime_r(), localtime(), localtime_r(), mktime(), strftime(), time(), `tm`*, tzset()*

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

Synopsis:

```
#include <time.h>

struct tm* gmtime_r( const time_t* timer,
                     struct tm* result );
```

Arguments:

timer A pointer to a **time_t** structure that contains the time that you want to convert.

result A pointer to a **tm** structure where the function can store the broken-down time.

Library:

libc

Description:

The *gmtime_r()* function converts the calendar time pointed to by *timer* into a broken-down time, expressed as Coordinated Universal Time (UTC) (formerly known as Greenwich Mean Time or GMT) and stores it in the **tm** structure pointed to by *result*.

You typically use the **date** command to set the computer's internal clock using Coordinated Universal Time (UTC). Use the **TZ** environment variable or **_CS_TIMEZONE** configuration string to establish the local time zone. For more information, see "Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*.

Returns:

A pointer to the **tm** structure containing the broken-down time.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

asctime(), asctime_r(), clock(), ctime(), difftime(), localtime(), localtime_r(), mktime(), strftime(), time(), `tm`*, tzset()*

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

Synopsis:

```
#include <netdb.h>

extern int h_errno;
```

Library:

libsocket

Description:

The *h_errno* variable can be set by any one of the following functions:

- *gethostbyaddr()*
- *gethostbyaddr_r()*
- *gethostbyname()*
- *gethostbyname2()*
- *gethostbyname_r()*
- *res_query()*
- *res_search()*

It can be set to any one of the following:

HOST_NOT_FOUND
: Authoritative answer: Unknown host.

NETDB_INTERNAL
: You specified an invalid address family when calling *gethostbyname2()*.

NO_DATA
: Valid name, no data record of the requested type. The name is known to the name server, but has no IP address associated with it — this isn't a temporary error. Another type of request to the

name server using this domain name will result in an answer (e.g. a mail-forwarder may be registered for this domain).

NO_RECOVERY

Unknown server error. An unexpected server failure was encountered. This is a nonrecoverable network error.

TRY_AGAIN — Nonauthoritative answer: Host name lookup failure. This is usually a temporary error and means that the local server didn't receive a response from an authoritative server. A retry at some later time may succeed.

Classification:

POSIX 1003.1-2001

Caveats:

Unlike *errno*, *h_errno isn't* thread-safe.

See also:

errno, *gethostbyaddr()*, *gethostbyaddr_r()*, *gethostbyname()*, *gethostbyname2()*, *gethostbyname_r()*, *res_query()*, *res_search()*

hcreate()

Create a hash search table

Synopsis:

```
#include <search.h>

int hcreate( size_t nel );
```

Arguments:

nel An estimate of the maximum number of entries that the table will contain. The algorithm might adjust this number upward in order to obtain certain mathematically favorable circumstances.

Library:

libc

Description:

The *hcreate()* function allocates space for the hash search table. You must call this function before using *hsearch()*.

The *hsearch()* and *hcreate()* functions use *malloc()* to allocate space.

Only one hash search table may be active at any given time. You can destroy the table by calling *hdestroy()*.

Returns:

0 if there isn't enough space available to allocate the table.

Examples:

See *hsearch()*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

bsearch(), hdestroy(), hsearch(), malloc()

The Art of Computer Programming, Volume 3, Sorting and Searching by Donald E. Knuth, published by Addison-Wesley Publishing Company, 1973.

hdestroy()

Destroy the hash search table

Synopsis:

```
#include <search.h>

void hdestroy( void );
```

Library:

libc

Description:

The *hdestroy()* function destroys the hash search table that was created by *hcreate()* and used by *hsearch()*. Only one hash search table may be active at any given time.

Examples:

See *hsearch()*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

hcreate(), *hsearch()*

herror()

Print the message associated with the value of h_errno to standard error

Synopsis:

```
#include <netdb.h>

void herror( const char* prefix );
```

Arguments:

prefix NULL, or a string that you want to print before the error message.

Library:

libsocket

Description:

The *herror()* function prints the message corresponding to the error number contained in *h_errno* to *stderr*. The following functions can set *h_errno*:

- *gethostbyaddr()*
- *gethostbyaddr_r()*
- *gethostbyname()*
- *gethostbyname2()*
- *gethostbyname_r()*
- *res_query()*
- *res_search()*

If the *prefix* string is non-NULL, it's printed, followed by a colon and a space. The error message is printed with a trailing newline. One of the following messages could be printed:

HOST_NOT_FOUND

Authoritative answer: Unknown host.

NETDB_INTERNAL
: You specified an invalid address family when calling *gethostbyname2()*.

NO_DATA
: Valid name, no data record of the requested type. The name is known to the name server, but has no IP address associated with it — this isn't a temporary error. Another type of request to the name server using this domain name will result in an answer (e.g. a mail-forwarder may be registered for this domain).

NO_RECOVERY
: Unknown server error. An unexpected server failure was encountered. This is a nonrecoverable network error.

TRY_AGAIN
: Nonauthoritative answer: Host name lookup failure. This is usually a temporary error and means that the local server didn't receive a response from an authoritative server. A retry at some later time may succeed.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

gethostbyaddr(), gethostbyaddr_r(), gethostbyname(), gethostbyname_r(), h_errno, res_query(), res_search(), stderr

Synopsis:

```
#include <netdb.h>

struct  hostent {
     char *   h_name;
     char **  h_aliases;
     int      h_addrtype;
     int      h_length;
     char **  h_addr_list;
};

#define h_addr  h_addr_list[0]
```

Description:

This structure describes an Internet host. It contains either the information obtained from a name server, or broken-out fields from a line in **/etc/hosts**.

The members of this structure are:

h_name	The official name of the host.
h_aliases	A zero-terminated array of alternate names for the host.
h_addrtype	The type of address being returned; currently always AF_INET.
h_length	The length of the address, in bytes.
h_addr_list	A zero-terminated array of network addresses for the host. Host addresses are returned in network byte order.

A **#define** statement is used to define the following:

h_addr	The first address in *h_addr_list*. This is for backward compatibility.

Classification:

Unix, POSIX 1003.1-2001

See also:

endhostent(), *gethostbyaddr()*, *gethostbyname()*, *gethostent()*, *sethostent()*

/etc/hosts, **/etc/resolv.conf** in the *Utilities Reference*

hsearch()

Search the hash search table

Synopsis:

```
#include <search.h>

ENTRY* hsearch ( ENTRY item,
                 ACTION action );
```

Arguments:

item A structure of type **ENTRY**, defined in **<search.h>**, that contains:

- **char ***key — a pointer to the comparison key.
- **void ***data — a pointer to any other data to be associated with the key.

action A member of an enumeration type **ACTION**, also defined in **<search.h>**, indicating what to do with the entry if it isn't in the table:

- ENTER — insert the entry in the table at the appropriate point. If the item is a duplicate of an existing item, the new item isn't added, and *hsearch()* returns a pointer to the existing one.
- FIND — don't add the entry. If the item can't be found, *hsearch()* returns NULL.

Library:

libc

Description:

The *hsearch()* function is a hash-table search routine generalized from Knuth (6.4) Algorithm D. Before using this function, you must call *hcreate()* to create the hash table.

The *hsearch()* function returns a pointer into a hash table indicating the location at which an entry can be found. This function uses *strcmp()* as the comparison function.

The *hsearch()* and *hcreate()* functions use *malloc()* to allocate space.

Only one hash search table may be active at any given time. You can destroy the table by calling *hdestroy()*.

Returns:

A pointer to the item found, or NULL if either the action is FIND and the item wasn't found, or the action is ENTER and the table is full.

Examples:

The following example reads in strings followed by two numbers and stores them in a hash table, discarding duplicates. It then reads in strings, finds the matching entry in the hash table and prints it.

```
#include <stdio.h>
#include <search.h>
#include <string.h>
#include <stdlib.h>
struct info {            /* this is the info stored in table */
     int age, room;      /* other than the key */
};
#define NUM_EMPL    5000 /* # of elements in search table */
main( )
{
               /* space to store strings */
     char string_space[NUM_EMPL*20];
               /* space to store employee info */
     struct info info_space[NUM_EMPL];
               /* next avail space in string_space */
     char *str_ptr = string_space;
               /* next avail space in info_space */
     struct info *info_ptr = info_space;
     ENTRY item, *found_item;
               /* name to look for in table */
     char name_to_find[30];
     int i = 0;

               /* create table */
     (void) hcreate(NUM_EMPL);
     while (scanf("%s%d%d", str_ptr, &info_ptr->age,
            &info_ptr->room) != EOF && i++ < NUM_EMPL) {
               /* put info in structure, and structure in item */
          item.key = str_ptr;
          item.data = (void *)info_ptr;
          str_ptr += strlen(str_ptr) + 1;
```

```
            info_ptr++;
                /* put item into table */
            (void) hsearch(item, ENTER);
        }

                /* access table */
        item.key = name_to_find;
        while (scanf("%s", item.key) != EOF) {
            if ((found_item = hsearch(item, FIND)) != NULL) {
                /* if item is in the table */
            (void)printf("found %s, age = %d, room = %d\n",
                found_item->key,
                ((struct info *)found_item->data)->age,
                ((struct info *)found_item->data)->room);
            } else {
            (void)printf("no such employee %s\n",
                name_to_find);
            }
        }
        hdestroy();
        return 0;
}
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

bsearch(), hcreate(), hdestroy(), malloc(), strcmp()

The Art of Computer Programming, Volume 3, Sorting and Searching by Donald E. Knuth, published by Addison-Wesley Publishing Company, 1973.

hstrerror()

Get an error message string associated with the error return status

Synopsis:

```
#include <netdb.h>

const char* hstrerror( int err );
```

Arguments:

err The error code that you want to get the message for. For more information, see *h_errno*.

Library:

libsocket

Description:

The *hstrerror()* function gets an error message string associated with the error return status from network host-related functions.

Network host-related functions such as the following can return the error status:

- *gethostbyaddr()*, *gethostbyaddr_r()*
- *gethostbyname()*, *gethostbyname_r()*
- *res_query()*
- *res_search()*

You can check the external integer *h_errno* to see whether this is a temporary failure or an invalid or unknown host.

Returns:

A pointer to the message string affiliated with an error number.

☞ Don't modify the message string.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

h_errno, *herror*

htonl()

Convert a 32-bit value from host-byte order to network-byte order

Synopsis:

```
#include <arpa/inet.h>

uint32_t htonl( uint32_t hostlong );
```

Arguments:

hostlong The value that you want to convert.

Library:

libc

Description:

The *htonl()* function converts a 32-bit value from host-byte order to network-byte order.

You typically use this routine in conjunction with the internet addresses and ports that *gethostbyname()* and *getservent()* return.

Returns:

The value in network-byte order.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

gethostbyname(), *getservent()*, *htons()*, *ntohl()*, *ntohs()*

htons()

Convert a 16-bit value from host-byte order to network-byte order

Synopsis:

```
#include <arpa/inet.h>

uint16_t htons( uint16_t hostshort );
```

Arguments:

hostshort The value that you want to convert.

Library:

libc

Description:

The *htons()* function converts a 16-bit value from host-byte order to network-byte order.

You typically use this routine in conjunction with the internet addresses and ports that *gethostbyname()* and *getservent()* return.

Returns:

The value in network-byte order.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

gethostbyname(), *getservent()*, *htonl()*, *ntohl()*, *ntohs()*

hwi_find_item()

Find an item in the hwinfo structure

Synopsis:

```
#include <hw/sysinfo.h>

unsigned hwi_find_item( unsigned start,
                        ... );
```

Arguments:

start Where to start the search for the given item.

For the initial call, set this argument to HWI_NULL_OFF. If the item found isn't the one that you want, pass the return value from the first call to *hwi_find_item()* as the *start* parameter of the next call. This makes the search pick up where it left off. You can repeat this process as many times as required (the return value from the second call going into the *start* parameter of the third, etc).

*char ** A sequence of names for identifying the item being searched.

Terminate the sequence with a NULL pointer. The last string before the NULL is the bottom-level item name that you're looking for, the string in front of that is the name of the item that owns the bottom-level item, etc.

Library:

libc

Description:

The *hwi_find_item()* function finds an item in the *hwinfo* structure of the system page.

Returns:

The offset of the item requested, or HWI_NULL_OFF if the item wasn't found.

Examples:

Find the first occurrence of an item called "foobar":

```
item_off = hwi_find_item(HWI_NULL_OFF, "foobar", NULL);
```

Find the first occurrence of an item called "foobar" that's owned by "sam":

```
item_off = hwi_find_item(HWI_NULL_OFF, "sam", "foobar", NULL);
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

hwi_find_tag(), *hwi_off2tag()*, *hwi_tag2off()*

"Structure of the system page" in the Customizing Image Startup Programs chapter of *Building Embedded Systems*

hwi_find_tag()

Find a tag in the hwinfo structure

Synopsis:

```
#include <hw/sysinfo.h>

unsigned hwi_find_tag( unsigned start,
                       int curr_item,
                       const char * tagname );
```

Arguments:

start	Where to start to search for the given item. For the initial call, set this argument to HWI_NULL_OFF. If the item found isn't the one that you want, pass the return value from the first call to *hwi_find_tag()* as the *start* parameter of the next call. This makes the search pick up where it left off. You can repeat this process as many times as required (the return value from the second call going into the *start* parameter of the third, etc).
curr_item	If this argument is nonzero, the search stops at the end of the current item (i.e. the one that *start* points to). If *curr_item* is zero, the search continues until the end of the section.
tagname	The name of tag to search for.

Library:

libc

Description:

The *hwi_find_tag()* function finds the tag named *tagname*.

Returns:

The offset of the tag, or HWI_NULL_OFF if the tag wasn't found.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

hwi_find_item(), *hwi_off2tag()*, *hwi_tag2off()*

"Structure of the system page" in the Customizing Image Startup Programs chapter of *Building Embedded Systems*

hwi_off2tag()

Return a pointer to the start of a tag in the hwinfo area of the system page

Synopsis:

```
#include <hw/sysinfo.h>

void * hwi_off2tag( unsigned offsect );
```

Arguments:

offsect The offset, in bytes from the start of the *hwinfo* section, of a tag.

Library:

libc

Description:

The *hwi_off2tag()* function returns a pointer to the start of the tag, given an offset.

Returns:

A pointer to the start of the tag.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

hwi_find_item(), *hwi_find_tag()*, *hwi_tag2off()*

"Structure of the system page" in the Customizing Image Startup Programs chapter of *Building Embedded Systems*

hwi_tag2off()

Return the offset from the start of the hwinfo area of the system page

Synopsis:

```
#include <hw/sysinfo.h>

unsigned hwi_tag2off( void *tag );
```

Arguments:

tag A pointer to a tag in the *hwinfo* area of the system page.

Library:

libc

Description:

Given a pointer to the start of a tag, the *hwi_tag2off()* function returns the offset, in bytes, from the beginning of the start of the *hwinfo* section.

Returns:

The offset of the tag, in bytes.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

hwi_find_item(), *hwi_find_tag()*, *hwi_off2tag()*

"Structure of the system page" in the Customizing Image Startup Programs chapter of *Building Embedded Systems*

hypot(), hypotf()

Calculate the length of the hypotenuse for a right-angled triangle

Synopsis:

```
#include <math.h>

double hypot( double x,
              double y );

float hypotf( float x,
              float y );
```

Arguments:

x, *y* The lengths of the sides that are adjacent to the right angle.

Library:

libm

Description:

These functions compute the length of the hypotenuse for a right triangle whose sides are *x* and *y* adjacent to the right angle. The calculation is equivalent to:

```
length = sqrt( x*x + y*y );
```

Returns:

The length of the hypotenuse.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

int main( void )
{
    printf( "%f\n", hypot( 3.0, 4.0 ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
5.000000
```

Classification:

hypot() is standard Unix; *hypotf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

sqrt

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>

int socket( AF_INET,
            SOCK_RAW,
            proto );
```

Description:

ICMP is the error- and control-message protocol used by IP and the Internet protocol family. The protocol may be accessed through a "raw socket" for network monitoring and diagnostic functions.

To get the *proto* parameter to *socket()* that's used to create an ICMP socket, call *getprotobyname()*. You normally use ICMP sockets, which are connectionless, with *sendto()* and *recvfrom()*, although you can also use *connect()* to fix the destination for future packets (in which case you can use the *read()* or *recv()*, and *write()* or *send()* system calls).

Outgoing packets automatically have an IP header prepended to them that's based on the destination address. Incoming packets are received with the IP header and IP options intact.

Returns:

A descriptor referencing the socket, or -1 if an error occurs (*errno* is set).

Errors:

EADDRNOTAVAIL
: Tried to create a socket with a network address for which no network interface exists.

EISCONN
: Tried to establish a connection on a socket that already has one, or tried to send a datagram with the

	destination address specified but the socket is already connected.
ENOBUFS	The system ran out of memory for an internal data structure.
ENOTCONN	Tried to send a datagram, but no destination address was specified, and the socket hasn't been connected.

See also:

ICMP6, IP protocols

connect(), getprotobyname(), read(), recv(), recvfrom(), send(), sendto(), socket(), write()

RFC 792

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <netinet/icmp6.h>

int socket( AF_INET6,
            SOCK_RAW,
            proto);
```

Description:

ICMP6 is the error and control message protocol that IP6 and the Internet Protocol family use. It may be accessed through a "raw socket" for network monitoring and diagnostic functions. Use the *getprotobyname()* function to obtain the *proto* parameter to the *socket()* function, or simply pass IPPROTO_ICMPV6.

ICMPv6 sockets are connectionless, and are normally used with the *sendto()* and *recvfrom()* functions. You may also use the *connect()* function to fix the destination for future packets (in which case, you may also use the *read()* or *recv()* functions and the *write()* or *send()* system calls).

Outgoing packets automatically have an IP6 header prepended to them (based on the destination address). The ICMP6 pseudo header checksum field (*icmp6_cksum*, found in the **icmp6_hdr** structure in **<netinet/icmp6.h>**) is filled automatically by the socket manager. Incoming packets are received without the IP6 header or extension headers.

☞ This behavior is opposite from both IPv4 raw sockets and ICMPv4 sockets.

ICMP6 type/code filter

Each ICMP6 raw socket has an associated filter whose data type is defined as **struct icmp6_filter**. This structure, along with the

macros and constants defined below are defined in the **<netinet/icmp6.h>** header.

You can get and set the current filter by calling *getsockopt()* and *setsockopt()* with a level of IPPROTO_ICMPV6 and an option name of ICMP6_FILTER.

These macros operate on an **icmp6_filter** structure:

```
ICMP6_FILTER_SETPASSALL( struct icmp6_filter * )
ICMP6_FILTER_SETBLOCKALL( struct icmp6_filter * )
ICMP6_FILTER_SETPASS( int, struct icmp6_filter * )
ICMP6_FILTER_SETBLOCK( int, struct icmp6_filter * )
ICMP6_FILTER_WILLPASS( int, const struct icmp6_filter * )
ICMP6_FILTER_WILLBLOCK( int, const struct icmp6_filter * )
```

If the first argument is an integer, it represents an ICMP6 message type, with a value between 0 and 255. The pointer arguments are pointers to the filters that are either set or examined, depending on the macro:

ICMP6_FILTER_SETPASSALL()

Pass all ICMPv6 messages to the application.

ICMP6_FILTER_SETBLOCKALL()

Block all ICMPv6 messages from the application.

ICMP6_FILTER_SETPASS()

Pass messages of a certain ICMPv6 type to the application.

ICMP6_FILTER_SETBLOCK()

Block messages of a certain ICMPv6 type from the application.

ICMP6_FILTER_WILLPASS()

Return true or false, depending on whether or not the specified message type is passed to the application.

ICMP6_FILTER_WILLBLOCK()

Return true or false, depending on whether or not the specified message type is blocked from the application.

When you create an ICMP6 raw socket, it passes all ICMPv6 message types to the application by default.

For more information, see *RFC 2292*.

See also:

INET6, IP6 protocols

connect(), *getprotobyname()*, *getsockopt()*, *read()*, *recv()*, *recvfrom()*, *send()*, *sendto()*, *setsockopt()*, *socket()*, *write()*

RFC 2292

if_freenameindex()

Free dynamic memory allocated by if_nameindex()

Synopsis:

```
#include <net/if.h>

void if_freenameindex( struct if_nameindex * ptr );
```

Arguments:

ptr A pointer to the **if_nameindex** structure to be freed.

Library:

libsocket

Description:

The *if_freenameindex()* function frees the dynamic memory that you allocated by calling *if_nameindex()*.

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getifaddrs(), if_indextoname(), if_nameindex(), if_nametoindex()

if_indextoname()

Map an interface index to its name

Synopsis:

```
#include <net/if.h>

char * if_indextoname( unsigned int ifindex,
                       char * ifname );
```

Arguments:

ifindex The interface index.

ifname A pointer to a buffer in which *if_indextoname()* copies the interface name. The buffer must be a minimum of IFNAMSIZ bytes long.

Library:

libsocket

Description:

The *if_indextoname()* function maps the interface index specified by *ifindex* to its corresponding name. The name is copied into the buffer pointed to by *ifname*.

Returns:

A pointer to the name, or NULL if There isn't an interface corresponding to the specified index.

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

getifaddrs(), *if_freenameindex()*, *if_nameindex()*, *if_nametoindex()*

if_nameindex()

Return a list of interfaces

Synopsis:

```
#include <net/if.h>

struct if_nameindex * if_nameindex( void );
```

Library:

libsocket

Description:

The *if_nameindex()* function returns an array of **if_nameindex** structures, with one structure per interface, as defined in the include file **<net/if.h>**. The **if_nameindex** structure contains at least the following members:

unsigned int *if_index*

The index of the interface (1, 2, . . .).

**char ***_if_name_

A null-terminated name (e.g. **le0**).

The end of the array of structures is indicated by an entry with an *if_index* of 0 and an *if_name* of NULL.

Returns:

A valid array of **if_nameindex** structures, or NULL if and error occurred while using *getifaddrs()* to retrieve the list, or there wasn't enough memory available.

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getifaddrs(), if_freenameindex(), if_indextoname(), if_nametoindex()

if_nametoindex()

Map an interface name to its index

Synopsis:

```
#include <net/if.h>

unsigned int if_nametoindex( const char * ifname );
```

Arguments:

ifname The interface name that you want to map.

Library:

libsocket

Description:

The *if_nametoindex()* function maps the interface name specified by *ifname* to its corresponding index.

Returns:

The index number of the interface, or 0 if the specified interface couldn't be found or an error occurred while using *getifaddrs()* to retrieve the list of interfaces.

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getifaddrs(), if_freenameindex(), if_indextoname(), if_nameindex()

Synopsis:

```
#include <ifaddrs.h>

struct ifaddrs {
    struct ifaddrs *  ifa_next;
    char *            ifa_name;
    u_int             ifa_flags;
    struct sockaddr * ifa_addr;
    struct sockaddr * ifa_netmask;
    struct sockaddr * ifa_dstaddr;
    void *            ifa_data;
};
```

Description:

The **ifaddrs** structure contains the following entries:

ifa_next	A pointer to the next structure in the list. This field is NULL in the last structure in the list.
ifa_name	The interface name.
ifa_flags	The interface flags, as set by the **ifconfig** utility.
ifa_addr	Either the address of the interface or the link-level address of the interface, if one exists; otherwise it's NULL. See the *sa_family* member of the **sockaddr** structure pointed to by *ifa_addr* to determine the format of the address.
ifa_netmask	The netmask associated with **ifa_addr**, if one is set; otherwise it's NULL.
ifa_dstaddr	The destination address on a P2P interface, if one exists; otherwise it's NULL. If the interface isn't a P2P interface, *ifa_dstaddr* contains the broadcast address associated with *ifa_addr*, if one exists; otherwise it's NULL (see **<ifaddr.h>**).
ifa_data	Currently, this is set to NULL.

Classification:

Unix

See also:

freeifaddrs(), getifaddrs()

ilogb(), ilogbf()

Compute the integral part of a logarithm

Synopsis:

```
#include <math.h>

int ilogb ( double x );

int ilogbf (float x );
```

Arguments:

x The number you want to compute the integral part of the logarithm.

Library:

libm

Description:

The *ilogb()* and *ilogbf()* functions compute the integral part of:

$log_r |x|$

as a signed integral value, for nonzero finite *x*, where *r* is the radix of the machine's floating point arithmetic.

Returns:

The exponent part of *x*, in integer format:

If *x* is:	*ilogb()* returns:
0	-INT_MAX
NAN	INT_MAX
negative infinity	INT_MAX
positive infinity	INT_MAX

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

int main( void )
{
    printf( "%f\n", ilogb(.5) );

    return EXIT_SUCCESS;
}
```

Classification:

ilogb() is standard Unix; *ilogbf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

log(), logb(), log10(), log1p()

in8()

Read an 8-bit value from a port

Synopsis:

```
#include <hw/inout.h>

uint8_t in8( uintptr_t port );
```

Arguments:

port The port you want to read the value from.

Library:

libc

Description:

The *in8()* function reads an 8-bit value from the specified *port*.

Returns:

An 8-bit value.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

See also:

in8s(), in16(), in16s(), in32(), in32s(), mmap_device_io(), out8(), out8s(), out16(), out16s(), out32(), out32s()

Synopsis:

```
#include <hw/inout.h>

void * in8s( void * buff,
             unsigned len,
             uintptr_t port );
```

Arguments:

buff A pointer to a buffer where the function can store the values read.

len The number of values that you want to read.

port The port you want to read the values from.

Library:

libc

Description:

The *in8s()* function reads *len* 8-bit values from the specified *port* and stores them in the buffer pointed to by *buff*.

Returns:

A pointer to the end of the read data.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

See also:

in8(), in16(), in16s(), in32(), in32s(), mmap_device_io(), out8(), out8s(), out16(), out16s(), out32(), out32s()

in16(), inbe16(), inle16()

Read a 16-bit value from a port

Synopsis:

```
#include <hw/inout.h>

uint16_t in16( uintptr_t port );

#define inbe16 ( port ) ...

#define inle16 ( port ) ...
```

Arguments:

port The port you want to read the value from.

Library:

libc

Description:

The *in16()* function reads a 16-bit value from the specified *port* in native-endian format (there's no conversion required).

The *inbe16()* and *inle16()* macros read a 16-bit value that's in big-endian or little-endian format, respectively, from the specified *port*, and returns the value as native-endian.

Returns:

A 16-bit value in native-endian.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

Both *inbe16()* and *inle16()* are implemented as macros.

See also:

in8(), in8s(), in16s(), in32(), in32s(), mmap_device_io(), out8(), out8s(), out16(), out16s(), out32(), out32s()

in16s()

Read 16-bit values from a port

Synopsis:

```
#include <hw/inout.h>

void * in16s( void * buff,
              unsigned len,
              uintptr_t port );
```

Arguments:

buff A pointer to a buffer where the function can store the values read.

len The number of values that you want to read.

port The port you want to read the values from.

Library:

libc

Description:

The *in16s()* function reads *len* 16-bit values from the specified *port* and stores them in the buffer pointed to by *buff*.

Returns:

A pointer to the end of the read data.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

See also:

in8(), in8s(), in16(), in32(), in32s(), mmap_device_io(), out8(), out8s(), out16(), out16s(), out32(), out32s()

in32(), inbe32(), inle32()

Read a 32-bit value from a port

Synopsis:

```
#include <hw/inout.h>

uint32_t in32( uintptr_t port );

#define inbe32 ( port ) ...

#define inle32 ( port ) ...
```

Arguments:

port The port you want to read the value from.

Library:

libc

Description:

The *in32()* function reads a 32-bit value from the specified *port*.

The *inbe32()* and *inle32()* macros read a 32-bit value that's in big-endian or little-endian format, respectively, from the specified *port*, and returns the value as native-endian.

Returns:

A 32-bit value in native-endian.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

Both *inbe32()* and *inle32()* are implemented as macros.

See also:

in8(), in8s(), in16(), in16s(), in32s(), mmap_device_io(), out8(), out8s(), out16(), out16s(), out32(), out32s()

Synopsis:

```
#include <hw/inout.h>

void * in32s( void * buff,
              unsigned len,
              uintptr_t port );
```

Arguments:

buff A pointer to a buffer where the function can store the values read.

len The number of values that you want to read.

port The port you want to read the values from.

Library:

libc

Description:

The *in32s()* function reads *len* 32-bit values from the specified *port* and stores them in the buffer pointed to by *buff*.

Returns:

A pointer to the end of the read data.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

See also:

in8(), in8s(), in16(), in16s(), in32(), mmap_device_io(), out8(), out8s(), out16(), out16s(), out32(), out32s()

index()

Find a character in a string

Synopsis:

```
#include <strings.h>

char* index( const char* s,
             int c );
```

Arguments:

s The string you want to search. This string must end with a null (`\0`) character. The null character is considered to be part of the string.

c The character you're looking for.

Library:

libc

Description:

The *index()* function returns a pointer to the first occurrence of the character *c* in the string *s*.

Returns:

A pointer to the character, or NULL if the character doesn't occur in the string.

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes

continued...

Safety	
Thread	Yes

See also:

rindex(), strchr(), strrchr()

inet_addr()

Convert a string into a numeric Internet address

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

in_addr_t inet_addr( const char * cp );
```

Arguments:

cp A pointer to a string that represents an Internet address.

Library:

libsocket

Description:

The *inet_addr()* routine converts a string representing an IPv4 Internet address (for example, "**127.0.0.1**") into a numeric Internet address. To convert a hostname such as **ftp.qnx.com**, call *gethostbyname()*.

All Internet addresses are returned in network byte order (bytes are ordered from left to right). All network numbers and local address parts are returned as machine-format integer values. For more information on Internet addresses, see *inet_net_ntop()*.

Returns:

An Internet address, or INADDR_NONE if an error occurs.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Although the value INADDR_NONE (**0xFFFFFFFF**) is a valid broadcast address, *inet_addr()* always indicates failure when returning that value. The *inet_aton()* function doesn't share this problem.

See also:

inet_aton(), *inet_network()*

inet_aton()

Convert a string into an Internet address stored in a structure

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

int inet_aton( const char * cp,
               struct in_addr * addr );
```

Arguments:

cp A pointer to the character string.

addr A pointer to a **in_addr** structure where the function can store the converted address.

Library:

libsocket

Description:

The *inet_aton()* routine interprets the specified character string as an IPv4 Internet address, placing the address into the structure provided.

All Internet addresses are returned in network byte order (bytes are ordered from left to right). All network numbers and local address parts are returned as machine-format integer values.

For more information on Internet addresses, see *inet_net_ntop()*.

Returns:

1 Success; the string was successfully interpreted.

0 Failure; the string is invalid.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

gethostbyname(), *getnetent()* *inet_addr()*, *inet_lnaof()*, *inet_makeaddr()*, *inet_netof()*, *inet_network()*, *inet_ntoa()*

`/etc/hosts`, **`/etc/networks`** in the *Utilities Reference*

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

unsigned long inet_lnaof( struct in_addr in );
```

Arguments:

in An Internet address.

Library:

libsocket

Description:

The *inet_lnaof()* routine returns the local network address for an IPv4 Internet address.

All Internet addresses are returned in network byte order (bytes are ordered from left to right). All network numbers and local address parts are returned as machine-format integer values. For more information on Internet addresses, see *inet_net_ntop()*.

Returns:

A local network address.

Classification:

Standard Unix, POSIX 1003.1g (draft)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

inet_aton(), *inet_netof()*

inet_makeaddr()

Convert a network number and a local network address into an Internet address

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

struct in_addr inet_makeaddr( unsigned long net,
                              unsigned long lna );
```

Arguments:

net An Internet network number.

lna The local network address.

Library:

libsocket

Description:

The *inet_makeaddr()* routine takes an Internet network number and a local network address and constructs an IPv4 Internet address.

All Internet addresses are returned in network byte order (bytes are ordered from left to right). All network numbers and local address parts are returned as machine-format integer values. For more information on Internet addresses, see *inet_net_ntop()*.

Returns:

An Internet address.

Classification:

Standard Unix, POSIX 1003.1g (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

inet_aton()

inet_net_ntop()

Convert an Internet network number to CIDR format

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

char * inet_net_ntop( int af,
                      const void * src,
                      int bits,
                      char * dst,
                      size_t size );
```

Arguments:

af	The address family. Currently, only AF_INET is supported.
src	A pointer to the Internet network number that you want to convert. The format of the address is interpreted according to *af*.
bits	The number of bits that specify the network number (*src*).
dst	a pointer to the buffer where the function can store the converted address.
size	The size of the buffer that *dst* points to, in bytes.

Library:

libsocket

Description:

The *inet_net_ntop()* function converts an Internet network number from network format (usually a **struct in_addr** or some other binary form, in network byte order) to CIDR (Classless Internet Domain Routing) presentation format that's suitable for external display purposes.

With CIDR, a single IP address can be used to designate many unique IP addresses. A CIDR IP address looks like a normal IP address,

except that it ends with a slash (/) followed by a number, called the *IP prefix*. For example:

```
172.200.0.0/16
```

The IP prefix specifies how many addresses are covered by the CIDR address, with lower numbers covering more addresses.

Network Numbers (IPv4 Internet addresses)

You can specify Internet addresses in the "dotted quad" notation, or Internet network numbers, using one of the following forms:

a.*b*.*c*.*d*/*bits* or *a*.*b*.*c*.*d*

When you specify a four-part address, each part is interpreted as a byte of data and is assigned, from left to right, to the four bytes of an Internet network number (or Internet address). When an Internet network number is viewed as a 32-bit integer quantity on a system that uses little-endian byte order (i.e. right to left), such as the Intel 386, 486 and Pentium processors, the bytes referred to above appear as "*d.c.b.a*".

a.*b*.*c* When you specify a three-part address, the last part is interpreted as a 16-bit quantity and is placed in the rightmost two bytes of the Internet network number (or network address). This makes the three-part address format convenient for specifying Class B network addresses as *net.net.host*.

a.*b* When you specify a two-part address, the last part is interpreted as a 24-bit quantity and is placed in the rightmost three bytes of the Internet network number (or network address). This makes the two-part number format convenient for specifying Class A network numbers as *net.host*.

a When you specify a one-part address, the value is stored directly in the Internet network number (network address) without any byte rearrangement.

All numbers supplied as “parts” in a dot notation may be decimal, octal, or hexadecimal, as specified in the C language. That is, a number is interpreted as decimal unless it has a leading 0 (octal), or a leading `0x` or `0X` (hex).

Returns:

A pointer to the destination string (*dst*), or NULL if a system error occurs (*errno* is set).

Errors:

ENOENT Invalid argument *af*.

Classification:

POSIX 1003.1-2000

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

inet_aton(), *inet_net_ntop()*

inet_netof()

Extract the network number from an Internet address

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

unsigned long inet_netof( struct in_addr in );
```

Arguments:

in An Internet address.

Library:

libsocket

Description:

The *inet_netof()* routine returns the network number of the specified IPv4 Internet address.

All Internet addresses are returned in network order (bytes are ordered from left to right). All network numbers and local address parts are returned as machine-format integer values. For more information on Internet addresses, see *inet_net_ntop()*.

Returns:

An Internet network number.

Classification:

Standard Unix, POSIX 1003.1g (draft)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

inet_aton(), *inet_lnaof()*

inet_net_pton()

Convert an Internet network number from CIDR format to network format

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

int inet_net_pton( int af,
                   const char * src,
                   void * dst,
                   size_t size );
```

Arguments:

af	The address family. Currently, only AF_INET is supported.
src	A pointer to the presentation-format (CIDR) address. The format of the address is interpreted according to *af*.
dst	A pointer to the buffer where the function can store the converted address.
size	The size of the buffer pointed to by *dst*, in bytes.

Library:

libsocket

Description:

The *inet_net_pton()* function converts an Internet network number from presentation format — a printable form as held in a character string, such as, Internet standard dot notation, or Classless Internet Domain Routing (CIDR) — to network format (usually a struct **in_addr** or some other internal binary representation, in network byte order).

For more information on Internet addresses, see *inet_net_ntop()*.

Returns:

The number of bits that specify the network number (computed based on the class, or specified with /CIDR), or -1 if an error occurred (*errno* is set).

Errors:

ENOENT Invalid argument *af*.

Classification:

POSIX 1003.1-2000

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

inet_aton(), *inet_net_ntop()*

inet_network()

Convert a string into an Internet network number

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

unsigned long inet_network( const char * cp );
```

Arguments:

cp A pointer to a string representing an Internet address.

Library:

libsocket

Description:

The *inet_network()* routine converts a string representing an IPv4 Internet address (for example, "`127.0.0.1`") into a numeric Internet network number.

All Internet addresses are returned in network order (bytes are ordered from left to right). All network numbers and local address parts are returned as machine-format integer values. For more information on Internet addresses, see *inet_net_ntop()*.

Returns:

An Internet network number, or INADDR_NONE if an error occurs.

Classification:

Standard Unix, POSIX 1003.1g (draft)

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

inet_addr(), *inet_aton()*

inet_ntoa()

Convert an Internet address into a string

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

char * inet_ntoa( struct in_addr in );
```

Arguments:

in The Internet address that you want to convert.

Library:

libsocket

Description:

The *inet_ntoa()* routine converts an IPv4 Internet address into an ASCII string representing the address in dot notation (for example, "`127.0.0.1`").

For more information on Internet addresses, see *inet_net_ntop()*.

Returns:

A string representing an Internet address.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

The string returned by this function is stored in a static buffer that's reused for every call to *inet_ntoa()*. For a thread-safe version, see *inet_ntoa_r()*.

See also:

inet_aton(), *inet_ntoa_r()*

inet_ntoa_r()

Convert an Internet address into a string

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <arpa/inet.h>

char * inet_ntoa_r( struct in_addr in,
                    char * buffer,
                    int bufflen );
```

Arguments:

in	The Internet address that you want to convert.
buffer	A buffer where the function can store the result.
bufflen	The size of the buffer, in bytes.

Library:

libsocket

Description:

The *inet_ntoa_r()* function is a thread-safe version of *inet_ntoa()*. It converts an IPv4 Internet address into a string (for example, "**127.0.0.1**"). For more information on this routine, see *inet_aton()*.

Returns:

A string representing an Internet address, or NULL if an error occurs (*errno* is set).

Errors:

ERANGE	The supplied *buffer* isn't large enough to store the result.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

inet_aton(), *inet_ntoa()*

inet_ntop()

Convert a numeric network address to a string

Synopsis:

```
#include <sys/socket.h>
#include <arpa/inet.h>

const char * inet_ntop( int af,
                        const void * src,
                        char * dst,
                        socklen_t size );
```

Arguments:

af The *src* address's network family; one of:

AF_INET	IPv4 addresses
AF_INET6	IPv6 addresses

src The numeric network address that you want to convert to a string.

dst The text string that represents the translated network address. You can use the following constants to allocate buffers of the correct size (they're defined in **<netinet/in.h>**):

- INET_ADDRSTRLEN — storage for an IPv4 address
- INET6_ADDRSTRLEN — storage for an IPv6 address

size The size of the buffer pointed to by *dst*.

Library:

libc

Description:

The *inet_ntop()* function converts a numeric network address pointed to by *src* into a text string in the buffer pointed to by *dst*.

Returns:

A pointer to the buffer containing the text version of the address, or NULL if an error occurs (*errno* is set).

Errors:

EAFNOSUPPORT
: The value of the *af* argument isn't a supported network family.

ENOSPC
: The *dst* buffer isn't large enough (according to *size*) to store the translated address.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <errno.h>

#define INADDR  "10.1.0.29"
#define IN6ADDR "DEAD:BEEF:7654:3210:FEDC:3210:7654:BA98"

int
main()
{
   struct in_addr inaddr;
   struct in6_addr in6addr;
   char buf[INET_ADDRSTRLEN], buf6[INET6_ADDRSTRLEN];
   int rval;

   if ( (rval = inet_pton(AF_INET, INADDR, &inaddr)) == 0) {
      printf("Invalid address: %s\n", INADDR);
      exit(EXIT_FAILURE);
   } else if (rval == -1) {
      perror("inet_pton");
      exit(EXIT_FAILURE);
   }

   if (inet_ntop(AF_INET, &inaddr, buf, sizeof(buf)) != NULL)
      printf("inet addr: %s\n", buf);
   else {
      perror("inet_ntop");
      exit(EXIT_FAILURE);
   }
```

```
   if ( (rval = inet_pton(AF_INET6, IN6ADDR, &in6addr)) == 0) {
      printf("Invalid address: %s\n", IN6ADDR);
      exit(EXIT_FAILURE);
   } else if (rval == -1) {
      perror("inet_pton");
      exit(EXIT_FAILURE);
   }

   if (inet_ntop(AF_INET6, &in6addr, buf6, sizeof(buf6)) != NULL)
      printf("inet6 addr: %s\n", buf6);
   else {
      perror("inet_ntop");
      exit(EXIT_FAILURE);
   }

   return(EXIT_SUCCESS);
}
```

Classification:

Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

inet_pton()

Synopsis:

```
#include <sys/socket.h>
#include <arpa/inet.h>

int inet_pton( int af,
               const char * src,
               void * dst );
```

Arguments:

af The *src* address's network family; one of:

AF_INET	IPv4 addresses
AF_INET6	IPv6 addresses

src A pointer to the text host address that you want to convert. The format of the address is interpreted according to *af*

dst A pointer to a buffer where the function can store the converted address.

Library:

libc

Description:

The *inet_pton()* function converts the standard text representation of the numeric network address (*src*) into its numeric network byte-order binary form (*dst*).

The converted address is stored in network byte order in *dst*. The buffer pointed to by *dst* must be large enough to hold the numeric address:

Family	Numeric address size
AF_INET	4 bytes
AF_INET6	16 bytes

AF_INET addresses

IPv4 addresses must be specified in the standard dotted-decimal form:

ddd.*ddd*.*ddd*.*ddd*

where *ddd* is a one- to three-digit decimal number between 0 and 255.

Many existing implementations of *inet_addr()* and *inet_aton()* accept nonstandard input: octal numbers, hexadecimal numbers, and fewer than four numbers. The *inet_pton()* function doesn't accept these formats.

AF_INET6 addresses

IPv6 addresses must be specified in one of the following standard formats:

- The preferred form is:

  x:*x*:*x*:*x*:*x*:*x*:*x*:*x*

  where *x* is a hexadecimal value for one of the eight 16-bit pieces of the address. For example:

  ```
  DEAD:BEEF:7654:3210:FEDC:3210:7654:BA98
  417A:200C:800:8:0:0:0:1080
  ```

- A `::` can be used once per address to represent multiple groups of 16 zero-bits. For example, the following addresses:

  ```
  1080:0:0:0:8:800:200C:417A
  FF01:0:0:0:0:0:0:43
  0:0:0:0:0:0:0:1
  0:0:0:0:0:0:0:0
  ```

  can be represented as:

```
1080::8:800:200C:417A
FF01::43
::1
::
```

- A convenient format when dealing with mixed IPv4 and IPv6 environments is:

  x:*x*:*x*:*x*:*x*:*x*:*d*.*d*.*d*.*d*

  where *x* is a hexadecimal value for one of the six high-order 16-bit pieces of the address and *d* is a decimal value for one of the four low-order 8-bit pieces of the address (standard AF_INET representation). For example:

  ```
  0:0:0:0:0:0:13.1.68.3
  0:0:0:0:0:FFFF:129.144.52.38
  ```

  Or, in their compressed forms:

  ```
  ::13.1.68.3
  ::FFFF:129.144.52.38
  ```

Returns:

1	Success.
0	The input isn't a valid address.
-1	An error occurred (*errno* is set).

Errors:

EAFNOSUPPORT

The *af* argument isn't one of the supported networking families.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <errno.h>

#define INADDR  "10.1.0.29"
```

```
#define IN6ADDR "DEAD:BEEF:7654:3210:FEDC:3210:7654:BA98"

int
main()
{
   struct in_addr inaddr;
   struct in6_addr in6addr;
   char buf[INET_ADDRSTRLEN], buf6[INET6_ADDRSTRLEN];
   int rval;

   if ( (rval = inet_pton(AF_INET, INADDR, &inaddr)) == 0) {
      printf("Invalid address: %s\n", INADDR);
      exit(EXIT_FAILURE);
   } else if (rval == -1) {
      perror("inet_pton");
      exit(EXIT_FAILURE);
   }

   if (inet_ntop(AF_INET, &inaddr, buf, sizeof(buf)) != NULL)
      printf("inet addr: %s\n", buf);
   else {
      perror("inet_ntop");
      exit(EXIT_FAILURE);
   }

   if ( (rval = inet_pton(AF_INET6, IN6ADDR, &in6addr)) == 0) {
      printf("Invalid address: %s\n", IN6ADDR);
      exit(EXIT_FAILURE);
   } else if (rval == -1) {
      perror("inet_pton");
      exit(EXIT_FAILURE);
   }

   if (inet_ntop(AF_INET6, &in6addr, buf6, sizeof(buf6)) != NULL)
      printf("inet6 addr: %s\n", buf6);
   else {
      perror("inet_ntop");
      exit(EXIT_FAILURE);
   }

   return(EXIT_SUCCESS);
}
```

Classification:

Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

inet_ntop()

RFC 2373

inet6_option_*()

Manipulate IPv6 hop-by-hop and destination options

Synopsis:

```
#include <netinet/in.h>

int inet6_option_space(int nbytes);

int inet6_option_init(void *bp,
                      struct cmsghdr **cmsgp,
                      int type);

int inet6_option_append(struct cmsghdr *cmsg,
                        const u_int8_t *typep,
                        int multx,
                        int plusy);

u_int8_t * inet6_option_alloc(struct cmsghdr *cmsg,
                              int datalen,
      int multx,
                              int plusy);

int inet6_option_next(const struct cmsghdr *cmsg,
                      u_int8_t **tptrp);

int inet6_option_find(const struct cmsghdr *cmsg,
                      u_int8_t **tptrp,
                      int type);
```

Arguments:

nbytes Size of the structure that defines the option. It includes any pad bytes at the beginning the value *y* in the alignment term *xn + y*, the type byte, the length byte, and the option data.

bp Pointer to previously allocated space that contains the ancillary data object. It must be large enough to contain all the individual options to be added by later calls to *inet6_option_append()* and *inet6_option_alloc()*.

cmsgp Pointer to a **cmsghdr** structure. The **cmsgp* variable is initialized by this function to point to the **cmsghdr**

structure constructed by this function in the buffer pointed to by *bp*.

type Either IPV6_HOPOPTS or IPV6_DSTOPTS. This type is stored in the *cmsg_type* member of the **cmsghdr** structure pointed to by **cmsgp*.

cmsg Pointer to the **cmsghdr** structure that must have been initialized by *inet6_option_init()*.

typep Pointer to the 8-bit option type. It's assumed that this field is immediately followed by the 8-bit option data length field, which is then followed by the option data. The caller initializes these three fields (the type-length-value, or TLV) before calling this function.

The option type must have a value from 2 to 255, inclusive. (0 and 1 are reserved for the **Pad1** and **PadN** options, respectively.)

The option data length must have a value between 0 and 255, inclusive, and is the length of the option data that follows.

multx value *x* in the alignment term *xn* + *y*. It must have a value of 1, 2, 4, or 8.

plusy Value *y* in the alignment term *xn* + *y*. It must have a value between 0 and 7, inclusive.

tptrp Pointer to a pointer to an 8-bit byte.

Library:

libsocket

Description:

These functions perform hop-by-hop and destination options following *RFC2292* that alleviates alignment constraints, padding and ancillary data manipulation. You can find the prototypes for these functions in the **<netinet/in.h>** header.

inet6_option_space()

This function returns the number of bytes required to hold an option when it's stored as ancillary data, including the **cmsghdr** structure at the beginning, and any padding at the end (to make its size a multiple of 8 bytes). The argument is the size of the structure that defines the option. It includes any pad bytes at the beginning (the value *y* in the alignment term *xn* + *y*), the type byte, the length byte, and the option data.

When multiple options are stored in a single ancillary data object, this function overestimates the amount of space required by the size of *N-1* **cmsghdr** structures, where *N* is the number of options to be stored in the object. This is of little consequence, since it's assumed that most hop-by-hop option and destination option headers carry only one option (see Appendix B of *RFC 2460*).

inet6_option_init()

This function is called once per ancillary data object that contains either hop-by-hop or destination options.

bp Pointer to previously allocated space that contains the ancillary data object. It must be large enough to contain all the individual options to be added by later calls to *inet6_option_append()* and *inet6_option_alloc()*.

cmsgp Pointer to a **cmsghdr** structure. The **cmsgp* variable is initialized by this function to point to the **cmsghdr** structure constructed by this function in the buffer pointed to by *bp*.

type Either IPV6_HOPOPTS or IPV6_DSTOPTS. This type is stored in the *cmsg_type* member of the **cmsghdr** structure pointed to by **cmsgp*.

Returns:

0 Success.

-1 An error has occurred.

inet6_option_append()

This function appends a hop-by-hop option or a destination option into an ancillary data object that has been initialized by *inet6_option_init()*.

cmsg Pointer to the **cmsghdr** structure that must have been initialized by *inet6_option_init()*.

typep Pointer to the 8-bit option type. It's assumed that this field is immediately followed by the 8-bit option data length field, which is then followed by the option data. The caller initializes these three fields (the type-length-value, or TLV) before calling this function.

The option type must have a value from 2 to 255, inclusive. (0 and 1 are reserved for the **Pad1** and **PadN** options, respectively.)

The option data length must have a value between 0 and 255, inclusive, and is the length of the option data that follows.

multx value *x* in the alignment term *xn* + *y*. It must have a value of 1, 2, 4, or 8.

plusy Value *y* in the alignment term *xn* + *y*. It must have a value between 0 and 7, inclusive.

Returns:

0 Success.

-1 An error has occurred.

inet6_option_alloc()

This function appends a hop-by-hop option or a destination option into an ancillary data object that has been initialized by *inet6_option_init()*.

The difference between this function and *inet6_option_append()* is that the latter copies the contents of the previously built option into the ancillary data object. This function returns a pointer to the space in the data object where the option's TLV must then be built by the caller.

cmsg pointer to the **cmsghdr** structure that must have been initialized by *inet6_option_init()*.

datalen Value of the option data length byte for this option. This value is required as an argument to allow the function to determine if padding should be appended at the end of the option, argument since the option data length must already be stored by the caller. (The *inet6_option_append()* function doesn't need a data length)

multx Value *x* in the alignment term *xn + y*. It must have a value of 1, 2, 4, or 8.

plusy Value of *y* in the alignment term *xn + y*. It must have a value between 0 and 7, inclusive.

Returns

Pointer to the 8-bit option type field that starts the option

Success.

NULL An error has occurred.

inet6_option_next()

This function processes the next hop-by-hop option or destination option in an ancillary data object. If another option remains to be processed, the return value of the function is 0 and **tptrp* points to the 8-bit option type field the option data.

The *cmsg* variable is a pointer to **cmsghdr** structure for which *cmsg_level* equals IPPROTO_IPV6 and *cmsg_type* equals either IPV6_HOPOPTS or IPV6_DSTOPTS.

The *tptrp* is a pointer to a pointer to an 8-bit byte and **tptrp* is used by the function to remember its place in the ancillary data object each time the function is called. The first time this function is called for a given ancillary data object, **tptrp* must be set to NULL.

Each time this function returns success, **tptrp* points to the 8-bit option type field for the next option to be processed.

Returns:

0 The option is located and the **tptrp* points to the 8-bit option type field.

-1 with **tptrp* pointing to NULL

No more options to process.

-1 with **tptrp* pointing to non-NULL

An error has occurred.

inet6_option_find()

This function is similar to *inet6_option_next()*. It however, lets the caller specify the option type to be searched for, instead of always returning the next option in the ancillary data object. The *cmsg* is a pointer to the **cmsghdr** structure of which *cmsg_level* equals IPPROTO_IPV6 and *cmsg_type* equals either IPV6_HOPOPTS or IPV6_DSTOPTS.

The *tptrp* is a pointer to a pointer to an 8-bit byte that is used by the function to remember its place in the ancillary data object each time the function is called.

The first time this function is called for a given ancillary data object, **tptrp* must be set to NULL. This function starts searching for an option of the specified type beginning after the value of **tptrp* pointer.

Returns:

0 with **tptrp* pointing to the 8-bit option

The option is located.

-1 with **tptrp* pointing to NULL

The option is not located.

-1 with **tptrp* pointing to non-NULL

An error has occurred.

Classification:

Standard *RFC 2292*

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

W. Stevens and M. Thomas, Advanced Sockets API for IPv6, *RFC 2292*, February 1998. Contains examples.

S. Deering and R. Hinden, Internet Protocol, Version 6 (IPv6) Specification, *RFC 2460*, December 1998.

Synopsis:

```
#include <netinet/in.h>

struct sockaddr_in6 {
    uint8_t sin6_len;
    sa_family_t sin6_family;
    in_port_t sin6_port;
    uint32_t sin6_flowinfo;
    struct in6_addr sin6_addr;
    uint32_t sin6_scope_id;
};
```

Description:

Protocols

The INET6 family consists of the:

- IPv6 network protocol
- Internet Control Message Protocol version 6 (ICMP)
- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP).

TCP supports the SOCK_STREAM abstraction, while UDP supports the SOCK_DGRAM abstraction. Note that TCP and UDP are common to INET and INET6. A raw interface to IPv6 is available by creating an Internet SOCK_RAW socket. The ICMPv6 message protocol may be accessed from a raw socket.

The INET6 protocol family is an updated version of the INET family. While INET implements Internet Protocol version 4, INET6 implements Internet Protocol version 6.

Addressing

IPv6 addresses are 16-byte quantities, stored in network standard (big-endian) byte order. The header file **<netinet/in.h>** defines this address as a discriminated union.

Sockets bound to the INET6 family use the structure shown above.

You can create sockets with the local address **::** (which is equal to IPv6 address **0:0:0:0:0:0:0:0**) to cause "wildcard" matching on incoming messages. You can specify the address in a call to *connect()* or *sendto()* as **::** to mean the local host. You can get the **::** value by setting the *sin6_addr* field to 0, or by using the address contained in the *in6addr_any* global variable, which is declared in **<netinet6/in6.h>**.

The IPv6 specification defines *scoped addresses*, such as link-local or site-local addresses. A scoped address is ambiguous to the kernel if it's specified without a scope identifier. To manipulate scoped addresses properly in your application, use the advanced API defined in *RFC 2292*. A compact description on the advanced API is available in IP6. If you specify scoped addresses without an explicit scope, the socket manager may return an error.

Scoped addresses are currently experimental, from both a specification and an implementation point of view.

The KAME implementation supports extended numeric IPv6 address notation for link-local addresses. For example, you can use **fe80::1%de0** to specify "**fe80::1** on the **de0** interface." The *getaddrinfo()* and *getnameinfo()* functions support this notation. Some utilities, such as **telnet** and **ftp**, can use the notation. With special programs like **ping6**, you can disambiguate scoped addresses by specifying the outgoing interface with extra command-line options.

The socket manager handles scoped addresses in a special manner. In the socket manager's routing tables or interface structures, a scoped address's interface index is embedded in the address. Therefore, the address contained in some of the socket manager structures isn't the same as on the wire. The embedded index becomes visible when using the PF_ROUTE socket or the *sysctl()* function. You shouldn't use the embedded form.

Interaction between IPv4/v6 sockets

The behavior of the AF_INET6 TCP/UDP socket is documented in the *RFC 2553* specification, which states:

- A specific bind on an AF_INET6 socket (*bind()* with an address specified) should accept IPv6 traffic to that address only.
- If you perform a wildcard bind on an AF_INET6 socket (*bind()* to the IPv6 address `::`), and there isn't a wildcard-bound AF_INET socket on that TCP/UDP port, then the IPv6 traffic as well as the IPv4 traffic should be routed to that AF_INET6 socket. IPv4 traffic should be seen by the application as if it came from an IPv6 address such as `::ffff:10.1.1.1`. This is called an *IPv4 mapped address*.
- If there are both wildcard-bound AF_INET sockets and wildcard-bound AF_INET6 sockets on one TCP/UDP port, they should operate independently: IPv4 traffic should be routed to the AF_INET socket, and IPv6 should be routed to the AF_INET6 socket.

However, the *RFC 2553* specification doesn't define the constraint between the binding order, nor how the IPv4 TCP/UDP port numbers and the IPv6 TCP/UDP port numbers relate each other (whether they must be integrated or separated). The behavior is very different from implementation to implementation. It is unwise to rely too much on the behavior of the AF_INET6 wildcard-bound socket. Instead, connect to two sockets, one for AF_INET and another for AF_INET6, when you want to accept both IPv4 and IPv6 traffic.

CAUTION: Use caution when handling connections from IPv4 mapped addresses with AF_INET6 sockets — if the target node routes IPv4 traffic to AF_INET6 sockets, malicious parties can bypass security.

Because of the security hole, by default, NetBSD doesn't route IPv4 traffic to AF_INET6 sockets. If you want to accept both IPv4 and IPv6 traffic, use two sockets. IPv4 traffic may be routed with multiple

per-socket/per-node configurations, but, it isn't recommended. See IP6 for details.

The IPv6 support is subject to change as the Internet protocols develop. Don't depend on details of the current implementation, but rather the services exported. Try to implement version-independent code as much as possible, because you'll need to support both INET and INET6.

See also:

ICMP, ICMP6, IP6, IP, TCP, UDP protocols

bind(), *connect()*, *getaddrinfo()*, *ioctl()*, *sendto()*, *socket()*, *sysctl()*

ftp, **ping6**, **telnet** in the *Utilities Reference*

RFC 2553, *RFC 2292*

inet6_rthdr_*()

Manipulate IPv6 Router header options

Synopsis:

```
#include <netinet/in.h>
size_t inet6_rthdr_space(int type,
                         int segments);

struct cmsghdr * inet6_rthdr_init(void *bp,
                                  int type);

int inet6_rthdr_add(struct cmsghdr *cmsg,
                    const struct in6_addr *addr,
                    unsigned int flags);

int inet6_rthdr_lasthop(struct cmsghdr *cmsg,
                        unsigned int flags);

int inet6_rthdr_reverse(const struct cmsghdr *in,
                        struct cmsghdr *out);

int inet6_rthdr_segments(const struct cmsghdr *cmsg);

struct in6_addr * inet6_rthdr_getaddr(struct cmsghdr *cmsg,
                                      int index);

int inet6_rthdr_getflags(const struct cmsghdr *cmsg,
                         int index);
```

Arguments:

type	The type of IPv6 Routing header (e.g. Type 0 as defined in **<netinet/in.h>**).
segments	The number of segments (addresses) in the Routing header.
bp	Pointer to the buffer that contains a **cmsghdr** structure followed by a Routing header of the specified type.
addr	IPv6 address structure.
flags	Routing header flags.

in	Ancillary data containing Routing header.
out	Ancillary data containing Routing header.
cmsg	Ancillary data containing Routing header.
index	A value between 0 and the number returned by *inet6_rthdr_segments()*.

Library:

libsocket

Description:

Your application can now call eight functions to build and examine a Routing header. The function prototypes for these functions are all in the **<netinet/in.h>** header.

The following functions build a Routing header:

Use this function:	To:
inet6_rthdr_space()	Return number of bytes required for ancillary data
inet6_rthdr_init()	Initialize ancillary data for Routing header
inet6_rthdr_add()	Add IPv6 address and flags to Routing header
inet6_rthdr_lasthop()	Specify the flags for the final hop

The following functions deal with a returned Routing header:

Use this function:	To:
inet6_rthdr_reverse()	Reverse a Routing header
inet6_rthdr_segments()	Return number of segments in a Routing header
inet6_rthdr_getaddr()	Fetch one address from a Routing header
inet6_rthdr_getflags()	Fetch one flag from a Routing header

inet6_rthdr_space()

This function returns the number of bytes required to hold a Routing header of the specified type containing a specified number of segments (addresses). For an IPv6 Type 0 Routing header, the number of segments must be between 1 and 23, inclusive. The return value includes the size of the **cmsghdr** structure that precedes the Routing header, and any required padding.

If the return value is 0, then either the type of the Routing header isn't supported by this implementation or the number of segments is invalid for this type of Routing header.

This function returns the size but doesn't allocate the space required for the ancillary data. This allows an application to allocate a larger buffer, if other ancillary data objects are desired. All the ancillary data objects must be specified to *sendmsg()* as a single **msg_control** buffer in the **msghdr** structure *msg_control* member.

inet6_rthdr_init()

This function initializes the buffer pointed to by *bp* to contain a **cmsghdr** structure followed by a Routing header of the specified type. The *cmsg_len* member of the **cmsghdr** structure is initialized to the size of the structure plus the amount of space required by the Routing header.

The *cmsg_level* and *cmsg_type* members are also initialized as required.

The caller must allocate the buffer and its size that is determined by calling *inet6_rthdr_space()*.

Upon success, the return value is the pointer to the **cmsghdr** structure, and this is then used as the first argument to the next two functions.

The function returns NULL on error.

inet6_rthdr_add()

This function adds the address pointed to by *addr* to the end of the Routing header being constructed and sets the type of this hop to the value of *flags*. For an **IPv6** Type 0 Routing header, *flags* must be either IPV6_RTHDR_LOOSE or IPV6_RTHDR_STRICT.

If successful, the *cmsg_len* member of the **cmsghdr** structure is updated to account for the new address in the Routing header.

Returns:

0 Success.

-1 An error has occurred.

inet6_rthdr_lasthop()

This function specifies the Strict/Loose flag for the final hop of a Routing header. For an **IPv6** Type 0 Routing header, *flags* must be either IPV6_RTHDR_LOOSE or IPV6_RTHDR_STRICT.

Returns:

0 Success.

-1 An error has occurred.

☞ A Routing header specifying N intermediate nodes requires N+1 Strict/Loose flags. This requires N calls to *inet6_rthdr_add()* followed by one call to *inet6_rthdr_lasthop()*.

inet6_rthdr_reverse()

☞ The *inet6_rthdr_reverse()* has not been implemented yet.

This function takes a Routing header that has been received as ancillary data (pointed to by the first argument, *in*) and writes a new Routing header. The Routing header sends datagrams along the reverse of that route. Both arguments are allowed to point to the same buffer (that is, the reversal can occur in place).

Returns:

0	Success.
-1	An error has occurred.

inet6_rthdr_segments()

This function returns the number of segments (addresses) contained in the Routing header described by *cmsg*.

Returns:

1 to 23	Success.
-1	An error has occurred.

inet6_rthdr_getaddr()

This function returns a pointer to the `IPv6` address specified by *index* in the Routing header described by *cmsg*. The *index* must have a value between 1 and the number returned by *inet6_rthdr_segments()*. An application should first call *inet6_rthdr_segments()* to obtain the number of segments in the Routing header.

The function returns NULL on error.

inet6_rthdr_getflags()

This function returns the flags value specified by *index* in the Routing header described by *cmsg*. The *index* must have a value between 0 and the number returned by *inet6_rthdr_segments()*. For an IPv6 Type 0 Routing header, the return value is either IPV6_RTHDR_LOOSE or IPV6_RTHDR_STRICT.

The function returns -1 on error.

☞ Addresses are indexed starting at 1, and flags starting at 0. They're consistent with the terminology and figures in *RFC2460*.

Classification:

RFC 2292

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

W. Stevens and M. Thomas, Advanced Sockets API for IPv6, *RFC 2292*, February 1998. Contains good examples.

S. Deering and R. Hinden, Internet Protocol, Version 6 (IPv6) Specification, *RFC 2460*, December 1998.

initgroups()

Initialize the supplementary group access list

Synopsis:

```
#include <grp.h>
#include <sys/types.h>

int initgroups( const char * name,
                gid_t basegid );
```

Arguments:

name The name of the user whose group membership you want to use as the supplementary group access list.

basegid A group ID that you want to include in the group access list.

Library:

libc

Description:

The *initgroups()* function reads the group membership for the user specified by *name* from the group database, and then initializes the supplementary group access list of the calling process (see *getgrnam()* and *getgroups()*).

If the number of groups in the supplementary access list exceeds NGROUPS_MAX, the extra groups are ignored.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EPERM The caller isn't **root**.

Files:

/etc/group The group database.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

If *initgroups()* fails, it *doesn't* change the supplementary group access list.

The *getgrouplist()* function called by *initgroups()* is based on *getgrent()*. If the calling process uses *getgrent()*, the in-memory group structure is overwritten in the call to *initgroups()*.

See also:

getgroups(), *getgrnam()*

initstate()

Initialize a pseudo-random number generator

Synopsis:

```
#include <stdlib.h>

char* initstate( unsigned int seed,
                 char* state,
                 size_t size );
```

Arguments:

seed	A starting point for the random-number sequence. This lets you restart the sequence at the same point.
state	The state array that you want to initialize.
size	The size, in bytes, of the state array; see below.

Library:

libc

Description:

The *initstate()* initializes the given state array for future use when generating pseudo-random numbers.

This function uses the *size* argument to determine what type of random-number generator to use; the larger the state array, the more random the numbers. Values for the amount of state information are 8, 32, 64, 128, and 256 bytes. Other values greater than 8 bytes are rounded down to the nearest one of these values. For values smaller than 8, *random()* uses a simple linear congruential random number generator.

Use this function in conjunction with the following:

random()	Generate a pseudo-random number using a default state.
setstate()	Specify the state of the pseudo-random number generator.

srandom() Set the seed used by the pseudo-random number generator.

If you haven't called *initstate()*, *random()* behaves as though you had called *initstate()* with a *seed* of 1 and a *size* of 128.

After initialization, you can restart a state array at a different point in one of these ways:

- Call *initstate()* with the desired seed, state array, and size of the array.
- Call *setstate()* with the desired state, then call *srandom()* with the desired seed. The advantage of using both of these functions is that the size of the state array doesn't have to be saved once it's initialized.

Returns:

A pointer to the previous state array, or NULL if an error occurred.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <time.h>

static char state1[32];

int main() {
   initstate( time(NULL), state1, sizeof(state1));
   setstate(state1);
   printf("%d0\n", random());
   return EXIT_SUCCESS;
}
```

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

drand48(), rand(), random(), setstate(), srand(), srandom()

input_line()

Get a string of characters from a file

Synopsis:

```
#include <stdio.h>

char* input_line( FILE* fp,
                  char* buf,
                  int bufsize );

extern int _input_line_max;
```

Arguments:

fp	The file that you want to read from.
buf	A pointer to a buffer where the function can store the string that it reads.
bufsize	The size of the buffer, in bytes.

Library:

libc

Description:

The *input_line()* function gets a string of characters from the file designated by *fp* and stores them in the array pointed to by *buf*. The *input_line()* function stops reading characters when:

- end-of-file is reached
- a newline character is read
- *bufsize* - 1 characters have been read.

In addition, the *input_line()* function buffers the last *_input_line_max* lines internally. The *_input_line_max* variable is defined in **<stdio.h>**. You can set it before calling *input_line()* for the first time; its default value is 20. While the line is being read, the KEY_UP and KEY_DOWN keys can be used to move to the previous and next line respectively in a circular buffer of previously read lines. The newline character (**\n**) is replaced with the null character on input.

Returns:

A pointer to the input line. On end-of-file or on encountering an error reading from *fp*, NULL is returned and *errno* is set.

Examples:

```
#include <stdlib.h>
#include <stdio.h>

#define SIZ 256

int _input_line_max;

int main( void )
  {
    FILE    *fp;
    char    *p,
         buf[SIZ];

    fp = stdin;               /* Or any stream */
    _input_line_max = 25;     /*  set before 1st call */

    while( ( p = input_line( fp, buf, SIZ ) ) != NULL ) {
      printf( "%s\n", buf );
      fflush( stdout );
    }
    return EXIT_SUCCESS;
  }
```

Classification:

QNX 4

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

InterruptAttach(), *InterruptAttach_r()*

Attach an interrupt handler to an interrupt source

Synopsis:

```
#include <sys/neutrino.h>

int InterruptAttach( int intr,
       const struct sigevent * (* handler)(void *, int),
       const void * area,
       int size,
       unsigned flags );

int InterruptAttach_r( int intr,
       const struct sigevent * (* handler)(void *, int),
       const void * area,
       int size,
       unsigned flags );
```

Arguments:

intr	The interrupt that you want to attach a handler to; see "Interrupt vector numbers," below.
handler	A pointer to the handler function; see "Interrupt handler function," below.
area	A pointer to a communications area in your process that the *handler* can assume is never paged out, or NULL if you don't want a communications area.
size	The size of the communications area.
flags	Flags that specify how you want to attach the interrupt handler. For more information, see "Flags," below.

Library:

libc

Description:

The *InterruptAttach()* and *InterruptAttach_r()* kernel calls attach the interrupt function *handler* to the hardware interrupt specified by *intr*. They automatically enable (i.e unmask) the interrupt level.

These functions are identical except in the way they indicate errors. See the Returns section for details.

Before calling either of these functions, the thread must request I/O privity by calling:

```
ThreadCtl( _NTO_TCTL_IO, 0 );
```

If the thread doesn't do this, the attachment fails with an error code of EPERM.

Interrupt vector numbers

The interrupt values for *intr* are *logical interrupt vector numbers* grouped into related "interrupt classes" that generally correspond to a particular interrupt line on the CPU. The following interrupt classes are present on all QNX Neutrino systems:

_NTO_INTR_CLASS_EXTERNAL

Normal external interrupts (such as the ones generated by the **INTR** pin on x86 CPUs).

_NTO_INTR_CLASS_SYNTHETIC

Synthetic, kernel-generated interrupts.

_NTO_INTR_SPARE is usually the only _NTO_INTR_CLASS_SYNTHETIC interrupt you'll use; _NTO_INTR_SPARE is guaranteed not to match any valid logical interrupt vector number.

There can be additional interrupt classes defined for specific CPUs or embedded systems. For the interrupt assignments for specific boards, see the sample build files in **${**QNX_TARGET**}/${**PROCESSOR**}/boot/build**.

Interrupts and startup code

The mapping of logical interrupt vector numbers is completely dependent on the implementor of the startup code.

Device drivers must:

- Let the user specify an interrupt number on the command line; don't use a hard-coded value. Eventually, the configuration manager will provide interrupt numbers for the device drivers.
- Store interrupt numbers in an **`unsigned int`** variable; don't assume an interrupt number fits into a byte.

Typical x86 Interrupt vector numbers

The following list contains typical interrupt assignments for the 16 hardware interrupts on an x86-based PC using **`startup-bios`**:

Interrupt *intr*	Description
0	A clock that runs at the resolution set by *ClockPeriod()*
1	Keyboard
2	Slave 8259 — you can't attach to this interrupt.
3	Com2
4	Com1
5	Net card / sound card / other
6	Floppy
7	Parallel printer / sound card / other
8	
9	Remapped interrupt 2
10	

continued...

Interrupt *intr*	Description
11	
12	
13	Co-processor
14	Primary disk controller
15	Secondary disk controller

☞ The interrupt assignments are different for other boards.

Interrupt handler function

The function to call is specified by the *handler* argument. This function runs in the environment of your process. If a pager is running that swaps pages out of memory, It's possible for your *handler* to reference a variable in the process address space that isn't present. This results in a kernel shutdown.

The *area* and *size* arguments define a communications area in your process that the *handler* can assume is never paged out. This typically is a structure containing buffers and information needed by the *handler* and the process when it runs. In a paging system, lock the memory pointed to by *area* by calling *mlock()* before attaching the *handler*. In a nonpaging system, you can omit the call to *mlock()* (but you should still call it for compatibility with future versions of the OS).

☞ The *area* argument can be NULL to indicate no communications area. If *area* is NULL, *size* should be 0.

The *handler* function's prototype is:

```
const struct sigevent* handler( void* area, int id );
```

Where *area* is a pointer to the *area* specified by the call to *InterruptAttach()*, and *id* is the ID returned by *InterruptAttach()*.

Follow the following guidelines when writing your handler:

- A temporary interrupt stack of limited depth is provided at interrupt time, so avoid placing large arrays or structures on the stack frame of the handler. It's safe to assume that about 200 bytes of stack are available.
- The interrupt handler runs asynchronously with the threads in the process. Any variables modified by the handler should be declared with the **`volatile`** keyword and modified with interrupts disabled or using the *atomic*()* functions in any thread and ISR.
- The interrupt handler should be kept as short as possible. If a significant amount of work needs to be done, the handler should deliver an event to awaken a thread to do the work.
- The handler can't call library routines that contain kernel calls *except* for *InterruptDisable()*, *InterruptEnable()*, *InterruptLock()*, *InterruptMask()*, *InterruptUnlock()*, and *InterruptUnmask()*.

  The handler can call *TraceEvent()*, but not all modes are valid.

The return value of the *handler* function should be NULL or a pointer to a valid **`sigevent`** structure that the kernel delivers. These events are defined in **`<signal.h>`**.

Consider the following when choosing the event type:

- Message-driven processes that block in a receive loop using *MsgReceivev()* should consider using SIGEV_PULSE to trigger a pulse.
- Threads that block at a particular point in their code and don't go back to a common receive point should consider using SIGEV_INTR as the event notification type and *InterruptWait()* as the blocking call.

☞ The thread that calls *InterruptWait() must* be the one that called *InterruptAttach()*.

- Using SIGEV_SIGNAL, SIGEV_SIGNAL_CODE, SIGEV_SIGNAL_THREAD, or SIGEV_THREAD is discouraged. It's less efficient than the other mechanisms for interrupt event delivery.

Flags

The *flags* argument is a bitwise OR of the following values, or 0:

Flag	Description
_NTO_INTR_FLAGS_END	Put the new handler at the end of the list of existing handlers (for shared interrupts) instead of the start.
_NTO_INTR_FLAGS_PROCESS	Associate the handler with the process instead of the attaching thread.
_NTO_INTR_FLAGS_TRK_MSK	Track calls to *InterruptMask()* and *InterruptUnmask()* to make detaching the interrupt handler safer.

_NTO_INTR_FLAGS_END

The interrupt structure allows hardware interrupts to be shared. For example, if two processes take over the same physical interrupt, both handlers are invoked consecutively. When a handler attaches, it's placed in front of any existing handlers for that interrupt and is called first. You can change this behavior by setting the _NTO_INTR_FLAGS_END flag in the *flags* argument. This adds the handler at the end of any existing handlers. Although the Neutrino microkernel allows full interrupt sharing, your hardware might not.

For example, the ISA bus doesn't allow interrupt sharing, while the PCI bus does.

Processor interrupts are enabled during the execution of the handler. *Don't* attempt to talk to the interrupt controller chip. The operating system issues the end-of-interrupt command to the chip after processing all handlers at a given level.

The first process to attach to an interrupt unmasks the interrupt. When the last process detaches from an interrupt, the system masks it.

If the thread that attached the interrupt handler terminates without detaching the handler, the kernel does it automatically.

_NTO_INTR_FLAGS_PROCESS

Adding _NTO_INTR_FLAGS_PROCESS to *flags* associates the interrupt handler with the *process* instead of the attaching thread. The interrupt handler is removed when the process exits, instead of when the attaching thread exits.

_NTO_INTR_FLAGS_TRK_MSK

The _NTO_INTR_FLAGS_TRK_MSK flag and the *id* argument to *InterruptMask()* and *InterruptUnmask()* let the kernel track the number of times a particular interrupt handler or event has been masked. Then, when an application detaches from the interrupt, the kernel can perform the proper number of unmasks to ensure that the interrupt functions normally. This is important for shared interrupt levels.

You should always set _NTO_INTR_FLAGS_TRK_MSK.

Blocking states

This call doesn't block.

Returns:

The only difference between these functions is the way they indicate errors:

InterruptAttach()

An interrupt function ID. If an error occurs, -1 is returned and *errno* is set.

InterruptAttach_r()

An interrupt function ID. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Use the function ID with the *InterruptDetach()* function to detach this interrupt handler.

Errors:

EAGAIN	All kernel interrupt entries are in use.
EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EINVAL	The value of *intr* isn't a valid interrupt number.
EPERM	The process doesn't have I/O privileges.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

If you're writing a resource manager and using the *resmgr_*()* functions with multiple threads, a thread that attaches to an interrupt *must* use _NTO_INTR_FLAGS_PROCESS in the *flags* argument when calling *InterruptAttach()*.

If your interrupt handler isn't SMP-safe, you must lock it to one processor using:

```
ThreadCtl( _NTO_TCTL_RUNMASK, ... );
```

See also:

atomic_add(), *atomic_clr()*, *atomic_set()*, *atomic_sub()*, *atomic_toggle()*, *InterruptAttachEvent()*, *InterruptDetach()*, *InterruptDisable()*, *InterruptEnable()*, *InterruptLock()*, *InterruptMask()*, *InterruptUnlock()*, *InterruptUnmask()*, *InterruptWait()*, *mlock()*, **sigevent**, *ThreadCtl()*, *TraceEvent()*

InterruptAttachEvent(), InterruptAttachEvent_r()

Attach an event to an interrupt source

Synopsis:

```
#include <sys/neutrino.h>

int InterruptAttachEvent(
        int intr,
        const struct sigevent* event,
        unsigned flags );

int InterruptAttachEvent_r(
        int intr,
        const struct sigevent* event,
        unsigned flags );
```

Arguments:

intr The *interrupt vector number* that you want to attach an event to; for more information, see "Interrupt vector numbers" in the documentation for *InterruptAttach()*.

event A pointer to the **sigevent** structure that you want to be delivered when this interrupt occurs.

flags Flags that specify how you want to attach the interrupt handler. For more information, see "Flags," below.

Library:

libc

Description:

The *InterruptAttachEvent()* and *InterruptAttachEvent_r()* kernel calls attach the given event to the hardware interrupt specified by *intr*. They automatically enable (i.e unmask) the interrupt level.

The *InterruptAttachEvent()* and *InterruptAttachEvent_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

Before calling either of these functions, the thread must request I/O privity by calling:

```
ThreadCtl( _NTO_TCTL_IO, 0 );
```

If the thread doesn't do this, it might SIGSEGV when it calls *InterruptUnlock()*.

To prevent infinite interrupt recursion, the kernel automatically does an *InterruptMask()* for *intr* when delivering the event. After the interrupt-handling thread has dealt with the event, it must call *InterruptUnmask()* to reenable the interrupt.

Consider the following when choosing an event type:

- Message-driven processes that block in a receive loop using *MsgReceivev()* should consider using SIGEV_PULSE to trigger a channel.
- Threads that block at a particular point in their code and don't go back to a common receive point, should consider using SIGEV_INTR as the event notification type and *InterruptWait()* as the blocking call.

The thread that calls *InterruptWait() must* be the one that called *InterruptAttachEvent()*.

- Using SIGEV_SIGNAL, SIGEV_SIGNAL_CODE, or SIGEV_SIGNAL_THREAD is discouraged. It is less efficient than the other mechanisms for interrupt event delivery.

Flags

The *flags* argument is a bitwise OR of the following values, or 0:

Flag	Description
_NTO_INTR_FLAGS_END	Put the new event at the end of the list of existing events instead of the start.
_NTO_INTR_FLAGS_PROCESS	Associate the event with the process instead of the attaching thread.
_NTO_INTR_FLAGS_TRK_MSK	Track calls to *InterruptMask()* and *InterruptUnmask()* to make detaching the interrupt handler safer.

_NTO_INTR_FLAGS_END

The interrupt structure allows hardware interrupts to be shared. For example if two processes call *InterruptAttachEvent()* for the same physical interrupt, both events are sent consecutively. When an event attaches, it's placed in front of any existing events for that interrupt and is delivered first. You can change this behavior by setting the _NTO_INTR_FLAGS_END flag in the *flags* argument. This adds the event at the end of any existing events.

_NTO_INTR_FLAGS_PROCESS

Adding _NTO_INTR_FLAGS_PROCESS to *flags* associates the interrupt event with the *process* instead of the attaching thread. The interrupt event is removed when the process exits, instead of when the attaching thread exits.

The kernel automatically attempts to set the _NTO_INTR_FLAGS_PROCESS flag if the event is directed at the process in general (for SIGEV_SIGNAL, SIGEV_SIGNAL_CODE, and SIGEV_PULSE events).

_NTO_INTR_FLAGS_TRK_MSK

The _NTO_INTR_FLAGS_TRK_MSK flag and the *id* argument to *InterruptMask()* and *InterruptUnmask()* let the kernel track the number of times a particular interrupt handler or event has been masked. Then, when an application detaches from the interrupt, the kernel can perform the proper number of unmasks to ensure that the interrupt functions normally. This is important for shared interrupt levels.

☞ You should always set _NTO_INTR_FLAGS_TRK_MSK.

Advantages & disadvantages

InterruptAttachEvent() has several advantages over *InterruptAttach()*:

- Less work is done at interrupt time (you avoid the context switch necessary to map in an interrupt handler).
- Interrupt handling code runs at the thread's priority, which lets you specify the priority of the interrupt handling.
- You can use process-level debugging on your interrupt handler code.

There are also some disadvantages:

- There might be a delay before the interrupt handling code runs (until the thread is scheduled to run).
- For multiple devices sharing an event, the amount of time spent with the interrupt masked increases.

You can freely mix calls to *InterruptAttach()* and *InterruptAttachEvent()* for a particular interrupt.

Blocking states

This call doesn't block.

Returns:

The only difference between these functions is the way they indicate errors:

InterruptAttachEvent()

An interrupt function ID. If an error occurs, -1 is returned and *errno* is set.

InterruptAttachEvent_r()

An interrupt function ID. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Use the ID with *InterruptDetach()* to detach this interrupt event.

Errors:

EAGAIN	All kernel interrupt entries are in use.
EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EINVAL	The value of *intr* isn't a valid interrupt number.
EPERM	The process doesn't have superuser capabilities.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

InterruptAttach(), *InterruptDetach()*, *InterruptLock()*, *InterruptMask()*, *InterruptUnlock()*, *InterruptUnmask()*, *InterruptWait()*, **`sigevent`**

InterruptDetach(), InterruptDetach_r()

Detach an interrupt handler by ID

Synopsis:

```
#include <sys/neutrino.h>

int InterruptDetach( int id );

int InterruptDetach_r( int id );
```

Arguments:

id The value returned by *InterruptAttach()* *InterruptAttachEvent()*, or *InterruptHookIdle()*.

Library:

libc

Description:

These kernel calls detach the interrupt handler specified by the *id* argument. If, after detaching, no thread is attached to the interrupt then the interrupt is masked off.

The *InterruptDetach()* and *InterruptDetach_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

Before calling either of these functions, the thread must request I/O privity by calling:

```
ThreadCtl( _NTO_TCTL_IO, 0 );
```

If the thread doesn't do this, it might SIGSEGV when it calls *InterruptUnlock()*.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

InterruptDetach()

If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

InterruptDetach_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EINVAL	The value of *id* doesn't exist for this process.
EPERM	The process doesn't have superuser capabilities.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

InterruptAttach(), *InterruptAttachEvent()*, *InterruptHookIdle()*, *InterruptUnlock()*

InterruptDisable()

Disable hardware interrupts

Synopsis:

```
#include <sys/neutrino.h>

void InterruptDisable( void );
```

Library:

libc

Description:

The *InterruptDisable()* function disables all hardware interrupts. You can call it from a thread or from an interrupt handler. Before calling this function, the thread must request I/O privity by calling:

```
ThreadCtl( _NTO_TCTL_IO, 0 );
```

Any kernel call results in the re-enabling of interrupts, and many library routines are built on kernel calls. Masked interrupts are not affected.

If the thread doesn't do this, it might SIGSEGV when *InterruptUnlock()* is called.

Reenable the interrupts by calling *InterruptEnable()*.

CAUTION: Since this function disables all hardware interrupts, take care to reenable them as quickly as possible. Failure to do so may result in increased interrupt latency and nonrealtime performance.

Use *InterruptDisable()* instead of an inline **cli** to ensure hardware portability with non-x86 CPUs.

Use *InterruptLock()* and *InterruptUnlock()* instead of *InterruptDisable()* and *InterruptEnable()*. The *InterruptLock()* and *InterruptUnlock()* functions perform the intended function on SMP hardware, and allow your interrupt thread to run on any processor in the system.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

InterruptEnable(), *InterruptLock()*, *InterruptMask()*, *InterruptUnlock()*, *InterruptUnmask()*, *ThreadCtl()*

InterruptEnable()

Enable hardware interrupts

Synopsis:

```
#include <sys/neutrino.h>

void InterruptEnable( void );
```

Library:

libc

Description:

The *InterruptEnable()* function enables all hardware interrupts. You can call it from a thread or from an interrupt handler. Before calling this function, the thread must request I/O privity by calling:

```
ThreadCtl( _NTO_TCTL_IO, 0 );
```

If the thread doesn't do this, it might SIGSEGV when *InterruptUnlock()* is called.

You should call this function as quickly as possible after calling *InterruptDisable()*.

Use *InterruptLock()* and *InterruptUnlock()* instead of *InterruptDisable()* and *InterruptEnable()*. The *InterruptLock()* and *InterruptUnlock()* functions perform the intended function on SMP hardware, and allow your interrupt thread to run on any processor in the system.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

InterruptDisable(), InterruptLock(), InterruptMask(), InterruptUnlock(), InterruptUnmask(), ThreadCtl()

InterruptHookIdle()

Attach an "idle" interrupt handler

Synopsis:

```
#include <sys/neutrino.h>

int InterruptHookIdle(
    void (*handler)(uint64_t *, struct qtime_entry *),
    unsigned flags );
```

Arguments:

handler A pointer to the handler function; see below.

flags Flags that specify how you want to attach the interrupt handler. For more information, see "Flags," below.

Library:

libc

Description:

The *InterruptHookIdle()* kernel call attaches the specified interrupt *handler* to the "idle" interrupt, which is called when the system is idle. This is typically used to implement power management features.

The arguments to the *handler* functions are:

uint64_t* A pointer to the time, in nanoseconds, when the next timer will expire.

struct qtime_entry * A pointer to the section of the system page with the time information, including the current time of day.

The simplest idle handler consists of a **halt** instruction.

Flags

The *flags* argument is a bitwise OR of the following values, or 0:

Flag	Description
_NTO_INTR_FLAGS_END	Put the new handler at the end of the list of existing handlers (for shared interrupts) instead of the start.
_NTO_INTR_FLAGS_PROCESS	Associate the handler with the process instead of the attaching thread.
_NTO_INTR_FLAGS_TRK_MSK	Track calls to *InterruptMask()* and *InterruptUnmask()* to make detaching the interrupt handler safer.

_NTO_INTR_FLAGS_END

The interrupt structure allows hardware interrupts to be shared. For example, if two processes take over the same physical interrupt, both handlers are invoked consecutively. When a handler attaches, it's placed in front of any existing handlers for that interrupt and is called first. You can change this behavior by setting the _NTO_INTR_FLAGS_END flag in the *flags* argument. This adds the handler at the end of any existing handlers.

Processor interrupts are enabled during the execution of the handler. *Don't* attempt to talk to the interrupt controller chip. The end of interrupt command is issued to the chip by the operating system after processing all handlers at a given level.

The first process to attach to an interrupt unmasks the interrupt. When the last process detaches from an interrupt, the system masks it.

If the thread that attached the interrupt handler terminates without detaching the handler, the kernel does it automatically.

_NTO_INTR_FLAGS_PROCESS

Adding _NTO_INTR_FLAGS_PROCESS to *flags* associates the interrupt handler with the *process* instead of the attaching thread. The interrupt handler is removed when the process exits, instead of when the attaching thread exits.

_NTO_INTR_FLAGS_TRK_MSK

The _NTO_INTR_FLAGS_TRK_MSK flag and the *id* argument to *InterruptMask()* and *InterruptUnmask()* let the kernel track the number of times a particular interrupt handler or event has been masked. Then, when an application detaches from the interrupt, the kernel can perform the proper number of unmasks to ensure that the interrupt functions normally. This is important for shared interrupt values.

Blocking states

This call doesn't block.

Returns:

An interrupt function ID, or -1 if an error occurs (*errno* is set).

Use the returned value with the *InterruptDetach()* function to detach this interrupt handler.

Errors:

EAGAIN	All kernel interrupt entries are in use.
EPERM	The process doesn't have superuser capabilities.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

InterruptAttach(), InterruptAttachEvent(), InterruptDetach(), InterruptHookTrace()

InterruptHookTrace()

Attach the pseudo interrupt handler that the instrumented module uses

Synopsis:

```
#include <sys/neutrino.h>

int InterruptHookTrace(
        const struct sigevent * (* handler)(int),
        unsigned flags );
```

Arguments:

handler	A pointer to the handler function.
flags	Flags that specify how you want to attach the interrupt handler.

Library:

libc

Description:

The *InterruptHookTrace()* kernel call attaches the pseudo interrupt handler *handle* that the instrumented module uses.

This function requires the instrumented kernel. For more information, see the documentation for the System Analysis Toolkit (SAT).

Returns:

An interrupt function ID, or -1 if an error occurs (*errno* is set).

Errors:

EAGAIN	All kernel interrupt entries are in use.
EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EPERM	The process doesn't have superuser capabilities.
ENOTSUP	The kernel is not instrumented.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

InterruptAttach(), TraceEvent()

InterruptLock()

Guard a critical section in an interrupt handler

Synopsis:

```
#include <sys/neutrino.h>

void InterruptLock( intrspin_t* spinlock );
```

Arguments:

spinlock The spinlock (a variable shared between the interrupt handler and a thread) to use.

☞ If *spinlock* isn't a **static** variable, you must initialize it by calling:

```
memset( spinlock, 0, sizeof( *spinlock ) );
```

before using it with *InterruptLock()*.

Library:

libc

Description:

The *InterruptLock()* function guards a critical section by locking the specified *spinlock*. You can call this function from a thread or from an interrupt handler. Before calling this function, the thread must request I/O privity by calling:

```
ThreadCtl( _NTO_TCTL_IO, 0 );
```

If the thread doesn't do this, it might SIGSEGV when *InterruptUnlock()* is called.

This function tries to acquire the *spinlock* (a variable shared between the interrupt handler and a thread) while interrupts are disabled. The code spins in a tight loop until the lock is acquired. It's important to release the lock as soon as possible. Typically, this is a few lines of code without any loops:

```
InterruptLock( &spinner );

/* ... critical section */

InterruptUnlock( &spinner );
```

InterruptLock() solves a common need in many realtime systems to protect access to shared data structures between an interrupt handler and the thread that owns the handler. The traditional POSIX primitives used between threads aren't available for use by an interrupt handler.

The *InterruptLock()* and *InterruptUnlock()* functions work on single-processor or multiprocessor machines.

Any kernel call results in the re-enabling of interrupts, and many library routines are built on kernel calls. Masked interrupts are not affected.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

InterruptDisable(), *InterruptEnable()*, *InterruptMask()*, *InterruptUnlock()*, *InterruptUnmask()*, *ThreadCtl()*

InterruptMask()

Disable a hardware interrupt

Synopsis:

```
#include <sys/neutrino.h>

int InterruptMask( int intr,
                   int id );
```

Arguments:

intr The interrupt you want to mask.

id The value returned by *InterruptAttach()* or *InterruptAttachEvent()*, or -1 if you don't want the kernel to track interrupt maskings and unmaskings for each handler.

The *id* is ignored unless you use the _NTO_INTR_FLAGS_TRK_MSK flag when you attach the handler.

Library:

libc

Description:

The *InterruptMask()* kernel call disables the hardware interrupt specified by *intr* for the handler specified by *id*. You can call this function from a thread or from an interrupt handler. Before calling this function, the thread must request I/O privity by calling:

```
ThreadCtl( _NTO_TCTL_IO, 0 );
```

If the thread doesn't do this, it might SIGSEGV when *InterruptUnmask()* is called.

Reenable the interrupt by calling *InterruptUnmask()*.

The kernel automatically enables an interrupt when the first handler attaches to it using *InterruptAttach()* and disables it when the last handler detaches.

This call is often used when a device presents a level-sensitive interrupt to the system that can't be easily cleared in the interrupt handler. Since the interrupt is level-sensitive, you can't exit the handler with the interrupt line active and unmasked. *InterruptMask()* lets you mask the interrupt in the handler and schedule a thread to do the real work of communicating with the device to clear the source. Once cleared, the thread should call *InterruptUnmask()* to reenable this interrupt.

To disable all hardware interrupts, use the *InterruptLock()* function.

To ensure hardware portability, use *InterruptMask()* instead of writing code that talks directly to the interrupt controller.

Calls to *InterruptMask()* are nested; the interrupt isn't unmasked until *InterruptUnmask()* has been called once for every call to *InterruptMask()*.

Returns:

The current mask level count for success; or -1 if an error occurs (*errno* is set).

Errors:

EINVAL The value of *intr* isn't a supported hardware interrupt.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

InterruptAttach(), *InterruptDisable()*, *InterruptEnable()*, *InterruptLock()*, *InterruptUnlock()*, *InterruptUnmask()*, *ThreadCtl()*

InterruptUnlock()

Release a critical section in an interrupt handler

Synopsis:

```
#include <sys/neutrino.h>

void InterruptUnlock( intrspin_t* spinlock );
```

Arguments:

spinlock The spinlock (a variable shared between the interrupt handler and a thread) used in a call to *InterruptLock()* to lock the handler.

Library:

libc

Description:

The *InterruptUnlock()* function releases a critical section by unlocking the specified *spinlock*, reenabling interrupts. You can call this function from a thread or from an interrupt handler.

Before calling this function, the thread must request I/O privity by calling:

```
ThreadCtl( _NTO_TCTL_IO, 0 );
```

If the thread doesn't do this, it might SIGSEGV.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

InterruptDisable(), *InterruptEnable()*, *InterruptLock()*, *InterruptMask()*, *InterruptUnmask()*, *ThreadCtl()*

InterruptUnmask()

Enable a hardware interrupt

Synopsis:

```
#include <sys/neutrino.h>

int InterruptUnmask( int intr,
                     int id );
```

Arguments:

intr The interrupt you want to unmask.

id The value returned by *InterruptAttach()* or *InterruptAttachEvent()*, or -1 if you don't want the kernel to track interrupt maskings and unmaskings for each handler.

The *id* is ignored unless you use the _NTO_INTR_FLAGS_TRK_MSK flag when you attach the handler.

Library:

libc

Description:

The *InterruptUnmask()* kernel call enables the hardware interrupt specified by *intr* for the interrupt handler specified by *intr* for the handler specified by *id* when the mask count reaches zero. You can call this function from a thread or from an interrupt handler. Before calling this function, the thread must request I/O privity by calling:

```
ThreadCtl( _NTO_TCTL_IO, 0 );
```

If the thread doesn't do this, it might SIGSEGV.

Calls to *InterruptMask()* are nested; the interrupt isn't unmasked until *InterruptUnmask()* has been called once for every call to *InterruptMask()*.

Returns:

The current mask count, or -1 if an error occurs (*errno* is set).

Errors:

EINVAL Not a supported hardware interrupt *intr*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

InterruptAttach(), *InterruptDisable()*, *InterruptEnable()*, *InterruptLock()*, *InterruptMask()*, *InterruptUnlock()* *ThreadCtl()*

InterruptWait(), *InterruptWait_r()*

Wait for a hardware interrupt

Synopsis:

```
#include <sys/neutrino.h>

int InterruptWait( int flags,
                   const uint64_t * timeout );

int InterruptWait_r( int flags,
                     const uint64_t * timeout );
```

Arguments:

flags This should currently be 0.

timeout This should currently be NULL. This may change in future versions.

Use *TimerTimeout()* to achieve a timeout.

Library:

libc

Description:

These kernel calls wait for a hardware interrupt. The calling thread should have attached a handler to the interrupt, by calling *InterruptAttach()* or *InterruptAttachEvent()*. The call to *InterruptWait()* or *InterruptWait_r()* blocks waiting for an interrupt handler to return an event with notification type SIGEV_INTR (i.e. a hardware interrupt).

The *InterruptWait()* and *InterruptWait_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

If the notification event occurs before *InterruptWait()* is called, a pending flag is set. When *InterruptWait()* is called, the flag is checked; if set, it's cleared and the call immediately returns with success.

Blocking states

STATE_INTR	The thread is waiting for an interrupt handler to return a SIGEV_INTR event.

Returns:

The only difference between these functions is the way they indicate errors:

InterruptWait()

If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

InterruptWait_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EINTR	The call was interrupted by a signal.
ENOTSUP	The reserved arguments aren't NULL.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

InterruptAttach(), *InterruptAttachEvent()*, *TimerTimeout()*

Execute a real-mode software interrupt

Synopsis:

```
#include <x86/v86.h>

int _intr_v86( int swi,
               struct _v86reg* regs,
               void* data,
               int datasize );
```

Arguments:

swi	The software interrupt that you want to execute.
regs	A pointer to a **_v86reg** structure that specifies the values you want to use for the registers on entry to real mode; see below.
data	A pointer to the data that you want to copy into memory; see below.
datasize	The size of the data, in bytes.

Library:

libc

Description:

The *_intr_v86()* function executes the real-mode software interrupt specified by *swi* in virtual 8086 mode. This allows access to the ROM BIOS functions that are designed to run in 16-bit real mode. Two common examples are:

Interrupt	Description
int 10h	Video BIOS
int 1ah	PCI

BIOS calls (such as **int 13h**, disk I/O) that require hardware interrupts to be directed at their code aren't supported.

Upon entry to real mode, the registers are loaded from *regs*. The segment registers and any pointers should address a 2K communication area located at offset **0:800h** in real memory. The buffer *data* of length *datasize* is copied to this area just before real mode is entered and copied back when the call completes. At this point *regs* is also updated to contain the values of the real-mode registers.

You should set the **DS**, **ES**, **FS** and **GS** segment registers to 0. The values in the **CS:IP**, and **SS:SP** registers are ignored and are set by the kernel. The stack provided is about 500 bytes in size.

The layout of real mode memory is described by the structure **_v86_memory** in **<x86/v86.h>**.

When a thread enters virtual 8086 mode, all threads in the system continue to be scheduled based upon their priority, including the calling thread. While in virtual 8086 mode, full access to IO ports and interrupt enable and disable are allowed. Only one thread may enter virtual 8086 mode at a time.

This function fails if the calling process doesn't have an effective user ID of **root** (*euid* 0).

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Errors:

EPERM The calling thread didn't have an effective user ID of **root**.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <stddef.h>
#include <errno.h>
#include <x86/v86.h>

struct _v86reg reg;

int main( void ) {
    char buf[4];

    /* Equipment call */
    printf("int 12\n");
    memset(&reg, 0, sizeof(reg));
    _intr_v86(0x12, &reg, NULL, 0);
    printreg();
    sleep(5);

    /* Enter 40 column text mode */
    printf("int 10 ah=00h al=00h\n");
    memset(&reg, 0, sizeof(reg));
    _intr_v86(0x10, &reg, NULL, 0);
    printreg();
    sleep(5);

    /* Enter 80 column text mode */
    printf("int 10 ah=00h al=02h\n");
    memset(&reg, 0, sizeof(reg));
    reg.eax = 2;
    _intr_v86(0x10, &reg, NULL, 0);
    printreg();
    sleep(5);

    /* Write a string from memory */
    printf("int 10 ah=13h al=00h\n");
    strcpy(buf, "Hi!");
    memset(&reg, 0, sizeof(reg));
    reg.eax = 0x1300;
    reg.es = 0;
    reg.ebp = offsetof(struct _v86_memory, userdata);
    reg.ecx = strlen(buf);
    reg.edx = 0;
    reg.ebx = 0x0007;
    _intr_v86(0x10, &reg, buf, strlen(buf));
    printreg();
    sleep(5);

    return EXIT_SUCCESS;
}
```

```
printreg() {

    printf("eax=%-8x ebx=%-8x ecx=%-8x edx=%-8x\n",
            reg.eax, reg.ebx, reg.ecx, reg.edx);
    printf("esi=%-8x edi=%-8x ebp=%-8x esp=%-8x\n",
            reg.esi, reg.edi, reg.ebp, reg.esp);
    printf(" ds=%-8x  es=%-8x  fs=%-8x  gs=%-8x\n",
            reg.ds, reg.es, reg.fs, reg.gs);
    printf("efl=%-8x\n\n",
            reg.efl);
}
```

Classification:

QNX Neutrino (x86 only)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Synopsis:

```
struct _io_connect {
    uint16_t                type;
    uint16_t                subtype;
    uint32_t                file_type;
    uint16_t                reply_max;
    uint16_t                entry_max;
    uint32_t                key;
    uint32_t                handle;
    uint32_t                ioflag;
    uint32_t                mode;
    uint16_t                sflag;
    uint16_t                access;
    uint16_t                zero;
    uint16_t                path_len;
    uint8_t                 eflag;
    uint8_t                 extra_type;
    uint16_t                extra_len;
    char                    path[1];
};
```

Description:

The **_io_connect** structure is used to describe a connect message that a resource manager receives and sends.

The members include:

type IO_CONNECT

subtype The type of connection that the message concerns; one of:

- _IO_CONNECT_COMBINE — combine with an I/O message.
- _IO_CONNECT_COMBINE_CLOSE — combine with I/O message and always close.
- _IO_CONNECT_OPEN
- _IO_CONNECT_UNLINK

- _IO_CONNECT_RENAME
- _IO_CONNECT_MKNOD
- _IO_CONNECT_READLINK
- _IO_CONNECT_LINK
- _IO_CONNECT_RSVD_UNBLOCK — place holder in the jump table.
- _IO_CONNECT_MOUNT

file_type The file type; one of the following (defined in **<sys/ftype.h>**):

- _FTYPE_ANY — the path name can be anything.
- _FTYPE_LINK — reserved for the Process Manager.
- _FTYPE_MOUNT — receive mount requests on the path (*path* must be NULL).
- _FTYPE_MQUEUE — reserved for a mqueue manager.
- _FTYPE_PIPE — reserved for a pipe manager.
- _FTYPE_SEM — reserved for a semaphore manager.
- _FTYPE_SHMEM — reserved for a shared memory object.
- _FTYPE_SOCKET — reserved for a socket manager.
- _FTYPE_SYMLINK — reserved for the Process Manager.

reply_max The maximum length of the reply message.

entry_max The maximum number of **_io_connect_entry** structures that the resource manager is willing to accept. If a path could reference more than one resource manager, it returns a list of **_io_connect_entry** structures referring to the overlapping resource managers.

key Reserved.

handle The handle returned by *resmgr_attach()*.

ioflag One of:

- O_RDONLY — open for reading only.
- O_RDWR — open for reading and writing. Opening a FIFO for read-write is unsupported.
- O_WRONLY — open for writing only.

You can also specify any combination of the remaining flags in the value of *ioflag*:

- O_APPEND — if set, the file offset is set to the end of the file prior to each write.
- O_CLOEXEC — close the file descriptor on execution.
- O_CREAT — create the file.
- O_DSYNC — if set, this flag affects subsequent I/O calls; each call to *write()* waits until all data is successfully transferred to the storage device such that it's readable on any subsequent open of the file (even one that follows a system failure) in the absence of a failure of the physical storage medium. If the physical storage medium implements a non-write-through cache, then a system failure may be interpreted as a failure of the physical storage medium, and data may not be readable even if this flag is set and the *write()* indicates that it succeeded.
- O_EXCL — if you set both O_EXCL and O_CREAT, *open()* fails if the file exists. The check for the existence of the file and the creation of the file if it doesn't exist are atomic; no other process that's attempting the same operation with the same filename at the same time will succeed. Specifying O_EXCL without O_CREAT has no effect.
- O_LARGEFILE — allow the file offset to be 64 bits long.

- O_NOCTTY — if set, and *path* identifies a terminal device, the *open()* function doesn't cause the terminal device to become the controlling terminal for the process.
- O_NONBLOCK — don't block.
- O_REALIDS — use the real **uid**/**gid** for permissions checking.
- O_RSYNC — read I/O operations on the file descriptor complete at the same level of integrity as specified by the O_DSYNC and O_SYNC flags.
- O_SYNC — if set, this flag affects subsequent I/O calls; each call to *read()* or *write()* is complete only when both the data has been successfully transferred (either read or written) and all file system information relevant to that I/O operation (including that required to retrieve said data) is successfully transferred, including file update and/or access times, and so on. See the discussion of a successful data transfer in O_DSYNC, above.
- O_TRUNC — if the file exists and is a regular file, and the file is successfully opened O_WRONLY or O_RDWR, the file length is truncated to zero and the mode and owner are left unchanged. O_TRUNC has no effect on FIFO or block or character special files or directories. Using O_TRUNC with O_RDONLY has no effect.

mode One of:

- S_IFBLK — block special.
- S_IFCHR — character special.
- S_IFDIR — directory.
- S_IFIFO — FIFO special.
- S_IFLNK — symbolic link.
- S_IFMT — type of file.

- S_IFNAM — special named file.
- S_IFREG — regular.
- S_IFSOCK — socket.

sflag How the client wants the file to be shared; a combination of the following bits:

- SH_COMPAT — set compatibility mode.
- SH_DENYRW — prevent read or write access to the file.
- SH_DENYWR — prevent write access to the file.
- SH_DENYRD — prevent read access to the file.
- SH_DENYNO — permit both read and write access to the file.

access The access permissions for the file or directory, specified as a combination of the following bits (defined in **<sys/stat.h>**):

Owner	Group	Others	Permission
S_IRUSR	S_IRGRP	S_IROTH	Read
S_IRWXU	S_IRWXG	S_IRWXO	Read, write, execute/search. A bitwise inclusive OR of the other three constants. (S_IRWXU is OR of IRUSR, S_IWSUR and S_IXUSR.)
S_IWUSR	S_IWGRP	S_IWOTH	Write
S_IXUSR	S_IXGRP	S_IXOTH	Execute/search

The following bits define miscellaneous permissions used by other implementations:

Bit	Equivalent
S_IEXEC	S_IXUSR
S_IREAD	S_IRUSR
S_IWRITE	S_IWUSR

path_len The length of the *path* member.

eflag Extended flags:

- _IO_CONNECT_EFLAG_DIR — the path referenced a directory.
- _IO_CONNECT_EFLAG_DOT — the last component of a path was `.` or `..` (i.e. the current or parent directory).

extra_type One of:

- _IO_CONNECT_EXTRA_NONE
- _IO_CONNECT_EXTRA_LINK
- _IO_CONNECT_EXTRA_SYMLINK
- _IO_CONNECT_EXTRA_MQUEUE
- _IO_CONNECT_EXTRA_PHOTON
- _IO_CONNECT_EXTRA_SOCKET
- _IO_CONNECT_EXTRA_SEM
- _IO_CONNECT_EXTRA_RESMGR_LINK
- _IO_CONNECT_EXTRA_PROC_SYMLINK
- _IO_CONNECT_EXTRA_RENAME
- _IO_CONNECT_EXTRA_MOUNT
- _IO_CONNECT_EXTRA_MOUNT_OCB

extra_len The length of any extra data included in the message.

path The path that the client is trying to connect to, relative to the resource manager's mountpoint.

Classification:

QNX Neutrino

See also:

_io_connect_ftype_reply, **_io_connect_link_reply**, **resmgr_connect_funcs_t**

"The _IO_OPEN message for filesystems" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

_io_connect_ftype_reply

Structure of a connect message giving a status and a file type

Synopsis:

```
struct _io_connect_ftype_reply {
        uint16_t                                status;
        uint16_t                                reserved;
        uint32_t                                file_type;
};
```

Description:

A resource manager uses the **_io_connect_ftype_reply** structure to send a status and a file type to a client that has sent a connect message.

The members include:

status Typically one of the *errno* values.

file_type The file type; one of the following (defined in **<sys/ftype.h>**):

- _FTYPE_ANY — the path name can be anything.
- _FTYPE_LINK — reserved for the Process Manager.
- _FTYPE_MOUNT — receive mount requests on the path (*path* must be NULL).
- _FTYPE_MQUEUE — reserved for a mqueue manager.
- _FTYPE_PIPE — reserved for a pipe manager.
- _FTYPE_SEM — reserved for a semaphore manager.
- _FTYPE_SHMEM — reserved for a shared memory object.
- _FTYPE_SOCKET — reserved for a socket manager.
- _FTYPE_SYMLINK — reserved for the Process Manager.

Classification:

QNX Neutrino

See also:

_io_connect, **_io_connect_link_reply**, **resmgr_connect_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

_io_connect_link_reply

Structure of a connect message that redirects a client to another resource

Synopsis:

```
struct _io_connect_link_reply {
    uint32_t                    reserved1;
    uint32_t                    file_type;
    uint8_t                     eflag;
    uint8_t                     reserved2[1];
    uint16_t                    chroot_len;
    uint32_t                    umask;
    uint16_t                    nentries;
    uint16_t                    path_len;
/*
    struct _io_connect_entry    server[nentries];
    char                        path[path_len];
or
    struct _server_info         info;
    io_?_t                      msg;
*/
};
```

Description:

A resource manager uses the **_io_connect_link_reply** structure in a reply to a client that redirects the client to another resource. The members include:

file_type The file type; one of the following (defined in **<sys/ftype.h>**):

- _FTYPE_ANY — the path name can be anything.
- _FTYPE_LINK — reserved for the Process Manager.
- _FTYPE_MOUNT — receive mount requests on the path (*path* must be NULL).
- _FTYPE_MQUEUE — reserved for a mqueue manager.
- _FTYPE_PIPE — reserved for a pipe manager.

- _FTYPE_SEM — reserved for a semaphore manager.
- _FTYPE_SHMEM — reserved for a shared memory object.
- _FTYPE_SOCKET — reserved for a socket manager.
- _FTYPE_SYMLINK — reserved for the Process Manager.

eflag Extended flags:

- _IO_CONNECT_EFLAG_DIR — the path referenced a directory.
- _IO_CONNECT_EFLAG_DOT — the last component of a path was `.` or `..` (i.e. the current or parent directory).

chroot_len The length of chroot in the returned path.

umask One of:

- S_IFBLK — block special.
- S_IFCHR — character special.
- S_IFDIR — directory.
- S_IFIFO — FIFO special.
- S_IFLNK — symbolic link.
- S_IFMT — type of file.
- S_IFNAM — special named file.
- S_IFREG — regular.
- S_IFSOCK — socket.

nentries If this member is zero, the path is a symbolic link.

path_len The length of the path including the terminating null character. If this member is zero, the path is null-terminated.

Classification:

QNX Neutrino

See also:

_io_connect, **_io_connect_ftype_reply**, **resmgr_connect_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

ioctl()

Control a device

Synopsis:

```
#include <sys/ioctl.h>

int ioctl( int fd,
           int request,
           ... );
```

Arguments:

fd An open file descriptor for the file or device that you want to manipulate.

request What you want to do to the file. The macros and definitions that you use in specifying a *request* are located in the file **<sys/ioctl.h>**.

Additional arguments

As required by the request.

Library:

libc

Description:

The *ioctl()* function manipulates the underlying parameters of files. In particular, it can be used to control many of the operating attributes of files (such as the attributes of terminals).

The *request* argument determines whether the subsequent arguments are an “in” or “out” parameter; it also specifies the size of the arguments in bytes.

Returns:

A value based on the *request*, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	Invalid descriptor *fd*.
EINVAL	The *request* or optional variables aren't valid.
ENOTTY	The *fd* argument isn't associated with a character special device; the specified *request* doesn't apply to the kind of object that the descriptor *fd* references.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

The *ioctl()* function is a Unix function that varies greatly from platform to platform.

See also:

devctl()

iofdinfo()

Retrieve server attributes

Synopsis:

```
#include <sys/iomgr.h>

int iofdinfo( int filedes,
              unsigned flags,
              struct _fdinfo * info,
              char * path,
              int maxlen );
```

Arguments:

filedes	A file descriptor for the connection that you want to query.
flags	Specify _FDINFO_FLAG_LOCALPATH to return only the local path info (i.e. exclude the network path info).
info	NULL, or a pointer to an **_fdinfo** structure that contains the connection information defined in **<sys/iomgr.h>**. Specify NULL if it's not required.
path	A pointer to a buffer where the function can store the path associated with the file descriptor. Specify NULL if it's not required.
maxlen	The length of the buffer pointed to *path*.

Library:

libc

Description:

The *iofdinfo()* function retrieves the server's attribute information for the connection referred to by *filedes*.

Returns:

The length of the associated *filedes* pathname, or -1 if an error occurs (*errno* is set).

Errors:

EFAULT	A fault occurred in a server's address space when it tried to access the caller's message buffers.
EMSGSIZE	Insufficient space available in the server's buffer for the `fdinfo` data structure.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_fdinfo(), iofunc_fdinfo_default(), resmgr_pathname()

iofunc_attr_init()

Initialize the default attribute structure

Synopsis:

```
#include <sys/iofunc.h>

void iofunc_attr_init ( iofunc_attr_t *attr,
                        mode_t mode,
                        iofunc_attr_t *dattr,
                        struct _client_info *info );
```

Arguments:

attr A pointer to the **iofunc_attr_t** structure that you want to initialize.

mode The type and access permissions that you want to use for the resource. For more information, see "Access permissions" in the documentation for *stat()*.

dattr NULL, or a pointer to a **iofunc_attr_t** structure that you want to use to initialize the structure pointed to by *attr*.

info NULL, or a pointer to a **_client_info** structure that contains the information about a client connection. For information about this structure, see *ConnectClientInfo()*.

Library:

libc

Description:

The *iofunc_attr_init()* function initializes the passed *attr* structure with the information derived from the optional *dattr*, the *mode*, and the user and group IDs from the optional *info* client information structure.

The *count*, *rcount*, *wcount*, *rlocks* and *wlocks* counters are reset to zero in the **iofunc_attr_t** structure that *attr* points to.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_lock(), **iofunc_attr_t**, *iofunc_attr_unlock()*, *iofunc_ocb_attach()*, *iofunc_ocb_detach()*, *resmgr_attach()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_attr_lock()

Lock the attribute structure

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_attr_lock( iofunc_attr_t *attr );
```

Arguments:

attr A pointer to the **iofunc_attr_t** structure that you want to lock.

Library:

libc

Description:

The *iofunc_attr_lock()* function locks the attribute structure that *attr* points to, preventing other threads in the resource manager from changing information.

Call this function (or *iofunc_attr_trylock()*) before you make any modifications to the attribute structure. After you're finished making modifications, call *iofunc_attr_unlock()* to release the lock.

Note that this is a *counting* locking mechanism. This means that a given thread can lock the attributes structure multiple times; it must then unlock the attributes structure a corresponding number of times in order to have the attributes structure considered unlocked. If another thread attempts to lock the structure while a thread has the structure locked, the other thread blocks.

Returns:

EOK Success.

EAGAIN On the first use, all kernel mutex objects were in use.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_init(), **iofunc_attr_t**, *iofunc_attr_trylock()*, *iofunc_attr_unlock()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

Synopsis:

```
#include <sys/iofunc.h>

typedef struct _iofunc_attr {
    IOFUNC_MOUNT_T                  *mount;     /* Used to find iofunc
    uint32_t                        flags;      /* Dirty and invalid
    int32_t                         lock_tid;   /* Thread that has at
    uint16_t                        lock_count; /* Lock count (0 == u
    uint16_t                        count;      /* File use count */
    uint16_t                        rcount;     /* File reader count
    uint16_t                        wcount;     /* File writer count
    uint16_t                        rlocks;     /* Number of read lock
    uint16_t                        wlocks;     /* Number of write lo
    struct _iofunc_mmap_list        *mmap_list; /* List of mmap ids *
    struct _iofunc_lock_list        *lock_list; /* Lock lists */
    void                            *list;      /* Reserved for future
    uint32_t                        list_size;  /* Size of reserved a
#if !defined(_IOFUNC_OFFSET_BITS) || _IOFUNC_OFFSET_BITS == 64
 #if _FILE_OFFSET_BITS - 0 == 64
    off_t                           nbytes;     /* Always Number of by
    ino_t                           inode;      /* mount point specif
 #else
    off64_t                         nbytes;     /* Always Number of by
    ino64_t                         inode;      /* mount point specif
 #endif
#elif _IOFUNC_OFFSET_BITS - 0 == 32
 #if !defined(_FILE_OFFSET_BITS) || _FILE_OFFSET_BITS == 32
  #if defined(__LITTLEENDIAN__)
    off_t                           nbytes;     /* Always Number of by
    off_t                           nbytes_hi;
    ino_t                           inode;      /* mount point specif
    ino_t                           inode_hi;
  #elif defined(__BIGENDIAN__)
    off_t                           nbytes_hi;
    off_t                           nbytes;     /* Always Number of by
    ino_t                           inode_hi;
    ino_t                           inode;      /* mount point specif
  #else
   #error endian not configured for system
  #endif
 #else
  #if defined(__LITTLEENDIAN__)
```

```
    int32_t                         nbytes;     /* Always Number of bytes
    int32_t                         nbytes_hi;
    int32_t                         inode;      /* mount point specific i
    int32_t                         inode_hi;
  #elif defined(__BIGENDIAN__)
    int32_t                         nbytes_hi;
    int32_t                         nbytes;     /* Always Number of bytes
    int32_t                         inode_hi;
    int32_t                         inode;      /* mount point specific i
  #else
   #error endian not configured for system
  #endif
 #endif
#else
 #error _IOFUNC_OFFSET_BITS value is unsupported
#endif
    uid_t                           uid;        /* User id */
    gid_t                           gid;        /* Group id */
    time_t                          mtime;      /* Modification time (wri
    time_t                          atime;      /* Access time (read upda
    time_t                          ctime;      /* Change time (write/cha
    mode_t                          mode;       /* File mode (S_* from st
    nlink_t                         nlink;      /* Number of links to the
    dev_t                           rdev;       /* dev num for CHR specia
} iofunc_attr_t;
```

Description:

The **iofunc_attr_t** structure describes the attributes of the device that's associated with a resource manager. The members include the following:

mount A pointer a structure information about the mountpoint. By default, this structure is of type **iofunc_mount_t**, but you can specify your own structure by changing the IOFUNC_MOUNT_T manifest.

flags Flags that your resource manager can set to indicate the state of the device. This member is a combination of the following flags:

IOFUNC_ATTR_ATIME

The access time is no longer valid. Typically set on a read from the resource.

IOFUNC_ATTR_CTIME

The change of status time is no longer valid. Typically set on a file info change.

IOFUNC_ATTR_DIRTY_NLINK

The number of links has changed.

IOFUNC_ATTR_DIRTY_MODE

The mode has changed.

IOFUNC_ATTR_DIRTY_OWNER

The uid or the gid has changed.

IOFUNC_ATTR_DIRTY_RDEV

The *rdev* member has changed, e.g. *mknod()*.

IOFUNC_ATTR_DIRTY_SIZE

The size has changed.

IOFUNC_ATTR_DIRTY_TIME

One or more of *mtime*, *atime*, or *ctime* has changed.

IOFUNC_ATTR_MTIME

The modification time is no longer valid. Typically set on a write to the resource.

In addition to the above, your resource manager can use in any way the bits in the range defined by IOFUNC_ATTR_PRIVATE (see **<sys/iofunc.h>**).

lock_tid The ID of the thread that has locked the attributes. To support multiple threads in your resource manager,

you'll need to lock the attribute structure so that only one thread at a time is allowed to change it.

The resource manager layer automatically locks the attribute (using for you when certain handler functions are called (i.e. IO_*).

lock_count The number of times the thread has locked the attribute structure. You can lock the attributes by calling *iofunc_attr_lock()* or *iofunc_attr_trylock()*; unlock them by calling *iofunc_attr_unlock()*

A thread must unlock the attributes as many times as it locked them.

count The number of OCBs using this attribute in any manner. When this count is zero, no one is using this attribute.

rcount The number of OCBs using this attribute for reading.

wcount The number of OCBs using this attribute for writing.

rlocks The number of read locks currently registered on the attribute.

wlocks The number of write locks currently registered on the attribute.

mmap_list and *lock_list*

To manage their particular functionality on the resource, the *mmap_list* member is used by *iofunc_mmap()* and *iofunc_mmap_default()*; the *lock_list* member is used by *iofunc_lock_default()*. Generally, you shouldn't need to modify or examine these members.

list Reserved for future use.

list_size Size of reserved area; reserved for future use.

nbytes The number of bytes in the resource; your resource manager can change this value.

For a file, this would contain the file's size. For special devices (e.g. **/dev/null**) that don't support *lseek()* or have a radically different interpretation for *lseek()*, this field isn't used (because you wouldn't use any of the helper functions, but would supply your own instead.) In these cases, we recommend that you set this field to zero, unless there's a meaningful interpretation that you care to put to it.

inode This is a mountpoint-specific inode that must be unique per mountpoint. You can specify your own value, or 0 to have the Process manager fill it in for you. For filesystem type of applications, this may correspond to some on-disk structure. In any case, the interpretation of this field is up to you.

uid and *gid* The user ID and group ID of the owner of this resource. These fields are updated automatically by the *chown()* helper functions (e.g. *iofunc_chown_default()*) and are referenced in conjunction with the *mode* member for access-granting purposes by the *open()* help functions (e.g. *iofunc_open_default()*).

mtime, *atime*, and *ctime*

POSIX time members:

- *mtime* — modification time (*write()* updates this).
- *atime* — access time (*read()* updates this).
- *ctime* — change of status time (*write()*, *chmod()* and *chown()* update this).

One or more of the three time members may be *invalidated* as a result of calling an iofunc-layer function. To see if a time member is invalid, check the *flags* member. This is to avoid having each and every I/O message handler go to the kernel and request the current time of day, just to fill in the attribute structure's time member(s).

To fill the members with the correct time, call *iofunc_time_update()*.

mode — The resource's mode (e.g. type, permissions). Valid modes may be selected from the S_* series of constants in **<sys/stat.h>**; see "Access permissions" in the documentation for *stat()*.

nlink — The number of links to this particular name; your resource manager can modify this member. For names that represent a directory, this value must be greater than 2.

rdev — The device number for a character special device and the **rdev** number for a named special device.

Classification:

QNX Neutrino

See also:

iofunc_attr_lock(), *iofunc_attr_trylock()*, *iofunc_attr_unlock()*, *iofunc_lock_default()*, *iofunc_mmap()*, *iofunc_mmap_default()*, **iofunc_ocb_t**, *iofunc_time_update()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_attr_trylock()

Try to lock the attribute structure

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_attr_trylock( iofunc_attr_t *attr );
```

Arguments:

attr A pointer to the **iofunc_attr_t** structure that you want to lock.

Library:

libc

Description:

The *iofunc_attr_trylock()* function attempts to lock the attribute structure *attr*, preventing other threads in the resource manager from changing information. If it can't lock *attr* immediately, it returns EBUSY.

Call this function (or *iofunc_attr_lock()*) before you make any modifications to the attribute structure. After you're finished making modifications, call *iofunc_attr_unlock()* to release the lock.

Note that this is a *counting* locking mechanism. This means that a given thread can lock the attributes structure multiple times; it must then unlock the attributes structure a corresponding number of times in order to have the attributes structure considered unlocked. If another thread attempts to lock the structure while a thread has the structure locked, the other thread will block.

Returns:

EOK	Success.
EBUSY	The calling thread couldn't lock the attributes immediately.
EAGAIN	On the first use, all kernel mutex objects were in use.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_init(), *iofunc_attr_lock()*, **iofunc_attr_t**, *iofunc_attr_unlock()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_attr_unlock()

Unlock the attribute structure

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_attr_unlock( iofunc_attr_t *attr );
```

Arguments:

attr A pointer to the **iofunc_attr_t** structure that you want to unlock.

Library:

libc

Description:

The *iofunc_attr_unlock()* function unlocks the attribute structure *attr*, allowing other threads in the resource manager to change information.

Use this function in conjunction with *iofunc_attr_lock()* or *iofunc_attr_trylock()*; call *iofunc_attr_unlock()* after you've made modifications to the attribute structure. You must unlock the structure as many times as you locked it.

Returns:

EOK Success.

EAGAIN On the first use, all kernel mutex objects were in use.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_init(), *iofunc_attr_lock()*, **iofunc_attr_t**, *iofunc_attr_trylock()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_check_access()

Check access permissions

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_check_access(
        resmgr_context_t *ctp,
        const iofunc_attr_t *attr,
        mode_t checkmode,
        const struct _client_info *info );
```

Arguments:

ctp	A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.
attr	A pointer to the **iofunc_attr_t** structure that defines the characteristics of the device that's associated with the resource manager.
checkmode	The type and access permissions that you want to check for the resource. For more information, see below.
info	A pointer to a **_client_info** structure that contains the information about a client connection. For information about this structure, see *ConnectClientInfo()*. You can get this structure by calling *iofunc_client_info()*.

Library:

libc

Description:

The *iofunc_check_access()* function verifies that the client is allowed access to the resource, as specified by a combination of who the client is (*info*), and the resource attributes *attr->mode*, *attr->uid* and *attr->gid*. Access is tested based upon the *checkmode* parameter.

The *checkmode* parameter determines which checks are done. It's a bitwise OR of the following constants:

S_ISUID — Verifies that the effective user ID of the client is equal to the user ID specified by the *attr->uid* member.

S_ISGID — Verifies that the effective group ID or one of the supplementary group IDs of the client is equal to the group ID specified by the *attr->gid* member.

S_IREAD — Verifies that the client has READ access to the resource as specified by *attr->mode*.

If the client's effective user ID matches that of *attr->uid*, then the permission check is made against the owner permission field of *attr->mode* (mask 0700 octal).

If the client's effective user ID doesn't match that of *attr->uid*, then if the client's effective group ID matches that of *attr->gid*, or one of the client's supplementary group IDs matches *attr->gid*, the check is made against the group permission field of *attr->mode* (mask 0070 octal).

If none of the group fields match, the check is made against the other permission field of *attr->mode* (mask 0007 octal).

S_IWRITE — Same as S_IREAD, except WRITE access is tested.

S_IEXEC — Same as S_IREAD, except EXECUTE access is tested. Note that since most resource managers don't actually execute code, the execute access is typically used in its directory sense, i.e. to test for directory accessibility, rather than execute access.

The S_ISUID and S_ISGID flags are mutually exclusive, that is, you may specify at most one of them. In conjunction with the S_ISUID and S_ISGID flags, you may specify zero or more of the S_IREAD,

S_IWRITE, and S_IEXEC flags. If no flags are specified, the permission checks are performed for privileged (**root**) access.

Here's some pseudo-code to try to explain this:

```
if superuser:
    return EOK

if S_ISUID and effective user ID == file user ID:
    return EOK

if S_ISGID and effective group ID == file group ID:
    return EOK

if S_IREAD or S_IWRITE or S_IEXEC:
    if caller's user ID == effective user ID:
        if all permissions are set in file's owner mode bits:
            return EOK
        else:
            return EACCESS

    if ( caller's group ID or supplementary group IDs ) ==
       effective group ID:
        if all permissions are set in file's group mode bits:
            return EOK
        else:
            return EACCESS

    if all permissions are set in file's other mode bits:
        return EOK
    else:
        return EACCESS

return EPERM
```

Returns:

EACCES	The client doesn't have permissions to do the operation.
ENOSYS	NULL was passed for *info* structure.
EOK	Successful completion.
EPERM	The group ID or owner ID didn't match.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_client_info(), *iofunc_open()*, *iofunc_read_verify()*, *iofunc_write_verify()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_chmod()

Handle an _IO_CHMOD message

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_chmod ( resmgr_context_t *ctp,
                   io_chmod_t *msg,
                   iofunc_ocb_t *ocb,
                   iofunc_attr_t *attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_chmod_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_chmod()* helper function implements POSIX semantics for the client's *chmod()* call, which is received as an _IO_CHMOD message by the resource manager.

The *iofunc_chmod()* function verifies that the client has the necessary permissions to effect a *chmod()* on the attribute. If so, the *chmod()* is performed, modifying elements of the *ocb->attr* structure. This

function takes care of updating the IOFUNC_ATTR_CTIME, IOFUNC_ATTR_DIRTY_TIME, and IOFUNC_ATTR_DIRTY_MODE bits in *ocb->attr->flags*. You can use *iofunc_time_update()*, to update the appropriate time fields in *ocb->attr*.

You can use *iofunc_chmod()*, for example, in a filesystem manager, where an _IO_CHMOD message was received, and the filesystem code must now write the values to the medium. The filesystem code may wish to block the client thread until the data was actually written to the medium. Contrast this scenario to the behavior of *iofunc_chmod_default()*, which calls this routine, and replies to the client thread.

io_chmod_t structure

The **io_chmod_t** structure holds the _IO_CHMOD message received by the resource manager:

```
struct _io_chmod {
    uint16_t                    type;
    uint16_t                    combine_len;
    mode_t                      mode;
};

typedef union {
    struct _io_chmod            i;
} io_chmod_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client). In this case, there's only an input message, *i*.

The *i* member is a structure of type **_io_chmod** that contains the following members:

type _IO_CHMOD.

combine_len If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

mode	The new mode. For more information, see "Access permissions" in the documentation for *stat()*.

Returns:

EOK	Successful completion.
EROFS	An attempt was made to chmod on a read-only filesystem.
EACCES	The client doesn't have permissions to do the operation.
EPERM	The group ID or owner ID didn't match.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

`iofunc_attr_t`, *iofunc_chmod_default()*, **`iofunc_ocb_t`**, *iofunc_time_update()*, **`resmgr_context_t`**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_chmod_default()

Default handler for _IO_CHMOD messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_chmod_default( resmgr_context_t *ctp,
                          io_chmod_t *msg,
                          iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_chmod_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_chmod()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_chmod_default()* function implements POSIX semantics for the client's *chmod()* call, which is received as an _IO_CHMOD message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *chmod* position, or you can call *iofunc_func_init()* to initialize all the functions to their default values.

The *iofunc_chmod_default()* function calls *iofunc_chmod()* to do the actual work, and (if installed in the *io_funcs* table) issues the reply back to the client.

Returns:

EOK	Successful completion.
EROFS	An attempt was made to *chmod()* on a read-only filesystem.
EACCES	The client doesn't have permissions to do the operation.
EPERM	The group ID or owner ID didn't match.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_chmod(), *iofunc_func_init()*, **iofunc_ocb_t**, *iofunc_time_update()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_chown()

Handle an _IO_CHOWN message

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_chown ( resmgr_context_t *ctp,
                   io_chown_t *msg,
                   iofunc_ocb_t *ocb,
                   iofunc_attr_t *attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_chown_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_chown()* helper function implements POSIX semantics for the client's *chown()* call, which is received as an _IO_CHOWN message by the resource manager.

The *iofunc_chown()* function verifies that the client has the necessary permissions to effect a chown on the attribute. If so, the chown is performed, modifying elements of the *ocb->attr* structure. As per

POSIX 1003.1, if the client isn't **root**, *iofunc_chown()* clears the set-user-id and set-group-id bits in the *ocb->attr->mode* member.

This function takes care of updating the IOFUNC_ATTR_CTIME, IOFUNC_ATTR_DIRTY_TIME, and IOFUNC_ATTR_DIRTY_MODE bits in *ocb->attr->flags*. You can use *iofunc_time_update()*, to update the appropriate time fields in *ocb->attr*.

io_chown_t structure

The **io_chown_t** structure holds the _IO_CHOWN message received by the resource manager:

```
struct _io_chown {
    uint16_t                    type;
    uint16_t                    combine_len;
    int32_t                     gid;
    int32_t                     uid;
};

typedef union {
    struct _io_chown            i;
} io_chown_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client). In this case, there's only an input message, *i*.

The *i* member is a structure of type **_io_chown** that contains the following members:

type — _IO_CHOWN.

combine_len — If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

gid — The new group ID.

uid — The new user ID.

Returns:

EOK	Successful completion.
EROFS	An attempt was made to chown on a read-only filesystem.
EACCES	The client doesn't have permissions to do the operation.
EPERM	The group ID or owner ID didn't match.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_t, *iofunc_chmod()*, *iofunc_chown_default()*, **iofunc_ocb_t**, *iofunc_time_update()*, *resmgr_attach()*, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_chown_default()

Default handler for _IO_CHOWN messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_chown_default( resmgr_context_t *ctp,
                          io_chown_t *msg,
                          iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_chown_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_chown()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_chown_default()* function implements POSIX semantics for the client's *chown()* call, which is received as an _IO_CHOWN message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *chown* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_chown_default()* function calls *iofunc_chown()* to do the actual work, and (if installed in the *io_funcs* table) issues the reply back to the client.

Returns:

EOK	Successful completion.
EROFS	An attempt was made to chown on a read-only filesystem.
EACCES	The client doesn't have permissions to do the operation.
EPERM	The group ID or owner ID didn't match.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_chown(), *iofunc_func_init()*, **iofunc_ocb_t**, *iofunc_time_update()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_client_info()

Return information about a client connection

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_client_info ( resmgr_context_t * ctp,
                         int ioflag,
                         struct _client_info * info );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

ioflag Zero, or the constant O_REALIDS. This argument is passed in the _IO_OPEN message during an open request. If O_REALIDS is specified, *iofunc_client_info()* swaps the real and effective values of the user and group IDs before returning. This is a QNX Neutrino extension, to swap real and effective user and group IDs in an atomic operation.

info A pointer to a **_client_info** structure that the function fills with information about a client connection. For information about this structure, see *ConnectClientInfo()*.

Library:

libc

Description:

The *iofunc_client_info()* function fetches the *info* structure for the client. It calls *ConnectClientInfo()* to gather the information, based on the server connection ID found in *ctp->info.scoid*.

Returns:

EFAULT	A fault occurred when the kernel tried to access the *info* buffer provided.
EINVAL	The client process is no longer valid.
EOK	Successful completion.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectClientInfo()

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_close_dup()

Free all locks allocated for the client process

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_close_dup( resmgr_context_t* ctp,
                      io_close_t* msg,
                      iofunc_ocb_t* ocb,
                      iofunc_attr_t* attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_close_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_close_dup()* helper function handles a _IO_CLOSE message. This function frees all locks allocated for the client process on the file descriptor and performs any POSIX-related cleanup required when a duplicated *ocb* is detached.

io_close_t structure

The **io_close_t** structure holds the _IO_CLOSE message received by the resource manager:

```
struct _io_close {
    uint16_t                    type;
    uint16_t                    combine_len;
};

typedef union {
    struct _io_close            i;
} io_close_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client). In this case, there's only an input message, *i*.

The *i* member is a structure of type **_io_close** that contains the following members:

type — _IO_CLOSE.

combine_len — If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

Returns:

EOK	Success.
Anything else	An error occurred.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_close_dup_default(), *iofunc_close_ocb()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_close_dup_default()

Default handler for _IO_CLOSE messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_close_dup_default(
        resmgr_context_t *ctp,
        io_close_t *msg,
        iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_close_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_close_dup()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_close_dup_default()* function implements default actions for the _IO_CLOSE message. This function simply calls *iofunc_close_dup()*, which does the actual work.

You can place *iofunc_close_dup_default()* directly into the *io_funcs* table passed to *resmgr_attach()*, at the *close_dup* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

☞ If your resource manager uses *iofunc_lock_default()*, you *must* use both this function (*iofunc_close_dup_default()*) and *iofunc_unblock_default()*, as they provide necessary ancillary functionality for managing file locks. This is because file locks are owned by the process, and aren't inherited by the child process.

Returns:

EOK Successful completion.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_close_dup(), *iofunc_func_init()*, **iofunc_ocb_t**, *iofunc_time_update()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_close_ocb()

Return the memory allocated for an OCB

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_close_ocb( resmgr_context_t* ctp,
                      iofunc_ocb_t* ocb,
                      iofunc_attr_t* attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_close_ocb()* function detaches the OCB specified by *ocb*, and releases the memory associated with it.

☞ This function assumes that *ocb* points to an **iofunc_ocb_t**. If you encapsulate **iofunc_ocb_t** in your own OCB it must be the first field of your OCB; otherwise, you can't call this function. If you provide an *ocb_free()* function in the mount structure then it's called at this point. This means that at least the **iofunc_ocb_t** portion of your OCB is no longer valid after *iofunc_close_ocb()* returns.

The *iofunc_close_ocb()* function calls *iofunc_ocb_detach()* on your behalf.

Returns:

EOK Success.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_t, *iofunc_close_dup()*, *iofunc_close_ocb_default()*, *iofunc_ocb_free()*, **iofunc_ocb_t**, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_close_ocb_default()

Return the memory allocated for an OCB

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_close_ocb_default( resmgr_context_t* ctp,
                              void* reserved,
                              iofunc_ocb_t* ocb );
```

Arguments:

ctp	A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.
reserved	This argument must be passed as NULL.
ocb	A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_close_ocb_default()* function detaches the OCB specified by *ocb*, and releases the memory associated with it.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *close_ocb* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

This function assumes that *ocb* points to an **iofunc_ocb_t**. If you encapsulate **iofunc_ocb_t** in your own OCB, it must be the first field of your OCB; otherwise, you can't call this function. If you provide an *ocb_free()* function in the mount structure, it's called at this point. This means that at least the **iofunc_ocb_t** portion of your OCB is no longer valid after *iofunc_close_ocb()* returns.

The *iofunc_close_ocb_default()* function calls *iofunc_close_ocb()*.

Returns:

EOK Success.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_close_ocb(), *iofunc_func_init()*, **iofunc_ocb_t**, *iofunc_time_update()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_devctl()

Handle an _IO_DEVCTL message

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_devctl( resmgr_context_t *ctp,
                   io_devctl_t *msg,
                   iofunc_ocb_t *ocb,
                   iofunc_attr_t *attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_devctl_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_devctl()* helper function implements POSIX semantics for the client's *devctl()* call, which is received as an _IO_DEVCTL message by the resource manager. This function handles the DCMD_ALL* functionality.

This function handles at least the following device control messages:

DCMD_ALL_GETFLAGS

Implements the functionality of the *fcntl()* get-flags command.

DCMD_ALL_SETFLAGS

Implements the functionality of the *fcntl()* set-flags command.

DCMD_ALL_GETMOUNTFLAGS

Returns the mount flag (*mount->flags*) for a resource that has a mount structure defined, else returns a mount flag of zero.

The supported mount flags (bitmask values) for DCMD_ALL_GETMOUNTFLAGS include:

_MOUNT_READONLY

Read only.

_MOUNT_NOEXEC

Can't exec from filesystem.

_MOUNT_NOSUID

Don't honor setuid bits on filesystem.

Any other device control messages return ENOTTY.

`io_devctl_t` structure

The **`io_devctl_t`** structure holds the _IO_ message received by the resource manager:

```
struct _io_devctl {
    uint16_t                    type;
    uint16_t                    combine_len;
    int32_t                     dcmd;
    int32_t                     nbytes;
    int32_t                     zero;
/*  char                        data[nbytes]; */
};

struct _io_devctl_reply {
    uint32_t                    zero;
    int32_t                     ret_val;
    int32_t                     nbytes;
    int32_t                     zero2;
/*  char                        data[nbytes]; */
```

```
    } ;

typedef union {
    struct _io_devctl           i;
    struct _io_devctl_reply     o;
} io_devctl_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client).

The *i* member is a structure of type **_io_devctl** that contains the following members:

type	_IO_DEVCTL.
combine_len	If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.
dcmd	The device-control command to execute.
nbytes	The number of bytes of data being passed with the command.

The commented-out declaration for *data* indicates that *nbytes* bytes of data immediately follow the **_io_devctl** structure.

The *_DEVCTL_DATA()* macro gets a pointer to the data that follows the message. Call it like this:

```
data = _DEVCTL_DATA (msg->i);
```

The *o* member of the **io_devctl_t** message is a structure of type **_io_devctl_reply** that contains the following members:

ret_val	The value returned by the command.
nbytes	The number of bytes of data being returned.

The commented-out declaration for *data* indicates that *nbytes* bytes of data immediately follow the **_io_devctl_reply** structure.

Returns:

EOK	Successful completion.
EINVAL	An attempt to set the flags for a resource that is synchronized, with no mount structure defined, or no synchronized I/O defined.
ENOTTY	An unsupported device control message was decoded.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

fcntl(), **iofunc_attr_t**, *iofunc_devctl_default()*, **iofunc_ocb_t**, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_devctl_default()

Default handler for _IO_DEVCTL messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_devctl_default( resmgr_context_t *ctp,
                           io_devctl_t *msg,
                           iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_devctl_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_devctl()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_devctl_default()* function implements POSIX semantics for the client's *devctl()* call, which is received as an _IO_DEVCTL message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *devctl* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_devctl_default()* function calls *iofunc_devctl()*, to do the actual work, and (if installed in the *io_funcs* table) issues the reply back to the client.

Returns:

EOK — Successful completion.

EINVAL — An attempt to set the flags for a resource that is synchronized, with no mount structure defined, or no synchronized I/O defined.

ENOTTY — An unsupported device control message was decoded.

_RESMGR_DEFAULT — An supported device control message that isn't a known DCMD_ALL_* command was decoded.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_devctl(), *iofunc_func_init()*, **iofunc_ocb_t**, *iofunc_time_update()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_fdinfo()

Handle an _IO_FDINFO message

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_fdinfo( resmgr_context_t * ctp,
                   iofunc_ocb_t * ocb,
                   iofunc_attr_t * attr,
                   struct _fdinfo * info );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr NULL, or a pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

info A pointer to a **_fdinfo** structure that the function fills with the information. This structure is defined in **<sys/iomgr.h>** as:

```
struct _fdinfo {
    uint32_t                    mode;   /* File mode */
    uint32_t                    ioflag; /* Current io flags */
    uint64_t                    offset; /* Current seek position */
    uint64_t                    size;   /* Current size of file */
    uint32_t                    flags;  /* _FDINFO_* */
    uint16_t                    sflag;  /* Share flags */
    uint16_t                    count;  /* File use count */
    uint16_t                    rcount; /* File reader count */
    uint16_t                    wcount; /* File writer count */
    uint16_t                    rlocks; /* Number of read locks */
    uint16_t                    wlocks; /* Number of write locks */
    uint32_t                    zero[6];
};
```

The **_fdinfo** structure is included in the reply part of a **io_fdinfo_t** structure; for more information, see the documentation for *iofunc_fdinfo_default()*.

Library:

libc

Description:

The *iofunc_fdinfo()* helper function provides the implementation for the client's *iofdinfo()* call, which is received as an _IO_FDINFO message by the resource manager.

The *iofunc_fdinfo()* function transfers the appropriate fields from the *ocb* and *attr* structures to the *info* structure. If *attr* is NULL, then the *attr* information comes from the structure pointed to by *ocb->attr*.

Returns:

EOK Successful completion.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofdinfo(), **iofunc_attr_t**, *iofunc_fdinfo_default()*, **iofunc_ocb_t**, **resmgr_context_t**, *resmgr_pathname()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_fdinfo_default()

Default handler for _IO_FDINFO messages

Synopsis:

```
#include <sys/iomgr.h>

int iofunc_fdinfo_default( resmgr_context_t * ctp,
                           io_fdinfo_t * msg,
                           iofunc_ocb_t * ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_fdinfo_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_fdinfo_default()* function provides the default handler for the client's *iofdinfo()* call, which is received as an _IO_FDINFO message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *fdinfo* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_fdinfo_default()* function calls *iofunc_fdinfo()* and *resmgr_pathname()* to do the actual write, and (if installed in the *io_funcs* table) replies back to the client.

io_fdinfo_t structure

The **io_fdinfo_t** structure holds the _IO_FDINFO message received by the resource manager:

```
struct _io_fdinfo {
    uint16_t                    type;
    uint16_t                    combine_len;
    uint32_t                    flags;
    int32_t                     path_len;
    uint32_t                    reserved;
};

struct _io_fdinfo_reply {
    uint32_t                    zero[2];
    struct _fdinfo              info;
/*  char                        path[path_len + 1];  */
};

typedef union {
    struct _io_fdinfo           i;
    struct _io_fdinfo_reply     o;
} io_fdinfo_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client).

The *i* member is a structure of type **_io_fdinfo** that contains the following members:

type — _IO_FDINFO.

combine_len — If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

flags — Specify _FDINFO_FLAG_LOCALPATH to return only the local path info (i.e. exclude the network path info).

path_len — The size of the path reply buffers that follow the reply.

The *o* member is a structure of type **_io_fdinfo_reply** that contains the following members:

info A **_fdinfo** structure that's defined (in **<sys/iomgr.h>**) as:

```
struct _fdinfo {
    uint32_t                    mode;   /* File mode */
    uint32_t                    ioflag; /* Current io flags */
    uint64_t                    offset; /* Current seek position */
    uint64_t                    size;   /* Current size of file */
    uint32_t                    flags;  /* _FDINFO_* */
    uint16_t                    sflag;  /* Share flags */
    uint16_t                    count;  /* File use count */
    uint16_t                    rcount; /* File reader count */
    uint16_t                    wcount; /* File writer count */
    uint16_t                    rlocks; /* Number of read locks */
    uint16_t                    wlocks; /* Number of write locks */
    uint32_t                    zero[6];
};
```

The commented-out declaration for *path* indicates that *path_len* + 1 bytes of data immediately follow the **_io_fdinfo_reply** structure.

Returns:

The length of the path, or -1 if an error occurs (*errno* is set).

Errors:

EMSGSIZE Insufficient space available in the server's buffer to receive the entire message.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofdinfo(), *iofunc_fdinfo_default()*, *iofunc_func_init()*, **iofunc_ocb_t**, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**, *_RESMGR_NPARTS()*, *resmgr_pathname()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_func_init()

Initialize the default POSIX-layer function tables

Synopsis:

```
#include <sys/iofunc.h>

void iofunc_func_init(
          unsigned nconnect,
          resmgr_connect_funcs_t *connect,
          unsigned nio,
          resmgr_io_funcs_t *io );
```

Arguments:

nconnect	The number of entries in the *connect* table that you want to fill. Typically, you pass _RESMGR_CONNECT_NFUNCS for this argument.
connect	A pointer to a **resmgr_connect_funcs_t** structure that you want to fill with the default connect functions.
nio	The number of entries in the *io* table that you want to fill. Typically, you pass _RESMGR_IO_NFUNCS for this argument.
io	A pointer to a **resmgr_io_funcs_t** structure that you want to fill with the default I/O functions.

Library:

libc

Description:

The *iofunc_func_init()* function initializes the passed *connect* and *io* structures with the POSIX-layer default functions. For information about the default functions, see **resmgr_connect_funcs_t** and **resmgr_io_funcs_t**.

The *nconnect* and *nio* arguments indicate how many entries this function should fill. This is in place to support forward compatibility.

Examples:

Fill a connect and I/O function table with the POSIX-layer defaults:

```
#include <sys/iofunc.h>

static resmgr_connect_funcs_t my_connect_functions;
static resmgr_io_funcs_t my_io_functions;

int main (int argc, char **argv)
{
...
    iofunc_func_init (_RESMGR_CONNECT_NFUNCS, &my_connect_functions,
                      _RESMGR_IO_NFUNCS, &my_io_functions);

/*
 * At this point, the defaults have been filled in.
 * You may now override some of the default functions with
 * functions that you have written:
*/

    my_io_functions.io_read = my_io_read;
...
}
```

The above example initializes your connect and I/O function structures (*my_connect_functions* and *my_io_functions*) with the POSIX-layer defaults. If you didn't override any of the functions, your resource manager would behave like **/dev/null** — any data written to it would be discarded, and an attempt to read data from it would immediately return an EOF.

Since this isn't desirable in most cases, you'll often provide functionality for some functions, such as reading, writing, and device control to your device. In the example above, we've explicitly supplied our own handler for reading from the device, via a function called *my_io_read()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_init(), *resmgr_attach()*, **resmgr_connect_funcs_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_link()

Link two directories

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_link( resmgr_context_t* ctp,
                 io_link_t* msg,
                 iofunc_attr_t* attr,
                 iofunc_attr_t* dattr,
                 struct _client_info* info );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_link_t** structure that contains the message that the resource manager received; see below.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the resource.

dattr NULL, or a pointer to the **iofunc_attr_t** structure that describes the characteristics of the parent directory.

info NULL, or a pointer to a **_client_info** structure that contains information about the client. For information about this structure, see *ConnectClientInfo()*.

Library:

libc

Description:

The *iofunc_link()* helper function links directory *attr* to *dattr* for context *ctp*. It's similar to the *iofunc_open()* function:

The *iofunc_link()* function checks to see if the client (described by the optional *info* structure) has access to open the resource (name passed

in the *msg* structure). The *attr* structure describes the resource's attributes, and the optional *dattr* structure defines the attributes of the parent directory (i.e. if *dattr* isn't NULL, it implies that the resource identified by *attr* is being created within the directory specified by *dattr*).

You can pass the *info* argument as NULL, in which case *iofunc_link()* obtains the client information itself via a call to *iofunc_client_info()*. It is, of course, more efficient to get the client info once, rather than calling this function with NULL every time.

If you pass NULL in *info*, the function returns information about a client's connection in *info*, and an error constant.

`io_link_t` structure

The **`io_link_t`** structure holds the _IO_CONNECT message received by the resource manager:

```
typedef union {
    struct _io_connect                  connect;
    struct _io_connect_link_reply       link_reply;
    struct _io_connect_ftype_reply      ftype_reply;
} io_link_t;
```

This message structure is a union of an input message (coming to the resource manager), **`_io_connect`**, and two possible output or reply messages (going back to the client):

- **`_io_connect_link_reply`** if the reply is redirecting the client to another resource

  Or:

- **`_io_connect_ftype_reply`** if the reply consists of a status and a file type.

The reply includes the following additional information:

```
struct _io_resmgr_link_extra {
    uint32_t                            nd;
    int32_t                             pid;
    int32_t                             chid;
    uint32_t                            handle;
```

```
    uint32_t                            flags;
    uint32_t                            file_type;
    uint32_t                            reserved[2];
};

typedef union _io_link_extra {
    struct _msg_info                    info;       /* EXTRA_LINK (from client) */
    void                                *ocb;       /* EXTRA_LINK (from resmgr functions) *
    char                                path[1];    /* EXTRA_SYMLINK */
    struct _io_resmgr_link_extra        resmgr;     /* EXTRA_RESMGR_LINK */
} io_link_extra_t;
```

info A pointer to a **_msg_info** structure.

Returns:

EOK	Success.
EBADFSYS.	NULL was passed in *attr* and *dattr*.
EFAULT	A fault occurred when the kernel tried to access the *info* buffer.
EINVAL	The client process is no longer valid.
ENOSYS	NULL was passed in *info*.
EPERM	The group ID or owner ID didn't match.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectClientInfo(), **iofunc_attr_t**, *iofunc_client_info()*, *iofunc_open()*, **_msg_info**, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_lock()

Lock a resource

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_lock( resmgr_context_t * ctp,
                 io_lock_t * msg,
                 iofunc_ocb_t * ocb,
                 iofunc_attr_t * attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_lock_t** structure that contains the message that the resource manager received.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The function *iofunc_lock()* does what is required for POSIX locks. This function isn't currently implemented.

Returns:

ENOSYS The *iofunc_lock()* function isn't currently supported.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_lock_calloc(), iofunc_lock_free()

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_lock_calloc()

Allocate memory to lock structures

Synopsis:

```
#include <sys/iofunc.h>

iofunc_lock_list_t *iofunc_lock_calloc
                    ( resmgr_context_t *ctp,
                      IOFUNC_OCB_T *ocb,
                      size_t size );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

ocb A pointer to the the Open Control Block (typically a **iofunc_ocb_t** structure) that was created when the client opened the resource.

size The amount of memory that you want to allocate.

Library:

libc

Description:

The function *iofunc_lock_calloc()* is used by *iofunc_lock()* to allocate memory to lock structures.

Returns:

A pointer to a zeroed buffer that the POSIX layer uses for locks, or NULL if no memory could be allocated.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_lock(), iofunc_lock_free()

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_lock_default()

Default handler for _IO_LOCK messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_lock_default( resmgr_context_t * ctp,
                         io_lock_t * msg,
                         iofunc_ocb_t * ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_lock_t** structure that contains the message that the resource manager received; see *iofunc_lock()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_lock_default()* function implements POSIX semantics for the _IO_LOCK message (generated as a result of a client *fcntl()* call).

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *lock* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_lock_default()* function verifies that the client has the necessary permissions to effect a lock on the resource. This includes checking for read and write permissions against the type of lock being effected. If so, the lock is performed, modifying elements of the *ocb->attr* structure, and updating *ocb->attr->locklist* to reflect the

new lock. This function calls *iofunc_lock()*, which does the actual work.

If your resource manager calls *iofunc_lock_default()*, it must call *iofunc_close_dup_default()* and *iofunc_unblock_default()* in their respective handlers.

Returns:

EOK	Successful completion.
EINVAL	An invalid range was specified for the lock operation, or an invalid lock operation was attempted.
EBADF	An attempt to perform a read lock on a write-only resource, or a write lock on a read-only resource was attempted.
ENOMEM	Insufficient memory exists to allocate an internal lock structure.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), *iofunc_lock()*, **iofunc_ocb_t**, *iofunc_time_update()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_lock_free()

Return memory allocated for lock structures

Synopsis:

```
#include <sys/iofunc.h>

void iofunc_lock_free( iofunc_lock_list_t* lock,
                       size_t size );
```

Arguments:

lock A pointer to the **iofunc_lock_list_t** list that you want to free.

size The amount of memory that you want to free.

Library:

libc

Description:

The function *iofunc_lock_free()* frees *lock* structures allocated by *iofunc_lock_calloc()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_lock(), iofunc_lock_calloc()

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_lock_ocb_default()

Default handler for the lock_ocb callout

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_lock_ocb_default( resmgr_context_t *ctp,
                             void *reserved,
                             iofunc_ocb_t *ocb );
```

Arguments:

ctp	A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.
reserved	This argument must be NULL.
ocb	A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_lock_ocb_default()* function calls *iofunc_attr_lock()* to enforce locking on the attributes for the group of messages that were sent by the client.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *lock_ocb* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

Returns:

EOK	Success.
EAGAIN	On the first use, all kernel mutex objects were in use.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_lock(), *iofunc_func_init()*, **iofunc_ocb_t**, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_lseek()

Handle an _IO_LSEEK message

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_lseek ( resmgr_context_t* ctp,
                   io_lseek_t* msg,
                   iofunc_ocb_t* ocb,
                   iofunc_attr_t* attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_lseek_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_lseek()* helper function implements POSIX semantics for the client's *lseek()* call, which is received as an _IO_LSEEK message by the resource manager.

The *iofunc_lseek()* function handles the three different *whence* cases: SEEK_SET, SEEK_CUR, and SEEK_END, updating the *ocb->offset* field with the new position.

Note that if the IOFUNC_MOUNT_32BIT flag isn't set in the mount structure, *iofunc_lseek()* handles 64-bit position offsets. If the flag is set (meaning this device supports only 32-bit offsets), the resulting offset value is treated as a 32-bit offset, and if it overflows 32 bits, it's truncated to LONG_MAX. Also, this function handles combine messages correctly, simplifying the work required to support lseek.

io_lseek_t structure

The **io_lseek_t** structure holds the _IO_LSEEK message received by the resource manager:

```
struct _io_lseek {
    uint16_t                    type;
    uint16_t                    combine_len;
    short                       whence;
    uint16_t                    zero;
    uint64_t                    offset;
};

typedef union {
    struct _io_lseek            i;
    uint64_t                    o;
} io_lseek_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client).

The *i* member is a structure of type **_io_lseek** that contains the following members:

type — _IO_LSEEK.

combine_len — If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

whence — SEEK_SET, SEEK_CUR, or SEEK_END.

offset The relative offset from the file position determined by the *whence* member.

The *o* member is the offset after the operation is complete.

Returns:

EOK Successful completion.

EINVAL The *whence* member in the _IO_LSEEK message wasn't one of SEEK_SET, SEEK_CUR, or SEEK_END, or the resulting position after the offset was applied resulted in a negative number (overflow).

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_t, *iofunc_lseek_default()*, **iofunc_ocb_t**, *lseek()*, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_lseek_default()

Default handler for _IO_LSEEK messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_lseek_default( resmgr_context_t* ctp,
                          io_lseek_t* msg,
                          iofunc_ocb_t* ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_lseek_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_lseek()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_lseek_default()* function implements POSIX semantics for the client's *lseek()* call, which is received as an _IO_LSEEK message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *lseek* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_lseek_default()* function calls *iofunc_lseek()* to do the actual work, and (if installed in the *io_funcs* table) issues the reply back to the client.

Returns:

EOK	Successful completion.
EINVAL	The *whence* member in the _IO_LSEEK message wasn't one of SEEK_SET, SEEK_CUR, or SEEK_END, or the resulting position after the offset was applied resulted in a negative number (overflow).

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), *iofunc_lseek()*, **iofunc_ocb_t**, *lseek()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_mknod()

Verify a client's ability to make a new filesystem entry point

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_mknod( resmgr_context_t *ctp,
                  io_mknod_t *msg,
                  iofunc_attr_t *attr,
                  iofunc_attr_t *dattr,
                  struct _client_info *info );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_mknod_t** structure that contains the message that the resource manager received; see below.

attr NULL, or a pointer to the **iofunc_attr_t** structure that describes the characteristics of the resource.

dattr A pointer to the **iofunc_attr_t** structure that you must set. The **iofunc_attr_t** structure describes the attributes of the parent directory.

info NULL, or a pointer to a **_client_info** structure that contains information about the client. For information about this structure, see *ConnectClientInfo()*.

Library:

libc

Description:

The *iofunc_mknod()* helper function supports *mknod()* requests by verifying that the client can make a new filesystem entry point. It's similar to *iofunc_open()*.

The *iofunc_mknod()* function checks to see if the client (described by the optional *info* structure) has access to open the resource (name passed in the *msg* structure). The *attr* structure describes the resource's attributes, and the optional *dattr* structure defines the attributes of the parent directory (i.e. if *dattr* isn't NULL, it implies that the resource identified by *attr* is being created within the directory specified by *dattr*).

The *info* argument can be passed as NULL, in which case *iofunc_mknod()* obtains the client information itself via a call to *iofunc_client_info()*. It is, of course, more efficient to get the client info once, rather than calling this function with NULL every time.

If an error occurs, the function returns information about a client's connection in *info* and a constant.

io_mknod_t structure

The **io_mknod_t** structure holds the _IO_CONNECT message received by the resource manager:

```
typedef union {
    struct _io_connect                  connect;
    struct _io_connect_link_reply       link_reply;
    struct _io_connect_ftype_reply      ftype_reply;
} io_mknod_t;
```

This message structure is a union of an input message (coming to the resource manager), **_io_connect**, and two possible output or reply messages (going back to the client):

- **_io_connect_link_reply** if the reply is redirecting the client to another resource

  Or:

- **_io_connect_ftype_reply** if the reply consists of a status and a file type.

Returns:

EOK	Success.
EBADFSYS	NULL was passed in *dattr*.
EFAULT	A fault occurred when the kernel tried to access the *info* buffer.
EINVAL	The client process is no longer valid.
ENOSYS	NULL was passed in *info*.
EPERM	The group ID or owner ID didn't match.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

_io_connect, **_io_connect_link_reply**, **_io_connect_ftype_reply**, *iofunc_client_info()*, *iofunc_open()*, *mknod()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_mmap()

Handle an IO_MMAP message

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_mmap ( resmgr_context_t * hdr,
                  io_mmap_t * msg,
                  iofunc_ocb_t * ocb,
                  iofunc_attr_t * attr );
```

Arguments:

hdr A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_mmap_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_mmap()* helper function provides functionality for the _IO_MMAP message. The _IO_MMAP message is an outcall from the Memory Manager (a part of the QNX Neutrino microkernel's **procnto**).

Note that if the Process Manager is to be able to execute from this resource, then you must use the *iofunc_mmap()* function.

io_mmap_t structure

The **io_mmap_t** structure holds the _IO_MMAP message received by the resource manager:

```
struct _io_mmap {
    uint16_t                    type;
    uint16_t                    combine_len;
    uint32_t                    prot;
    uint64_t                    offset;
    struct _msg_info            info;
    uint32_t                    zero[6];
};

struct _io_mmap_reply {
    uint32_t                    zero;
    uint32_t                    flags;
    uint64_t                    offset;
    int32_t                     coid;
    int32_t                     fd;
};

typedef union {
    struct _io_mmap             i;
    struct _io_mmap_reply       o;
} io_mmap_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client).

The *i* member is a structure of type **_io_mmap** that contains the following members:

type — _IO_MMAP.

combine_len — If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

prot — The access capabilities that the client wants to use for the memory region being mapped. This can be a

combination of at least the following protection bits, as defined in **<sys/mman.h>**:

- PROT_EXEC — the region can be executed.
- PROT_NOCACHE — disable caching of the region (e.g. so it can be used to access dual-ported memory).
- PROT_NONE — the region can't be accessed.
- PROT_READ — the region can be read.
- PROT_WRITE — the region can be written.

offset The offset into shared memory of the location that the client wants to start mapping.

info A pointer to a **_msg_info**, structure that contains information about the message received by the resource manager.

The *o* member of the **io_mmap_t** structure is a structure of type **_io_mmap_reply** that contains the following members:

flags Reserved for future use.

offset Reserved for future use.

coid A file descriptor that the process manager can use to access the mapped file.

fd Reserved for future use.

Returns:

A nonpositive value (i.e. ≤ 0)

Successful completion.

EROFS An attempt to memory map (mmap) a read-only file, using the PROT_WRITE page protection mode.

EACCES The client doesn't have the appropriate permissions.

ENOMEM	Insufficient memory exists to allocate internal resources required to effect the mapping.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_t, *iofunc_mmap_default()*, **iofunc_ocb_t**, **_msg_info**, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_mmap_default()

Default handler for _IO_MMAP messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_mmap_default ( resmgr_context_t * hdr,
                          io_mmap_t * msg,
                          iofunc_ocb_t * ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_mmap_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_mmap()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_mmap_default()* function provides functionality for the _IO_MMAP message. This message is private to the Memory Manager (a part of the Neutrino microkernel's **procnto**).

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *mmap* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

Note that if the Process Manager is to be able to execute from this resource, then you must use the *iofunc_mmap()* function.

The *iofunc_mmap_default()* function calls *iofunc_mmap()*, to do the actual work, and (if installed in the *io_funcs* table) issues the reply back to the client.

Returns:

A nonpositive value (i.e. ≤ 0)

Successful completion.

EROFS — An attempt to memory map (mmap) a read-only file, using the PROT_WRITE page protection mode.

EACCES — The client doesn't have the appropriate permissions.

ENOMEM — Insufficient memory exists to allocate internal resources required to effect the mapping.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), *iofunc_mmap()*, **iofunc_ocb_t**, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_notify()

Install, poll, or remove a notification handler

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_notify( resmgr_context_t *ctp,
                   io_notify_t *msg,
                   iofunc_notify_t *nop,
                   int trig,
                   const int *notifycounts,
                   int *armed );
```

Arguments:

ctp — A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg — A pointer to the **io_notify_t** structure that contains the message that the resource manager received; see below.

nop — An array of **iofunc_notify_t** structures that represent the events supported by the calling resource manager. Traditionally this array contained three members which represent, in order, the input, output, and out-of-band notification lists. Since the addition of extended events (see below), three is now the minimum size of this array. The actual size must support indexing by the conditions being triggered up to _NOTIFY_MAXCOND.

Generally, this structure is maintained by the resource manager within an extended attributes structure.

trig — A bitmask indicating which sources are currently satisfied, and could cause a trigger to occur. This bitmask may be indicated via two sets of flags. Traditionally, the value was any combination of _NOTIFY_COND_INPUT, _NOTIFY_COND_OUTPUT

and _NOTIFY_COND_OBAND. With the addition of extended events, this can also be any combination of the _NOTIFY_CONDE* flags. Note the following flags are considered equivalent:

```
_NOTIFY_COND_INPUT  == _NOTIFY_CONDE_RDNORM
_NOTIFY_COND_OUTPUT == _NOTIFY_CONDE_WRNORM
_NOTIFY_COND_OBAND  == _NOTIFY_CONDE_RDBAND
```

Setting the _NOTIFY_COND_EXTEN flag may affect the "*armed*" parameter as indicated below.

You typically set this value, based on the conditions in effect at the time of the call.

notifycounts NULL, or an array of integers representing the number of elements that must be present in the queue of each event represented by the *nop* array in order for the event to be triggered. Both this array and the *nop* array should contain the same number of elements. Note that if any condition is met, nothing is armed. Only if none of the conditions are met, does the event get armed in accordance with the *notifycounts* parameter. If this parameter isn't specified (passed as NULL), a value of 1 is assumed for all counts.

armed NULL, or a pointer to a location where the function can store a 1 to indicate that a notification entry is armed, or a 0 otherwise. If the _NOTIFY_COND_EXTEN bit is set in the *trig* parameter and *armed* is not NULL, it is promoted from being a strictly resultant parameter to value resultant and must contain the number of elements in the *nop* and *notifycounts* array (provided *notifycounts* is not NULL) at the time of the call. If either of the above conditions is not met, *armed* remains strictly a resultant parameter, and the traditional number of three elements is assumed in *nop* and *notifycounts*.

Library:

libc

Description:

The POSIX layer helper function *iofunc_notify()* is used by a resource manager to implement notification.

This routine examines the message that the resource manager received (passed in the *msg* argument), and determines what action the client code is attempting to perform:

_NOTIFY_ACTION_POLL

Return a one-part IOV with the *flags* field set to indicate which conditions (input, output, or out-of-band) are available. The caller should return (*_RESMGR_NPARTS*(1)) to the resource manager library, which returns a one-part message to the client.

_NOTIFY_ACTION_POLLARM

Similar to _NOTIFY_ACTION_POLL, with the additional characteristic of arming the event if *none* of the conditions is met.

_NOTIFY_ACTION_TRANARM

For each of the sources specified, create a notification entry and store the client's **struct sigevent** event structure in it. Note that only one transition arm is allowed at a time *per device*. If the client specifies an event of SIGEV_NONE, the action is to disarm. When the event is triggered, the notification is automatically disarmed.

io_notify_t structure

The **io_notify_t** structure holds the _IO_NOTIFY message received by the resource manager:

```
struct _io_notify {
    uint16_t                    type;
    uint16_t                    combine_len;
```

```
    int32_t                     action;
    int32_t                     flags;
    struct sigevent             event;
};

struct _io_notify_reply {
    uint32_t                    zero;
    uint32_t                    flags;
};

typedef union {
    struct _io_notify           i;
    struct _io_notify_reply     o;
} io_notify_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client).

The *i* member is a structure of type **_io_notify** that contains the following members:

type _IO_NOTIFY.

combine_len If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

action _NOTIFY_ACTION_POLL, _NOTIFY_ACTION_POLLARM, or _NOTIFY_ACTION_TRANARM, as described above.

flags One of the following:

- _NOTIFY_COND_INPUT — this condition is met when there are one or more units of input data available (i.e. clients can now issue reads).
- _NOTIFY_COND_OUTPUT — this condition is met when there's room in the output buffer for one or more units of data (i.e. clients can now issue writes).

- _NOTIFY_COND_OBAND — the condition is met when one or more units of out-of-band data are available.

event A pointer to a **sigevent** structure that defines the event that the resource manager is to deliver once a condition is met.

The *o* member is a structure of type **_io_notify_reply** that contains the following members:

flags Which of the conditions were triggered; see the *flags* for **_io_notify**, above.

iofunc_notify_t structure

The **iofunc_notify_t** structure is defined in **<sys/iofunc.h>** as follows:

```
typedef struct _iofunc_notify {
    int                         cnt;
    struct _iofunc_notify_event *list;
} iofunc_notify_t;
```

The members of the **iofunc_notify_t** structure include:

cnt The smallest *cnt* member in the list; see below.

list A pointer to a linked list of **iofunc_notify_event_t** structures that represent (in order), the input, output, and out-of-band notification lists.

The **iofunc_notify_event_t** is defined as:

```
typedef struct _iofunc_notify_event {
    struct _iofunc_notify_event *next;
    int                         rcvid;
    int                         scoid;
    int                         cnt;
    struct sigevent             event;
} iofunc_notify_event_t;
```

The members of the **iofunc_notify_event_t** structure include:

next A pointer to the next element in the list.

rcvid The receive ID of the client to notify.

scoid The server connection ID.

cnt The number of bytes available. Some clients, such as **io-char**, may want a sufficiently large amount of data to be available before they access it.

event A pointer to a **sigevent** structure that defines the event that the resource manager is to deliver once a condition is met.

Returns:

EBUSY A notification was already armed for this resource, and this library function enforces a restriction of one per resource.

_RESMGR_NPARTS (1)

Normal return, indicates a one-part IOV should be returned to the client.

Examples:

See the Writing a Resource Manager chapter of *Programmer's Guide*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_notify_remove(), *iofunc_notify_trigger()*, *_RESMGR_NPARTS()*, **sigevent**

"Handling *ionotify()* and *select()*" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_notify_remove()

Remove notification entries from list

Synopsis:

```
#include <sys/iofunc.h>

void iofunc_notify_remove( resmgr_context_t * ctp,
                           iofunc_notify_t * nop );
```

Arguments:

ctp NULL, or a pointer to a **resmgr_context_t** structure for the client whose entries you want to remove.

nop An array of three **iofunc_notify_t** structures that represent (in order), the input, output, and out-of-band notification lists whose entries you want to remove; for information about this structure, see the documentation for *iofunc_notify()*.

Library:

libc

Description:

The *iofunc_notify_remove()* function removes all of the entries associated with the current client from the notification list passed in *nop*. The client information is obtained from the *ctp*.

If the *ctp* pointer is NULL, then *all* of the notify entries will be removed. A resource manager generally calls this function, with NULL as the *ctp* in the *close_ocb* callout, to clean up all handles associated with this connection. If the handles are shared between several connections, then the *ctp* should be provided to clean up after each client.

Examples:

See the “Writing a Resource Manager” chapter in the *Programmer’s Guide*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_notify(), iofunc_notify_trigger()

"Handling *ionotify()* and *select()*" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_notify_trigger()

Send notifications to queued clients

Synopsis:

```
#include <sys/iofunc.h>

void iofunc_notify_trigger( iofunc_notify_t *nop,
                            int count,
                            int index );
```

Arguments:

nop An array of three **iofunc_notify_t** structures that represent (in order), the input, output, and out-of-band notification lists whose entries you want to examine; for information about this structure, see the documentation for *iofunc_notify()*.

count The count that you want to compare to the trigger value for the event.

index The index into the *nop* array that you want to check; one of the following:

- IOFUNC_NOTIFY_INPUT
- IOFUNC_NOTIFY_OUTPUT
- IOFUNC_NOTIFY_OBAND

Library:

libc

Description:

The *iofunc_notify_trigger()* function examines all entries given in the list maintained at *nop [index]* to see if the event should be delivered to the client. If the specified *count* is greater than the trigger count for the particular notification list element, this function calls *MsgDeliverEvent()* to deliver the event to the client whose *rcvid* is stored in the notification list element, and the list element is disarmed.

Note that if the client has specified a code of SI_NOTIFY, then the value that the client specified (e.g. the *value* member of the **struct sigevent**) has the top three bits ORed with the reason for the trigger (this is the expression **_NOTIFY_COND_INPUT << index**), as in the following table:

index = IOFUNC_NOTIFY_INPUT

0x10000000, or _NOTIFY_COND_INPUT

index = IOFUNC_NOTIFY_OUTPUT

0x20000000, or _NOTIFY_COND_OUTPUT

index = IOFUNC_NOTIFY_OBAND

0x40000000, or _NOTIFY_COND_OBAND

If the client has specified a code of something other than SI_NOTIFY then this routine doesn't modify the value member in any way.

Examples:

See the Writing a Resource Manager chapter of *Programmer's Guide*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_notify(), *iofunc_notify_remove()*, **`sigevent`**

"Handling *ionotify()* and *select()*" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_ocb_attach()

Initialize an Open Control Block

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_ocb_attach(
        resmgr_context_t * ctp,
        io_open_t * msg,
        iofunc_ocb_t * ocb,
        iofunc_attr_t * attr,
        const resmgr_io_funcs_t * io_funcs );
```

Arguments:

ctp	A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.
msg	A pointer to the **io_open_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_open()*.
ocb	NULL, or a pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.
attr	A pointer to a **iofunc_attr_t** structure that defines the characteristics of the device that the resource manager handles.
io_funcs	A pointer to a **resmgr_io_funcs_t** that specifies the I/O functions for the resource manager.

Library:

libc

Description:

The *iofunc_ocb_attach()* function examines the mode specified by the io_open *msg*, and increments the read and write count flags (*ocb->attr->rcount* and *ocb->attr->wcount*), and the locking flags (*ocb->attr->rlocks* and *ocb->attr->wlocks*), as specified by the open mode.

This function is called by *iofunc_open_default()* as part of its initialization.

This function allocates the memory for the OCB if you pass NULL as the *ocb*.

Returns:

EOK Successful completion.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_init(), **iofunc_attr_t**, *iofunc_ocb_detach()*, **iofunc_ocb_t**, *iofunc_open_default()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_ocb_calloc()

Allocate an iofunc Open Control Block

Synopsis:

```
#include <sys/iofunc.h>

iofunc_ocb_t * iofunc_ocb_calloc(
                        resmgr_context_t * ctp,
                        iofunc_attr_t * attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

attr A pointer to a **iofunc_attr_t** structure that defines the characteristics of the device that the resource manager handles.

Library:

libc

Description:

The *iofunc_ocb_calloc()* function allocates an iofunc OCB. It has a number of uses:

- It can be used as a helper function to encapsulate the allocation of the iofunc OCB, so that your routines don't have to know the details of the iofunc OCB structure.
- Because it's in the resource manager shared library, you can override this function with your own, allowing you to manage an OCB that has additional members, perhaps specific to your particular resource manager. If you do this, be sure to place the iofunc OCB structure as the first element of your extended OCB, and also override the *iofunc_ocb_free()* function to release memory.
- Another reason to override *iofunc_ocb_calloc()* might be to place limits on the number of OCBs that are in existence at any one

time; the current function simply allocates OCBs until the free store is exhausted.

You should fill in the attribute's mount structure (i.e. the *attr->mount* pointer) instead of replacing this function.

If you specify *iofunc_ocb_calloc()* and *iofunc_ocb_free()* callouts in the attribute's mount structure, then you should use the callouts instead of calling the standard *iofunc_ocb_calloc()* and *iofunc_ocb_free()* functions.

Returns:

A pointer to an **iofunc_ocb_t** OCB structure.

Examples:

Override *iofunc_ocb_calloc()* and *iofunc_ocb_free()* to manage an extended OCB:

```
typedef struct
{
    iofunc_ocb_t    iofuncOCB; /* the OCB used by iofunc_* */
    int             myFlags;
    char            moreOfMyStuff;
}   MyOCBT;

MyOCBT *iofunc_ocb_calloc (resmgr_context_t *ctp,
                           iofunc_attr_t *attr)
{
    return ((MyOCBT *) calloc (1, sizeof (MyOCBT));
}

void iofunc_ocb_free (MyOCBT *ocb)
{
    free (ocb);
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_ocb_free(), **iofunc_ocb_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_ocb_detach()

Release Open Control Block resources

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_ocb_detach( resmgr_context_t * ctp,
                       iofunc_ocb_t * ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_ocb_detach()* function releases any resources allocated to the passed *ocb*, such as any memory map (mmap) entries.

This function doesn't free the memory associated with the OCB itself.

The *iofunc_ocb_detach()* function also updates the time structure, by calling *iofunc_time_update()*, and decrements the read, write, lock, and use counters, according to the mode that was used to open the resource (from *ocb->ioflag*).

The counters are incremented in *iofunc_ocb_attach()*, and represent the number of OCBs that are using the managed resource in the respective manners (e.g.: *ocb->attr->rcount* keeps count of how many OCBs are using the resource specified by *attr* for read access).

If you're are using *iofunc_mmap()* or *iofunc_mmap_default()*, you must call *iofunc_ocb_detach()* to clean up. This function is called by *iofunc_close_ocb()*.

Returns:

A bitwise OR of flags describing the state of the managed resource:

IOFUNC_OCB_LAST_READER

This OCB was the last one performing read operations on the resource. This flag is set when the *ocb->attr->rcount* flag is decremented to zero.

IOFUNC_OCB_LAST_WRITER

This OCB was the last one performing write operations on the resource. This flag is set when the *ocb->attr->wcount* flag is decremented to zero.

IOFUNC_OCB_LAST_RDLOCK

This OCB was the last one holding a read lock on the resource. This flag is set when the *ocb->attr->rlocks* flag is decremented to zero.

IOFUNC_OCB_LAST_WRLOCK

This OCB was the last one holding a write lock on the resource. This flag is set when the *ocb->attr->wlocks* flag is decremented to zero.

IOFUNC_OCB_LAST_INUSE

This OCB was the last one using the resource. This flag is set when the *ocb->attr->count* flag is decremented to zero.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_close_ocb(), *iofunc_close_ocb_default()*, *iofunc_mmap()*, *iofunc_mmap_default()*, *iofunc_ocb_attach()*, **iofunc_ocb_t**, *iofunc_time_update()*, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_ocb_free()

Deallocate an iofunc Open Control Block's memory

Synopsis:

```
#include <sys/iofunc.h>

void iofunc_ocb_free( iofunc_ocb_t * ocb );
```

Arguments:

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_ocb_free()* function returns the memory allocated to an iofunc OCB to the free store pool. This function is the complement of *iofunc_ocb_calloc()*.

If you've overridden the definition of *iofunc_ocb_calloc()*, you should also override the definition of *iofunc_ocb_free()* to correctly handle the release of the memory. This is because the *iofunc_ocb_calloc()* functions uses an internal memory management function to allocate the memory, and the default *iofunc_ocb_free()* function also uses this internal function to deallocate memory. Therefore, you can't mix internal memory management functions (*_scalloc()* and *_sfree()*) with user-level memory management functions (*calloc()* and *free()*).

You should fill in the attribute's mount structure (i.e. the *attr->mount* pointer) instead of replacing this function.

If you specify *iofunc_ocb_free()* and *iofunc_ocb_calloc()* callouts in the attribute's mount structure, then you should use the callouts instead of calling the standard *iofunc_ocb_free()* and *iofunc_ocb_calloc()* functions.

Examples:

See *iofunc_ocb_calloc()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_close_ocb(), *iofunc_ocb_calloc()*, **iofunc_ocb_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

Synopsis:

```
#include <sys/iofunc.h>

typedef struct _iofunc_ocb {
    IOFUNC_ATTR_T                   *attr;      /* Used to find iofunc
    int32_t                         ioflag;     /* open's oflag + 1 *
#if !defined(_IOFUNC_OFFSET_BITS) || _IOFUNC_OFFSET_BITS == 64
 #if _FILE_OFFSET_BITS - 0 == 64
    off_t                           offset;
 #else
    off64_t                         offset;
 #endif
#elif _IOFUNC_OFFSET_BITS - 0 == 32
 #if !defined(_FILE_OFFSET_BITS) || _FILE_OFFSET_BITS == 32
  #if defined(__LITTLEENDIAN__)
    off_t                           offset;
    off_t                           offset_hi;
  #elif defined(__BIGENDIAN__)
    off_t                           offset_hi;
    off_t                           offset;
  #else
   #error endian not configured for system
  #endif
 #else
  #if defined(__LITTLEENDIAN__)
    int32_t                         offset;
    int32_t                         offset_hi;
  #elif defined(__BIGENDIAN__)
    int32_t                         offset_hi;
    int32_t                         offset;
  #else
   #error endian not configured for system
  #endif
 #endif
#else
 #error _IOFUNC_OFFSET_BITS value is unsupported
#endif
    uint16_t                        sflag;
    uint16_t                        flags;
    void                            *reserved;
} iofunc_ocb_t;
```

Description:

The **iofunc_ocb_t** structure is an *Open Control Block*, a block of data that's established by a resource manager during its handling of the client's *open()* function.

A resource manager creates an instance of this structure whenever a client opens a resource. For example, *iofunc_open_default()* calls *iofunc_ocb_calloc()* to allocate an OCB. The OCB exists until the client closes the file descriptor associated with the open operation. The resource manager passes this structure to all of the functions that implement the I/O operations for the file descriptor.

The **iofunc_ocb_t** structure includes the following members:

attr A pointer to the OCB's attributes. By default, this structure is of type **iofunc_attr_t**, but you can redefine the IOFUNC_ATTR_T manifest if you want to use a different structure in your resource manager.

ioflag The mode (e.g. reading, writing, blocking) that the resource was opened with.

The bits in this member are the same as those for the *oflag* argument to *open()* plus 1.

This information is inherited from the **io_connect_t** structure that's available in the message passed to the open handler.

offset, *offset_hi*

The read/write offset into the resource (e.g. our current *lseek()* position within a file), defined in a variety of ways to suit 32- and 64-bit offsets. Your resource manager can modify this offset.

sflag The sharing mode; see *sopen()*. This information is inherited from the **io_connect_t** structure that's available in the message passed to the open handler.

flags When the IOFUNC_OCB_PRIVILEGED bit is set, a privileged process (i.e. **root**) performed the *open()*. Additionally, you can use flags in the range defined by IOFUNC_OCB_FLAGS_PRIVATE (see **<sys/iofunc.h>**) for your own purposes. Your resource manager can modify these flags.

Classification:

QNX Neutrino

See also:

iofunc_attr_t, *iofunc_ocb_calloc()*, *iofunc_open_default()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_open()

Verify a client's ability to open a resource

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_open( resmgr_context_t *ctp,
                 io_open_t *msg,
                 iofunc_attr_t *attr,
                 iofunc_attr_t *dattr,
                 struct _client_info *info );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_open_t** structure that contains the message that the resource manager received; see below.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the resource.

dattr NULL, or a pointer to the **iofunc_attr_t** structure that describes the characteristics of the parent directory.

info NULL, or a pointer to a **_client_info** structure that contains the information about a client connection. For information about this structure, see *ConnectClientInfo()*.

Library:

libc

Description:

The *iofunc_open()* function checks to see if the client (described by the optional *info* structure) has access to open the resource whose name is passed in *msg->connect.path*.

The *attr* structure describes the resource's attributes. The optional *dattr* structure defines the attributes of the parent directory; if *dattr*

isn't NULL, the resource identified by *attr* is being created within the directory specified by *dattr*.

The *info* argument can be passed as NULL, in which case *iofunc_open()* obtains the client information itself via a call to *iofunc_client_info()*. It is, of course, more efficient to get the client info once, rather than calling this function with NULL every time.

Note that if you're handling a request to read directory entry, you must return data formatted to match the **`struct dirent`** type. A helper function, *iofunc_stat()*, can aid in this.

A resource manager's response to an *open()* request isn't always a yes-or-no answer. It's possible to return a connect message indicating that the server would like some other action taken. For example, if the open occurs on a path that represents a symbolic link to some other path, the server could respond using the *_IO_SET_CONNECT_RET()* macro and the _IO_CONNECT_RET_LINK value.

For example, an open handler that only redirects pathnames might look something like:

```
io_open(resmgr_context_t *ctp, io_open_t *msg,
        iofunc_attr_t *dattr, void *extra) {
    char *newpath;

    /* Do all the error/access checking ... */

    /* Lookup the redirected path and store
       the new path in 'newpath' */
    newpath = get_a_new_path(msg->connect.path);

    _IO_SET_CONNECT_RET(ctp, _IO_CONNECT_RET_LINK);
    len = strlen(newpath) + 1;

    msg->link_reply.eflag = msg->connect.eflag;
    msg->link_reply.nentries = 0;
    msg->link_reply.path_len = len;
    strcpy((char *)(msg->link_reply + 1), newpath);

    len += sizeof(msg->link_reply);

    return(_RESMGR_PTR(ctp, &msg->link_reply, len));
}
```

In this example, we use the macro *_IO_SET_CONNECT_RET()* (defined in **<sys/iomsg.h>**) to set the *ctp->status* field to _IO_CONNECT_RET_LINK. This value indicates to the resource-manager framework that the return value isn't actually a simple return code, but a new request to be processed.

The path for this new request follows directly after the *link_reply* structure and is *path_len* bytes long. The final few lines of the code just stuff an IOV with the reply message (and the new path to be queried) and return to the resource-manager framework.

`io_open_t` structure

The **`io_open_t`** structure holds the _IO_CONNECT message received by the resource manager:

```
typedef union {
    struct _io_connect                  connect;
    struct _io_connect_link_reply       link_reply;
    struct _io_connect_ftype_reply      ftype_reply;
} io_open_t;
```

This message structure is a union of an input message (coming to the resource manager), **`_io_connect`**, and two possible output or reply messages (going back to the client):

- **`_io_connect_link_reply`** if the reply is redirecting the client to another resource

  Or:

- **`_io_connect_ftype_reply`** if the reply consists of a status and a file type.

Returns:

EOK	Successful completion.
Other	There was an error, as defined by the POSIX semantics for the open call. This error should be returned to the next higher level.

Examples:

This is a sample skeleton for a typical filesystem, in pseudo-code, to illustrate the steps that need to be taken to handle an open request for a file:

```
if the open request is for a path (i.e. multiple
  directory levels)
    call iofunc_client_info to get information
      about client
    for each directory component
        call iofunc_check_access to check execute
          permission for access
        /*
         recall that execute permission on a
         directory is really the "search"
         permission for that directory
        */
    next
    /*
     at this point you have verified access
     to the target
    */
endif

if O_CREAT is set and the file doesn't exist
    call iofunc_open, passing the attribute of the
      parent as dattr
    if the iofunc_open succeeds,
        do the work to create the new inode,
          or whatever
    endif
else
    call iofunc_open, passing the attr of the file
     and NULL for dattr
endif

/*
 at this point, check for things like o_trunc,
 etc. -- things that you have to do for the attr
*/

call iofunc_ocb_attach
return EOK
```

For a device (i.e. *resmgr_attach()* didn't specify that the managed resource is a directory), the following steps apply:

```
/*
```

```
 at startup time (i.e.:  in the main() of the
 resource manager)
*/
call iofunc_attr_init to initialize an attribute
  structure

/* in the io_open message handler: */
call iofunc_open, passing in the attribute of the
  device and NULL for dattr

call iofunc_ocb_attach
return EOK
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

_io_connect, **_io_connect_link_reply**, **_io_connect_ftype_reply**, *iofunc_attr_init()*, *iofunc_check_access()*, *iofunc_client_info()*, *iofunc_ocb_attach()*, *iofunc_stat()*, *resmgr_open_bind()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_open_default()

Default handler for _IO_CONNECT messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_open_default( resmgr_context_t *ctp,
                         io_open_t *msg,
                         iofunc_attr_t *attr,
                         void *extra );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_open_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_open()*.

attr A pointer to the **iofunc_attr_t** structure that defines the characteristics of the device that the resource manager is controlling.

Library:

libc

Description:

The *iofunc_open_default()* function implements the default actions for the _IO_CONNECT message in a resource manager. This function calls:

- *iofunc_open()* to check the client's open mode against the resources attributes to see if the client can open the resource in that mode
- *iofunc_ocb_calloc()* to allocate an Open Control Block (OCB)
- *iofunc_ocb_attach()* to initialize the OCB
- *resmgr_open_bind()* to bind the newly-created OCB to the request.

You can place this function directly into the *connect_funcs* table passed to *resmgr_attach()*, at the *open* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

See the "Examples" section in the description of *iofunc_open()* for the skeleton outline of the functionality (the second example, where *resmgr_attach()* doesn't specify that the managed resource is a directory).

Returns:

EOK	Successful completion.
ENOSPC	There's insufficient memory to allocate the OCB.
ENOMEM	There's insufficient memory to allocate an internal data structure required by *resmgr_open_bind()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), *iofunc_ocb_attach()*, *iofunc_ocb_calloc()*, *iofunc_open()*, *iofunc_time_update()*, *resmgr_attach()*, **resmgr_connect_funcs_t**,, *resmgr_open_bind()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_openfd()

Increment count and locking flags

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_openfd( resmgr_context_t *ctp,
                   io_openfd_t *msg,
                   iofunc_ocb_t *ocb,
                   iofunc_attr_t *attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_openfd_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_openfd()* helper function examines the mode specified by the _IO_OPENFD message, and increments the read and write count flags (*ocb->attr->rcount* and *ocb->attr->wcount*), and the locking flags (*ocb->attr->rlocks* and *ocb->attr->wlocks*), as specified by the open mode.

The function does what's needed to support the *openfd()* function.

io_openfd_t structure

The **io_openfd_t** structure holds the _IO_OPENFD message received by the resource manager:

```
struct _io_openfd {
    uint16_t                    type;
    uint16_t                    combine_len;
    uint32_t                    ioflag;
    uint16_t                    sflag;
    uint16_t                    xtype;
    struct _msg_info            info;
    uint32_t                    reserved2;
    uint32_t                    key;
};

typedef union {
    struct _io_openfd           i;
} io_openfd_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client). In this case, there's only an input message, *i*.

The *i* member is a structure of type **_io_openfd** that contains the following members:

type — _IO_OPENFD.

combine_len — If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

ioflag — How the client wants to open the file; a combination of the following bits:

- O_RDONLY — permit the file to be only read.
- O_WRONLY — permit the file to be only written.
- O_RDWR — permit the file to be both read and written.

- O_APPEND — cause each record that's written to be written at the end of the file.
- O_TRUNC — if the file exists, truncate it to contain no data. This flag has no effect if the file doesn't exist.

sflag — How the client wants the file to be shared; a combination of the following bits:

- SH_COMPAT — set compatibility mode.
- SH_DENYRW — prevent read or write access to the file.
- SH_DENYWR — prevent write access to the file.
- SH_DENYRD — prevent read access to the file.
- SH_DENYNO — permit both read and write access to the file.

xtype — Extended type information that can change the behavior of an I/O function. One of:

- _IO_OPENFD_NONE — no extended type information.
- _IO_OPENFD_PIPE — a pipe is being opened.
- _IO_OPENFD_RESERVED — reserved

info — A pointer to a **_msg_info** structure that contains information about the message received by the resource manager.

key — Reserved for future use.

Returns:

EOK	Success.
EACCES	You don't have permission to open the file.
EBUSY	The file has shared locks that are in use.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_ocb_attach(), *iofunc_openfd_default()*, **_msg_info**, *openfd()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_openfd_default()

Default handler for _IO_OPENFD messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_openfd_default( resmgr_context_t *ctp,
                           io_openfd_t *msg,
                           iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_openfd_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_openfd()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The function *iofunc_openfd_default()* function implements POSIX semantics for the client's *openfd()* call, which is received as an _IO_OPENFD message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *openfd* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_openfd_default()* function calls *iofunc_openfd()* to do the actual work, and (if installed in the *io_funcs* table) issues the reply back to the client.

Returns:

EOK	Success.
EACCES	You don't have permission to open the file.
EBUSY	The file has shared locks that are in use.
EINVAL	The message type is invalid.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_chown_default(), *iofunc_func_init()*, **iofunc_ocb_t**, *iofunc_openfd()*, *iofunc_sync_default()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_pathconf( resmgr_context_t *ctp,
                     io_pathconf_t *msg,
                     iofunc_ocb_t *ocb,
                     iofunc_attr_t *attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_pathconf_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_pathconf()* helper function does what's needed to support *pathconf()* with the *mount* and *attr* passed to it. Other fsys *pathconf()* requests need to be handled by the caller.

If you write your own *pathconf* callout for your resource manager, use the following macro to pass the requested value back to the caller:

```
_IO_SET_PATHCONF_VALUE( resmgr_context_t *ctp,
                        int value )
```

io_pathconf_t structure

The **io_pathconf_t** structure holds the _IO_PATHCONF message received by the resource manager:

```
struct _io_pathconf {
    uint16_t                    type;
    uint16x_t                    combine_len;
    short                       name;
    uint16_t                    zero;
};

typedef union {
    struct _io_pathconf         i;
/*  value is returned with MsgReply */
} io_pathconf_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client). In this case, there's only an input message, *i*.

The *i* member is a structure of type **_io_pathconf** that contains the following members:

type	_IO_PATHCONF.
combine_len	If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.
name	The name of the configurable limit; see *pathconf()*.

Returns:

EOK, or _RESMGR_DEFAULT if the function didn't handle the *pathconf()* request.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_t, **iofunc_ocb_t**, *iofunc_pathconf_default()*, *pathconf()*, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_pathconf_default()

Default handler for _IO_PATHCONF messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_pathconf_default( resmgr_context_t *ctp,
                             io_pathconf_t *msg,
                             iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_pathconf_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_pathconf()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_pathconf_default()* function implements POSIX semantics for the client's *pathconf()* call, which is received as an _IO_PATHCONF message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *pathconf* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_pathconf_default()* function returns information about the resource, as per the POSIX specifications for *pathconf()*. The *iofunc_pathconf_default()* function simply calls *iofunc_pathconf()*, which does the actual work.

Returns:

EOK	Successful completion.
EINVAL	The pathconf parameter being ascertained wasn't one of _PC_CHOWN_RESTRICTED, _PC_NO_TRUNC, or _PC_SYNC_IO.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), **iofunc_ocb_t**, *iofunc_pathconf()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_read_default()

Default handler for _IO_READ messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_read_default( resmgr_context_t *ctp,
                         io_read_t *msg,
                         iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_read_t** structure that contains the message that the resource manager received. For more information, see the documentation for *iofunc_read_verify()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_read_default()* function implements POSIX semantics for the client's *read()* call, which is received as an _IO_READ message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *read* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_read_default()* function calls *iofunc_read_verify()* to do the actual work, and (if installed in the *io_funcs* table) issues the reply back to the client.

Returns:

EBADF	The client doesn't have read access to this resource.
EINVAL	The extended type information is invalid.
EOK	The client has read access to this resource.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), **iofunc_ocb_t**, *iofunc_read_verify()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_read_verify()

Verify a client's read access to a resource

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_read_verify( resmgr_context_t* ctp,
                        io_read_t* msg,
                        iofunc_ocb_t* ocb,
                        int* nonblock );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_read_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

nonblock NULL, or a pointer to a location where the function can store a value that indicates whether or not the device is nonblocking:

- Zero — the client doesn't want to be blocked (i.e. O_NONBLOCK was set).
- Nonzero — the client wants to be blocked.

Library:

libc

Description:

The *iofunc_read_verify()* helper function checks that the client that sent the _IO_READ message actually has read access to the resource, and, if *nonblock* isn't NULL, sets *nonblock* to O_NONBLOCK or 0).

The read permission check is done against *ocb->ioflag*.

Note that the **io_read_t** message has an override flag called *msg->i.xtype*. This flag allows the client to override the default blocking behavior for the resource on a per-request basis. This override flag is checked, and returned in the optional *nonblock*.

Note that if you're reading from a directory entry, you must return **struct dirent** structures in the *read* callout for your resource manager.

You'll also need to indicate how many bytes were read. You can do this with the macro:

```
_IO_SET_READ_NBYTES( resmgr_context_t *ctp,
                     int nbytes )
```

io_read_t structure

The **io_read_t** structure holds the _IO_READ message received by the resource manager:

```
struct _io_read {
    uint16_t                    type;
    uint16_t                    combine_len;
    int32_t                     nbytes;
    uint32_t                    xtype;
    uint32_t                    zero;
};

typedef union {
    struct _io_read             i;
/*  unsigned char               data[nbytes];   */
/*  nbytes is returned with MsgReply */
} io_read_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client). In this case, there's only an input message, *i*.

The *i* member is a structure of type **_io_read** that contains the following members:

type _IO_READ.

combine_len If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

nbytes The number of bytes that the client wants to read.

xtype Extended type information; one of:

- _IO_XTYPE_NONE
- _IO_XTYPE_READCOND
- _IO_XTYPE_MQUEUE
- _IO_XTYPE_TCPIP
- _IO_XTYPE_TCPIP_MSG
- _IO_XTYPE_OFFSET
- _IO_XTYPE_REGISTRY
- _IO_XFLAG_DIR_EXTRA_HINT — this flag is valid only when reading from a directory. The filesystem should normally return extra directory information when it's easy to get. If this flag is set, it is a hint to the filesystem to try harder (possibly causing media lookups) to return the extra information. The most common use would be to return _DTYPE_LSTAT information.
- _IO_XFLAG_NONBLOCK
- _IO_XFLAG_BLOCK

For more information, see "Handling other read/write details" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

The commented-out declaration for *data* indicates that *nbytes* bytes of data immediately follow the **`io_read_t`** structure.

Returns:

EOK	The client has read access to this resource.
EBADF	The client doesn't have read access to this resource.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_open(), *iofunc_write_verify()*

Writing a Resource Manager chapter of the *Programmer's Guide*

iofunc_readlink()

Verify a client's ability to read a symbolic link

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_readlink( resmgr_context_t *ctp,
                     io_readlink_t *msg,
                     iofunc_attr_t *attr,
                     struct _client_info *info );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_readlink_t** structure that contains the message that the resource manager received; see below.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

info A pointer to a **_client_info** structure that contains the information about a client connection. For information about this structure, see *ConnectClientInfo()*.

Library:

libc

Description:

The *iofunc_readlink()* helper function supports *readlink()* requests by verifying that the client can read a symbolic link. It's similar to *iofunc_open()*.

The *iofunc_read()* function checks to see if the client (described by the optional *info* structure) has access to open the resource (name passed in the *msg* structure). The *attr* structure describes the resource's attributes.

The *info* argument can be passed as NULL, in which case *iofunc_read()* obtains the client information itself via a call to *iofunc_client_info()*. It is, of course, more efficient to get the client info once, rather than calling this function with NULL every time.

The *iofunc_readlink()* function handles the readlink verification for the POSIX layer.

`io_readlink_t` structure

The **`io_readlink_t`** structure holds the _IO_CONNECT message received by the resource manager:

```
typedef union {
    struct _io_connect                  connect;
    struct _io_connect_link_reply       link_reply;
    struct _io_connect_ftype_reply      ftype_reply;
} io_readlink_t;
```

This message structure is a union of an input message (coming to the resource manager), **`_io_connect`**, and two possible output or reply messages (going back to the client):

- **`_io_connect_link_reply`** if the reply is redirecting the client to another resource

  Or:

- **`_io_connect_ftype_reply`** if the reply consists of a status and a file type.

Returns:

EBADFSYS	NULL was passed in *attr*.
EOK	Successful completion.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

_io_connect, **_io_connect_link_reply**, **_io_connect_ftype_reply**, *iofunc_open()*, *readlink()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_rename( resmgr_context_t* ctp,
                   io_rename_t* msg,
                   iofunc_attr_t* oldattr,
                   iofunc_attr_t* olddattr,
                   iofunc_attr_t* newattr,
                   iofunc_attr_t* newdattr,
                   struct _client_info* info );
```

Arguments:

ctp	A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.
msg	A pointer to the **io_rename_t** structure that contains the message that the resource manager received; see below.
oldattr	A pointer to the **iofunc_attr_t** structure that describes the characteristics of the resource.
olddattr	NULL, or a pointer to the **iofunc_attr_t** structure that describes the characteristics of the parent directory.
newattr	A pointer to the **iofunc_attr_t** structure that describes the characteristics of the target, if it exists.
newdattr	NULL, or a pointer to the **iofunc_attr_t** structure that describes the characteristics of the parent directory of the target.
info	NULL, or a pointer to a **_client_info** structure that contains the information about a client connection. For information about this structure, see *ConnectClientInfo()*.

Library:

libc

Description:

The function *iofunc_rename()* does permission checks for the _IO_CONNECT message (subtype _IO_CONNECT_RENAME) for context *ctp*. The *newattr* argument is the attribute of the target if it already exists.

This function is similar to *iofunc_open()*. The *iofunc_rename()* function checks to see if the client (described by the optional *info* structure) has access to open the resource (name passed in the *msg* structure). The *attr* structure describes the resource's attributes.

The *info* argument can be passed as NULL, in which case *iofunc_rename()* obtains the client information itself via a call to *iofunc_client_info()*. It is, of course, more efficient to get the client information once, rather than call this function with NULL every time.

io_rename_t structure

The **io_rename_t** structure holds the _IO_CONNECT message received by the resource manager:

```
typedef union {
    struct _io_connect                  connect;
    struct _io_connect_link_reply       link_reply;
    struct _io_connect_ftype_reply      ftype_reply;
} io_rename_t;
```

This message structure is a union of an input message (coming to the resource manager), **_io_connect**, and two possible output or reply messages (going back to the client):

- **_io_connect_link_reply** if the reply is redirecting the client to another resource

  Or:

- **_io_connect_ftype_reply** if the reply consists of a status and a file type.

The reply includes the following extra information:

```
typedef union _io_rename_extra {
    char                                path[1];
} io_rename_extra_t;
```

Returns:

EACCES	The client doesn't have permissions to do the operation.
EBADFSYS	NULL was passed in *oldattr*, *olddattr*, or *newdattr*.
EFAULT	A fault occurred when the kernel tried to access the *info* buffer.
EINVAL	The *oldattr* and *newdattr* have identical values, the client process is no longer valid, or attempt to remove the parent (`"."`) directory.
EISDIR	The old link is a directory but the new link isn't a directory.
ENOTDIR	Attempt to unlink a nondirectory entry using directory semantics (e.g. **`rmdir`** *file*).
ENOTEMPTY	Attempt to remove a directory that isn't empty.
EOK	Successful completion or there was already a *newattr* entry.
EPERM	The group ID or owner ID didn't match.
EROFS	Attempt to remove an entry on a read-only filesystem.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

_io_connect, **_io_connect_link_reply**, **_io_connect_ftype_reply**, *iofunc_client_info()*, *iofunc_open()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_space_verify()

Do permission checks for the _IO_SPACE message

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_space_verify( resmgr_context_t *ctp,
                         io_space_t *msg,
                         iofunc_ocb_t *ocb,
                         int *nonblock );
```

Arguments:

ctp — A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg — A pointer to the **io_space_t** structure that contains the message that the resource manager received; see below.

ocb — A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

nonblock — NULL, or a pointer to a location where the function can store a value that indicates whether or not the device is nonblocking:

- Zero — the client doesn't want to be blocked (i.e. O_NONBLOCK was set).
- Nonzero — the client wants to be blocked.

Library:

libc

Description:

The *iofunc_space_verify()* helper function checks the client's permission for an _IO_SPACE message.

io_space_t structure

The **io_space_t** structure holds the _IO_SPACE message received by the resource manager:

```
struct _io_space {
    uint16_t                    type;
    uint16_t                    combine_len;
    uint16_t                    subtype;
    short                       whence;
    uint64_t                    start;
    uint64_t                    len;
};

typedef union {
    struct _io_space            i;
    uint64_t                    o;
} io_space_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client).

The *i* member is a structure of type **_io_space** that contains the following members:

type _IO_SPACE.

combine_len If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

subtype F_ALLOCSP or F_FREESP.

whence The position in the file. The possible values (defined in **<unistd.h>**) are:

- SEEK_CUR The new file position is computed relative to the current file position. The value of *start* may be positive, negative or zero.

SEEK_END	The new file position is computed relative to the end of the file.
SEEK_SET	The new file position is computed relative to the start of the file. The value of *start* must not be negative.

start — The relative offset from the file position determined by the *whence* member.

len — The relative size by which to increase the file.

A value of zero means to end of file.

The *o* member is the file size.

Returns:

EBADF	The client doesn't have read access to this resource.
EISDIR	The resource is a directory.
EOK	The client has read access to this resource.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_ocb_t, *iofunc_open()*, *iofunc_write_default()*, *iofunc_write_verify()*, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_stat()

Populate a **stat** *structure*

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_stat( resmgr_context_t* ctp,
                 iofunc_attr_t* attr,
                 struct stat* stat );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

stat A pointer to the **stat** structure that you want to fill. For more information, see *stat()*.

Library:

libc

Description:

The *iofunc_stat()* function populates the passed *stat* structure based on information from the passed *attr* structure and the context pointer, *ctp*.

This is typically used when the resource manager is handling the _IO_STAT message, and needs to format the current status information for the resource.

Returns:

EOK Successful completion.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_t, *iofunc_stat_default()*, *iofunc_time_update()*, **resmgr_context_t**, *stat()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_stat_default()

Default handler for _IO_STAT messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_stat_default( resmgr_context_t *ctp,
                         io_stat_t *msg,
                         iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_stat_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_stat_default()* function implements POSIX semantics for the client's *stat()* or *fstat()* call, which is received as an _IO_STAT message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *stat* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_stat_default()* function calls:

- *iofunc_time_update()*, to ensure that the time entries in the *ocb->attr* structure are current and valid
- *iofunc_stat()* to construct a status entry based on the information in the *ocb->attr* structure.

io_stat_t structure

The **io_stat_t** structure holds the _IO_STAT message received by the resource manager:

```
struct _io_stat {
    uint16_t                    type;
    uint16_t                    combine_len;
    uint32_t                    zero;
};

typedef union {
    struct _io_stat             i;
    struct stat                 o;
} io_stat_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client).

The *i* member is a structure of type **_io_stat** that contains the following members:

type _IO_STAT.

combine_len If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

The *o* member is a structure of type **stat**; for more information, see *stat()*.

Returns:

EOK Successful completion.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), **iofunc_ocb_t**, *iofunc_stat()*, *iofunc_time_update()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**, *stat()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_sync()

Indicate if synchronization is needed

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_sync( resmgr_context_t* ctp,
                 iofunc_ocb_t* ocb,
                 int ioflag );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

ioflag The operation being performed on the OCB:

- _IO_FLAG_WR — writing.
- _IO_FLAG_RD — reading.

Library:

libc

Description:

The *iofunc_sync()* function indicates if some form of synchronization is needed.

Returns:

O_DSYNC	Data integrity is needed.
O_SYNC	File integrity is needed.
0	Synchronization isn't needed.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_open(), *iofunc_write_default()*, *iofunc_write_verify()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_sync_default()

Default handler for _IO_SYNC messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_sync_default( resmgr_context_t *ctp,
                         io_sync_t *msg,
                         iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_sync_t** structure that contains the message that the resource manager received. For more information, see *iofunc_sync_verify()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The function *iofunc_sync_default()* function implements POSIX semantics for the client's *sync()* call, which is received as an _IO_SYNC message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *sync* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_sync_default()* function calls *iofunc_sync_verify()* which checks to see if the client can synchronize the resource, and (if installed in the *io_funcs* table) issues the reply back to the client.

Returns:

EINVAL	The resource doesn't support synchronizing.
EOK	The client can synchronize the resource.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), **iofunc_ocb_t**, *iofunc_sync()*, *iofunc_sync_verify()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_sync_verify()

Verify permissions to sync

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_sync_verify( resmgr_context_t *ctp,
                        io_sync_t *msg,
                        iofunc_ocb_t *ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_sync_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_sync_verify()* function verifies that the client has permission to synchronize.

io_sync_t structure

The **io_sync_t** structure holds the _IO_SYNC message received by the resource manager:

```
struct _io_sync {
    uint16_t                    type;
    uint16_t                    combine_len;
    uint32_t                    flag;
};
```

```
typedef union {
    struct _io_sync             i;
} io_sync_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client). In this case, there's only an input message, *i*.

The *i* member is a structure of type **_io_sync** that contains the following members:

type _IO_SYNC.

combine_len If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

flag One of:

- O_DSYNC
- O_RSYNC
- O_SYNC

For more information about these flags, see *open()*.

Returns:

EINVAL The resource doesn't support syncing.

EOK The client has read access to this resource.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_ocb_t, *iofunc_open()*, *iofunc_write_default()*, *iofunc_write_verify()*, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_time_update()

Update time stamps

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_time_update( iofunc_attr_t* attr );
```

Arguments:

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_time_update()* function examines the *flags* member in the passed *attr* structure against the bits IOFUNC_ATTR_ATIME, IOFUNC_ATTR_MTIME, and IOFUNC_ATTR_CTIME. If any of these bits are set, the corresponding time member of *attr* (e.g. *attr->atime*) isn't valid. This function updates all invalid *attr* members to the current time.

If *iofunc_time_update()* makes any change to the *attr* structure's time members, it sets IOFUNC_ATTR_DIRTY_TIME in the *attr* structure's *flags* member. This function always clears the IOFUNC_ATTR_ATIME, IOFUNC_ATTR_MTIME, and IOFUNC_ATTR_CTIME bits from *attr->flags*.

Returns:

EOK Successful completion.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_t

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_unblock()

Unblock OCBs

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_unblock( resmgr_context_t * ctp,
                    iofunc_attr_t * attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_unblock()* function unblocks any clients that are blocked on any internal resource manager structures.

Currently, this involves only the advisory lock list that's maintained by the attribute.

If a client connection is found:

- that client is unblocked, and is replied to with the error EINTR.
- *iofunc_unblock()* returns _RESMGR_NOREPLY.

If no client connection is found, *iofunc_unblock()* returns _RESMGR_DEFAULT.

Returns:

_RESMGR_DEFAULT

No client connection was found.

_RESMGR_NOREPLY

A client connection has been unblocked.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_unblock_default()

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_unblock_default()

Default unblock handler

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_unblock_default( resmgr_context_t * ctp,
                            io_pulse_t * msg,
                            iofunc_ocb_t * ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_pulse_t** structure that describes the pulse that the resource manager received.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_unblock_default()* function calls *iofunc_unblock()*.

The *iofunc_unblock_default()* function implements the functionality required when the client requests to be unblocked (e.g. a signal or timeout).

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *unblock* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The unblock message is synthesized by the resource-manager shared library when a client wishes to unblock from its *MsgSendv()* to the

resource manager. The *iofunc_unblock_default()* function takes care of freeing up any locks that the client may have placed on the resource.

Returns:

_RESMGR_DEFAULT

No client connection was found.

_RESMGR_NOREPLY

A client connection has been unblocked.

Examples:

If you're calling *iofunc_lock_default()*, your unblock handler should call *iofunc_unblock_default()*:

```
if((status = iofunc_unblock_default(...)) != _RESMGR_DEFAULT) {
return status;
}

/* Do your own thing to look for a client to unblock */
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), *iofunc_lock_default()*, **iofunc_ocb_t**, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_unlink()

Verify that an entry can be unlinked

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_unlink( resmgr_context_t* ctp,
                   io_unlink_t* msg,
                   iofunc_attr_t* attr,
                   iofunc_attr_t* dattr,
                   struct _client_info* info );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_unlink_t** structure that contains the message that the resource manager received; see below.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the resource.

dattr NULL, or a pointer to the **iofunc_attr_t** structure that describes the characteristics of the parent directory.

info NULL, or a pointer to a **_client_info** structure that contains information about the client. For information about this structure, see *ConnectClientInfo()*.

Library:

libc

Description:

The *iofunc_unlink()* function verifies that the *msg* specifies valid semantics for an unlink, and that the client is allowed to unlink the resource, as specified by a combination of who the client is (*info*), and the resource attributes *attr*, *dattr*, *attr->uid* and *attr->gid*.

If a directory entry is being removed, *iofunc_unlink()* checks to see that the directory is empty. The *iofunc_unlink()* function also updates the time stamps, and decrements the link count for the entry.

io_unlink_t structure

The **io_unlink_t** structure holds the _IO_CONNECT message received by the resource manager:

```
typedef union {
    struct _io_connect                  connect;
    struct _io_connect_link_reply       link_reply;
    struct _io_connect_ftype_reply      ftype_reply;
} io_unlink_t;
```

This message structure is a union of an input message (coming to the resource manager), **_io_connect**, and two possible output or reply messages (going back to the client):

- **_io_connect_link_reply** if the reply is redirecting the client to another resource

  Or:

- **_io_connect_ftype_reply** if the reply consists of a status and a file type.

Returns:

EOK	Successful completion.
ENOTDIR	Attempt to unlink a nondirectory entry using directory semantics, (e.g. **rmdir** *file*).
EINVAL	Attempt to remove the **"."** directory.
ENOTEMPTY	Attempt to remove a directory that isn't empty.
EROFS	Attempt to remove an entry on a read-only filesystem.
EACCES	The client doesn't have permissions to do the operation.
EPERM	The group ID or owner ID didn't match.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

_io_connect, **_io_connect_link_reply**, **_io_connect_ftype_reply**, *ConnectClientInfo()*, **iofunc_attr_t**, *iofunc_check_access()*, **resmgr_context_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_unlock_ocb_default()

Default handler for the unlock_ocb callout

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_unlock_ocb_default(
        resmgr_context_t * ctp,
        void * reserved,
        iofunc_ocb_t * ocb );
```

Arguments:

ctp	A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.
reserved	This argument must be NULL.
ocb	A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_unlock_ocb_default()* function calls *iofunc_attr_unlock()* to enforce unlocking on the attributes for the group of messages that were sent by the client.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *unlock_ocb* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

Returns:

EOK	Success.
EAGAIN	On the first use, all kernel mutex objects were in use.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_unlock(), *iofunc_func_init()*, **iofunc_ocb_t**, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_utime()

Update time stamps

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_utime( resmgr_context_t* ctp,
                  io_utime_t* msg,
                  iofunc_ocb_t* ocb,
                  iofunc_attr_t* attr );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_utime_t** structure that contains the message that the resource manager received; see below.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

attr A pointer to the **iofunc_attr_t** structure that describes the characteristics of the device that's associated with your resource manager.

Library:

libc

Description:

The *iofunc_utime()* helper function examines the *flags* member in the passed *attr* structure and sets the IOFUNC_ATTR_ATIME and IOFUNC_ATTR_MTIME bits if requested.

The function sets the IOFUNC_ATTR_CTIME and IOFUNC_ATTR_DIRTY_TIME bits. It then calls *iofunc_time_update()* to update the file times.

io_utime_t structure

The **io_utime_t** structure holds the _IO_UTIME message received by the resource manager:

```
struct _io_utime {
    uint16_t                    type;
    uint16_t                    combine_len;
    int32_t                     cur_flag;
    struct utimbuf              times;
};

typedef union {
    struct _io_utime            i;
} io_utime_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client). In this case, there's only an input message, *i*.

The *i* member is a structure of type **_io_utime** that contains the following members:

type — _IO_UTIME.

combine_len — If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

cur_flag — If set, *iofunc_utime()* ignores the *times* member, and set the appropriate file times to the current time.

times — A **utimbuf** structure that specifies the time to use when setting the file times. For more information about this structure, see *utime()*.

Returns:

EACCES	The client doesn't have permissions to do the operation.
EFAULT	A fault occurred when the kernel tried to access the *info* buffer.
EINVAL	The client process is no longer valid.
ENOSYS	NULL was passed in *info*.
EOK	Successful completion.
EPERM	The group ID or owner ID didn't match.
EROFS	Attempt to remove an entry on a read-only filesystem.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_time_update(), *iofunc_utime_default()*, *utime()*

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_utime_default()

Default handler for _IO_UTIME messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_utime_default( resmgr_context_t* ctp,
                          io_utime_t* msg,
                          iofunc_ocb_t* ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_utime_t** structure that contains the message that the resource manager received; see *iofunc_utime()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_utime_default()* function implements POSIX semantics for the client's *utime()* call, which is received as an _IO_UTIME message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *utime* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_utime_default()* function calls *iofunc_utime()*, which does the actual work. It verifies that the client has the necessary permissions to effect a utime on the device. If so, the utime is

performed, modifying elements of the *ocb->attr* structure. This function takes care of updating these bits in the flags member of *ocb->attr*:

- IOFUNC_ATTR_ATIME
- IOFUNC_ATTR_CTIME
- IOFUNC_ATTR_MTIME
- IOFUNC_ATTR_DIRTY_TIME
- IOFUNC_ATTR_DIRTY_MODE

The *iofunc_utime()* function then calls *iofunc_time_update()* to update the appropriate time fields in *ocb->attr*.

Returns:

EOK	Successful completion.
EROFS	An attempt was made to utime a read-only filesystem.
EACCES	The client doesn't have permissions to do the operation.
EPERM	The group ID or owner ID didn't match.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), *iofunc_time_update()*, **iofunc_ocb_t**, *iofunc_utime()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_write_default()

Default handler for _IO_WRITE messages

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_write_default( resmgr_context_t* ctp,
                          io_write_t* msg,
                          iofunc_ocb_t* ocb );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg A pointer to the **io_write_t** structure that contains the message that the resource manager received. For more information, see *iofunc_write_verify()*.

ocb A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

Library:

libc

Description:

The *iofunc_write_default()* function implements POSIX semantics for the client's *write()* call, which is received as an _IO_WRITE message by the resource manager.

You can place this function directly into the *io_funcs* table passed to *resmgr_attach()*, at the *write* position, or you can call *iofunc_func_init()* to initialize all of the functions to their default values.

The *iofunc_write_default()* function calls *iofunc_write_verify()* to do the actual work, and (if installed in the *io_funcs* table) issues the reply back to the client.

Returns:

EBADF	The client doesn't have read access to this resource.
EINVAL	An unknown *xtype* was given.
EOK	The client has read access to this resource.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_func_init(), **iofunc_ocb_t**, *iofunc_open()*, *iofunc_write_verify()*, *resmgr_attach()*, **resmgr_context_t**, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the *Programmer's Guide*.

iofunc_write_verify()

Verify a client's write access to a resource

Synopsis:

```
#include <sys/iofunc.h>

int iofunc_write_verify( resmgr_context_t* ctp,
                         io_write_t* msg,
                         iofunc_ocb_t* ocb,
                         int* nonblock );
```

Arguments:

ctp — A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

msg — A pointer to the **io_write_t** structure that contains the message that the resource manager received; see below.

ocb — A pointer to the **iofunc_ocb_t** structure for the Open Control Block that was created when the client opened the resource.

nonblock — NULL, or a pointer to a location where the function can store a value that indicates whether or not the device is nonblocking:

- Zero — the client doesn't want to be blocked (i.e. O_NONBLOCK was set).
- Nonzero — the client wants to be blocked.

Library:

libc

Description:

The *iofunc_write_verify()* function checks that the client that sent the write message actually has write access to the resource, and, optionally (if *nonblock* isn't NULL), sets *nonblock* to O_NONBLOCK or 0.

The write permission check is done against *ocb->ioflag*.

Note that the **io_write_t** message has an override flag called *msg->i.xtype*. This flag allows the client to override the default blocking behavior for the resource on a per-request basis. This override flag is checked, and returned in the optional *nonblock*.

In *write* callout for your resource manager, you'll need to indicate how many bytes were written. You can do this with the macro:

```
_IO_SET_WRITE_NBYTES( resmgr_context_t *ctp,
                      int nbytes )
```

io_write_t structure

The **io_write_t** structure holds the _IO_WRITE message received by the resource manager:

```
struct _io_write {
    uint16_t                    type;
    uint16_t                    combine_len;
    int32_t                     nbytes;
    uint32_t                    xtype;
    uint32_t                    zero;
/*  unsigned char               data[nbytes];   */
};


typedef union {
    struct _io_write            i;
/*  nbytes is returned with MsgReply */
} io_write_t;
```

The I/O message structures are unions of an input message (coming to the resource manager) and an output or reply message (going back to the client). In this case, there's only an input message, *i*.

The *i* member is a structure of type **_io_write** that contains the following members:

type _IO_WRITE.

combine_len If the message is a combine message, _IO_COMBINE_FLAG is set in this member. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

nbytes The number of bytes that the client wants to write.

xtype Extended type information; one of:

- _IO_XTYPE_NONE
- _IO_XTYPE_READCOND
- _IO_XTYPE_MQUEUE
- _IO_XTYPE_TCPIP
- _IO_XTYPE_TCPIP_MSG
- _IO_XTYPE_OFFSET
- _IO_XTYPE_REGISTRY
- _IO_XFLAG_DIR_EXTRA_HINT — this flag is valid only when reading from a directory. The filesystem should normally return extra directory information when it's easy to get. If this flag is set, it is a hint to the filesystem to try harder (possibly causing media lookups) to return the extra information. The most common use would be to return _DTYPE_LSTAT information.
- _IO_XFLAG_NONBLOCK
- _IO_XFLAG_BLOCK

For more information, see "Handling other read/write details" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

The commented-out declaration for *data* indicates that *nbytes* bytes of data immediately follow the **_io_write** structure.

Returns:

EOK	The client has write access to this resource.
EBADF	The client doesn't have write access to this resource.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

iofunc_read_verify()

Writing a Resource Manager chapter of the *Programmer's Guide*.

ionotify()

Arm a resource manager

Synopsis:

```
#include <unistd.h>
#include <sys/iomsg.h>

int ionotify ( int fd,
               int action,
               int flags,
               const struct sigevent* event );
```

Arguments:

fd	The file descriptor associated with the resource manager that you want to notify.
action	The type of arming action to take; see "Actions," below.
flags	The types of conditions that can be checked for notification; see "Flags," below.
event	A pointer to a **sigevent** structure that defines the event that you want the resource manager to send as a notification, or NULL to disarm a notification.

Library:

libc

Description:

The *ionotify()* function arms the resource manager associated with *fd* to send the event notification *event*. The event is sent when a condition specified by a combination of *action* and *flags* occurs.

Flags

The *flags* argument specifies the types of conditions that can be checked for notification. Each resource manager maintains a different context for each notification condition. Only those notification bits specified are affected. In the following example, the second call to

ionotify() doesn't affect the first, since it specifies a different notification:

```
ionotify( fd, _NOTIFY_ACTION_POLLARM,
          _NOTIFY_COND_INPUT, &event );
ionotify( fd, _NOTIFY_ACTION_POLLARM,
          _NOTIFY_COND_OUTPUT, &event );
```

The conditions specified by *flags* are:

_NOTIFY_COND_OBAND

Out-of-band data is available. The definition of out-of-band data depends on the resource manager.

_NOTIFY_COND_OUTPUT

There's room in the output buffer for more data. The amount of room available needed to satisfy this condition depends on the resource manager. Some resource managers may default to an empty output buffer, while others may choose some percentage of the buffer empty.

_NOTIFY_COND_INPUT

There's input data available. The amount of data available defaults to 1. For a character device such as a serial port, this would be a character. For a POSIX message queue, it would be a message. Each resource manager selects an appropriate object.

The method for changing the default number for _NOTIFY_COND_OUTPUT and _NOTIFY_COND_INPUT depends on the device. For example, character special devices can call *readcond()*.

For resource managers that support both an edited and raw mode, the mode should be set to raw to ensure proper operation of *ionotify()*.

The above flags are located in the top bits of *flags*. They are defined by _NOTIFY_COND_MASK.

In the case of an asynchronous notification using the passed *event*, such as a Neutrino pulse or queued realtime signal, the 32-bit value in

event->sigev_value.sival_int is returned to you unmodified, *unless* you've selected the SI_NOTIFY code, in which case the top bits (defined by _NOTIFY_COND_MASK) are set to the active notifications. In this case, you should limit the *sival_int* to the mask defined by _NOTIFY_DATA_MASK.

For example, the Unix *select()* function specifies SI_NOTIFY and uses the allowable data bits of *sival_int* as a serial number.

☞ If you're using the SI_NOTIFY code, then you should clear the bits as specified by _NOTIFY_COND_MASK in the *sigev_value* field — the resource manager only ever ORs in a value, it never clears the bits.

Actions

The *action* argument specifies the type of arming action to take. When a condition is armed, the resource manager monitors it and, when met, delivers *event* using *MsgDeliverEvent()*. When an event is delivered, it's always disarmed except where noted below.

Note that for transition arming (as specified by an *action* of _NOTIFY_ACTION_TRANARM, only *one* notification of that type can be outstanding *per device*. When the transition arm fires, it's removed.

Each action is designed to support a specific notification type as follows:

_NOTIFY_ACTION_POLL

This action does a poll of the notification conditions specified by *flags*. It never arms an event, and it cancels all other asynchronous event notifications set up by a previous call to *ionotify()*. This also allows it to be used as a simple "disarm" call.

Returns active conditions as requested by *flags*.

_NOTIFY_ACTION_POLLARM

This action does a poll in the same way as _NOTIFY_ACTION_POLL. However, if none of the conditions

specified in *flags* are present then each condition specified in *flags* is armed. If any condition is met, none of the conditions are armed. The Unix *select()* function uses *ionotify()* with this action.

Returns active conditions as requested by *flags*.

_NOTIFY_ACTION_TRANARM

This action arms for transitions of the notification conditions specified by *flags*. A transition is defined as a data transition from empty to nonempty on input. Its use on output isn't defined. Note that if there is data available when this call is used, a data transition *won't* occur. To generate an event using this type of notification, you must arm the event and then drain the input using a nonblocking read. After this point, new input data causes the event to be delivered. The *mq_notify()* function uses *ionotify()* with this action.

Since this arms for a transition, the return value is always zero.

You can use the _NOTIFY_ACTION_POLLARM or _NOTIFY_ACTION_POLL action to generate events that are level- as opposed to transition-oriented.

When an action is armed in a resource manager, it remains armed until:

- A thread sets a new action (this disarms any current action and possibly arms a new action),
- The event is delivered and the action wasn't a continuous one,
- The thread closes the device.

Returns:

Active conditions as requested by *flags*. In the case of a transition action, a zero is returned. If an error occurs, -1 is returned (*errno* is set).

Errors:

EBADF	The connection indicated by *fd* doesn't exist, or *fd* is no longer connected to a channel.
EFAULT	A fault occurred when the kernel tried to access the buffers provided. This may have occurred on the receive or the reply.
EINTR	The call was interrupted by a signal.
ENOMEM	The resource manager couldn't allocate a notify entry to save the request.
ENOSYS	The requested action isn't supported by this resource manager.
ESRVRFAULT	A fault occurred in a server's address space while accessing the server's message buffers. This may have occurred on the receive or the reply.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

`sigevent`

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>

int socket( AF_INET,
            SOCK_RAW,
            proto );
```

Description:

IP is the transport layer protocol used by the Internet protocol family. You may set options at the IP level when you're using higher-level protocols based on IP, such as TCP and UDP. You may also access IP through a "raw socket" (when you're developing new protocols or special-purpose applications).

There are several IP-level *setsockopt()* and *getsockopt()* options. You can use IP_OPTIONS to provide IP options to be transmitted in the IP header of each outgoing packet or to examine the header options on incoming packets. IP options may be used with any socket type in the Internet family. The format of IP options to be sent is that specified by the IP protocol specification (*RFC-791*), with one exception: the list of addresses for Source Route options must include the first-hop gateway at the beginning of the list of gateways. The first-hop gateway address is extracted from the option list and the size adjusted accordingly before use. To disable previously specified options, use a zero-length buffer:

```
setsockopt(s, IPPROTO_IP, IP_OPTIONS, NULL, 0);
```

You can use IP_TOS and IP_TTL to set the type-of-service and time-to-live fields in the IP header for SOCK_STREAM and SOCK_DGRAM sockets. For example:

```
int tos = IPTOS_LOWDELAY;       /* see <netinet/ip.h> */
setsockopt(s, IPPROTO_IP, IP_TOS, &tos, sizeof(tos));

int ttl = 60;                   /* max = 255 */
setsockopt(s, IPPROTO_IP, IP_TTL, &ttl, sizeof(ttl));
```

If the IP_RECVDSTADDR option is enabled on a SOCK_DGRAM or SOCK_RAW socket, the *recvmsg()* call returns the destination IP address for a UDP datagram. The *msg_control* field in the **msghdr** structure points to a buffer that contains a **cmsghdr** structure followed by the IP address. The **cmsghdr** fields have the following values:

```
cmsg_len = sizeof(struct cmsghdr) + sizeof(struct in_addr)
cmsg_level = IPPROTO_IP
cmsg_type = IP_RECVDSTADDR
```

If the IP_RECVIF option is enabled on a SOCK_DGRAM or SOCK_RAW socket, the *recvmsg()* call returns a **struct sockaddr_dl** corresponding to the interface on which the packet was received. The *msg_control* field in the **msghdr** structure points to a buffer that contains a **cmsghdr** structure followed by the **struct sockaddr_dl**. The **cmsghdr** fields have the following values:

```
cmsg_len = sizeof(struct cmsghdr) + sizeof(struct sockaddr_dl)
cmsg_level = IPPROTO_IP
cmsg_type = IP_RECVIF
```

Raw IP sockets are connectionless, and are normally used with the *sendto()* and *recvfrom()* calls, although you can also use *connect()* to fix the destination for future packets (in which case you can use the *read()* or *recv()* and *write()* or *send()* system calls).

If the *proto* parameter to *socket()* is 0, the default protocol IPPROTO_RAW is used for outgoing packets, and only incoming packets destined for that protocol are received. If *proto* is nonzero, that protocol number will be used on outgoing packets and to filter incoming packets.

Outgoing packets automatically have an IP header prepended to them (based on the destination address and the protocol number the socket is created with), unless the IP_HDRINCL option has been set. Incoming packets are received with IP header and options intact.

IP_HDRINCL indicates the complete IP header is included with the data and may be used only with the SOCK_RAW type.

```
#include <netinet/ip.h>

int hincl = 1;                  /* 1 = on, 0 = off */
setsockopt(s, IPPROTO_IP, IP_HDRINCL, &hincl, sizeof(hincl));
```

The program must set all the fields of the IP header, including the following:

```
ip->ip_v = IPVERSION;
ip->ip_hl = hlen >> 2;
ip->ip_id = 0;  /* 0 means kernel set appropriate value */
ip->ip_off = offset;
```

If the header source address is set to INADDR_ANY, the kernel chooses an appropriate address.

Multicasting

IP multicasting is supported only on AF_INET sockets of type SOCK_DGRAM and SOCK_RAW, and only on networks where the interface driver supports multicasting.

Multicast Options

IP_MULTICAST_TTL

Change the time-to-live (TTL) for outgoing multicast datagrams in order to control the scope of the multicasts:

```
u_char ttl;     /* range: 0 to 255, default = 1 */
setsockopt(s, IPPROTO_IP, IP_MULTICAST_TTL, &ttl, sizeof(ttl));
```

Datagrams with a TTL of 1 aren't forwarded beyond the local network. Multicast datagrams with a TTL of 0 aren't transmitted on any network, but may be delivered locally if the sending host belongs to the destination group and if multicast loopback hasn't been disabled on the sending socket (see below). Multicast datagrams with TTL greater than 1 may be forwarded to other networks if a multicast router is attached to the local network.

IP_MULTICAST_IF

For hosts with multiple interfaces, each multicast transmission is sent from the primary network interface. The IP_MULTICAST_IF option overrides the default for subsequent transmissions from a given socket:

```
struct in_addr addr;
setsockopt(s, IPPROTO_IP, IP_MULTICAST_IF, &addr, sizeof(addr));
```

where *addr* is the local IP address of the desired interface or INADDR_ANY to specify the default interface. You can get an interface's local IP address and multicast capability by sending the SIOCGIFCONF and SIOCGIFFLAGS requests to *ioctl()*. Normal applications shouldn't need to use this option.

IP_MULTICAST_LOOP

If a multicast datagram is sent to a group to which the sending host itself belongs (on the outgoing interface), a copy of the datagram is, by default, looped back by the IP layer for local delivery. The IP_MULTICAST_LOOP option gives the sender explicit control over whether or not subsequent datagrams are looped back:

```
u_char loop;    /* 0 = disable, 1 = enable (default) */
setsockopt(s, IPPROTO_IP, IP_MULTICAST_LOOP, &loop, sizeof(loop));
```

This option improves performance for applications that may have no more than one instance on a single host (such as a router demon), by eliminating the overhead of receiving their own transmissions. It shouldn't generally be used by applications for which there may be more than one instance on a single host (such as a conferencing program) or for which the sender doesn't belong to the destination group (such as a time querying program).

A multicast datagram sent with an initial TTL greater than 1 may be delivered to the sending host on a different interface from that on which it was sent, if the host belongs to the

destination group on that other interface. The loopback control option has no effect on such delivery.

IP_ADD_MEMBERSHIP

A host must become a member of a multicast group before it can receive datagrams sent to the group. To join a multicast group, use the IP_ADD_MEMBERSHIP option:

```
struct ip_mreq mreq;
setsockopt(s, IPPROTO_IP, IP_ADD_MEMBERSHIP, &mreq, sizeof(mreq));
```

where *mreq* is the following structure:

```
struct ip_mreq {
   struct in_addr imr_multiaddr; /* multicast group to join */
   struct in_addr imr_interface; /* interface to join on */
   }
```

Set *imr_interface* to INADDR_ANY to choose the default multicast interface, or to the IP address of a particular multicast-capable interface if the host is multihomed. Membership is associated with a single interface; programs running on multihomed hosts may need to join the same group on more than one interface. Up to IP_MAX_MEMBERSHIPS (currently 20) memberships may be added on a single socket.

IP_DROP_MEMBERSHIP

To drop a membership, use:

```
struct ip_mreq mreq;
setsockopt(s, IPPROTO_IP, IP_DROP_MEMBERSHIP, &mreq, sizeof(mreq));
```

where *mreq* contains the same values as used to add the membership. Memberships are dropped when the socket is closed or the process exits.

Returns:

A descriptor referencing the socket, or -1 if an error occurs (*errno* is set).

Errors:

EADDRNOTAVAIL
: You tried to create a socket with a network address for which no network interface exists.

EISCONN
: You tried to establish a connection on a socket that already has one or to send a datagram with the destination address specified, but the socket is already connected.

ENOBUFS
: The system ran out of memory for an internal data structure.

ENOTCONN
: You tried to send a datagram, but no destination address was specified and the socket hasn't been connected.

☞

The following error specific to IP may occur when setting or getting IP options:

EINVAL
: An unknown socket option name was given. The IP option field was improperly formed — an option field was shorter than the minimum value or longer than the option buffer provided.

See also:

ICMP protocol

connect(), getsockopt(), ioctl(), read(), recv(), recvfrom(), recvmsg(), send(), sendto(), setsockopt(), socket(), write()

RFC 791

IPsec

Internet security protocol

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <netinet6/ipsec.h>

int socket( PF_KEY,
            SOCK_RAW,
            PF_KEY_V2 );
```

Description:

IPsec is a security protocol for the Internet Protocol layer. It consists of these sub-protocols:

AH (Authentication Header)

Guarantees the integrity of the IP packet and protects it from intermediate alteration or impersonation by attaching a cryptographic checksum computed by one-way hash functions.

ESP (Encapsulated Security Payload)

Protects the IP payload from wire-tapping by encrypting it using secret-key cryptography algorithms.

IPsec has these modes of operation:

- Transport — protects peer-to-peer communication between end nodes.
- Tunnel — supports IP-in-IP encapsulation operation and is designed for security gateways, like VPN configurations.

Kernel interface

The IPsec protocol behavior is controlled by these engines:

- Key management engine — accessed from an application using PF_KEY sockets. The *RFC 2367* specification defines the PF_KEY socket API.

- Policy engine — accessed with the PF_KEY API, the *setsockopt()* operations, and the *sysctl()* interface. (The **sysctl** utility is a cover for the *sysctl()* function.) The *setsockopt()* function defines per-socket behavior and the *sysctl()* interface defines host-wide default behavior.

These engines are located in the socket manager. The socket manager implements the PF_KEY interface and allows you to define IPsec policy similar to per-packet filters. Note that the socket manager code doesn't implement the dynamic encryption key exchange protocol IKE (Internet Key Exchange) — that implementation should be done at the application level (usually as daemons), using the previously described APIs.

Policy management

The socket manager implements experimental policy management. You can manage the IPsec policy in these ways:

- Configure a per-socket policy using *setsockopt()*.
- Configure the socket manager packet filter-based policy using the PF_KEY interface or via the **setkey** utility.

  In this case, the default policy is allowed with the **setkey**. By configuring the policy to **default**, you can use the system-wide **sysctl** utility variables. (The **sysctl** utility displays various runtime options.)

If the socket manager finds no matching policy, the system-wide default value is applied.

For a list of *net.inet6.ipsec6.** variables, see the **sysctl** utility in the *Utilities Reference*.

Miscellaneous **sysctl** variables

The following variables are accessible via the **sysctl** utility for tweaking socket manager IPsec behavior:

Name	Type	Changeable?
net.inet.ipsec.ah_cleartos	Integer	Yes
net.inet.ipsec.ah_offsetmask	Integer	Yes
net.inet.ipsec.dfbit	Integer	Yes
net.inet.ipsec.ecn	Integer	Yes
net.inet.ipsec.debug	Integer	Yes
net.inet6.ipsec6.ecn	Integer	Yes
net.inet6.ipsec6.debug	Integer	Yes

The variables are interpreted as follows:

ipsec.ah_cleartos

When computing AH authentication data, the socket manager clears the type-of-service field in the IPv4 header if the value is set to a nonzero value. The variable tweaks AH behavior to interoperate with devices that implement *RFC 1826* AH. Set this to a nonzero value (clear the type-of-service field) if you want to conform to *RFC 2402*.

ipsec.ah_offsetmask

When computing AH authentication data, the socket manager includes the 16-bit fragment offset field (including flag bits) in the IPv4 header, after computing a logical “AND” with the variable. This variable tweaks the AH behavior to interoperate with devices that implement *RFC 1826* AH. Set this value to zero (clear the fragment offset field during computation) if you want to conform to *RFC 2402*.

ipsec.dfbit Configures the socket manager behavior for IPv4 IPsec tunnel encapsulation. The variable is supplied to conform to *RFC 2403* Chapter 6.1.

If the value is set to:	Then:
0	The DF bit on the outer IPv4 header is cleared.
1	The outer DF bit on the header is set from the inner DF bit.
2	The DF bit is copied from the inner header to the outer.

ipsec.ecn — If set to nonzero, the IPv4 IPsec tunnel encapsulation/decapsulation behavior supports ECN (Explicit Congestion Notification), as documented in the IETF draft **`draft-ietf-ipsec-ecn-02.txt`**.

ipsec.debug — If set to nonzero, debug messages are generated to the **`syslog`**.

Variables under the *net.inet6.ipsec6* tree have meaning similar to their *net.inet.ipsec* counterparts.

Protocols

Because the IPsec protocol works like a plugin to the INET and INET6 protocols, IPsec supports most of the protocols defined upon those IP-layer protocols. Some of the protocols, like ICMP or ICMP6, may behave differently with IPsec. This is because IPsec can prevent ICMP or ICMP6 routines from looking into the IP payload.

Setting the policy

You can set the policy manually by calling **`setkey`**, or set it permanently in **`/etc/inetd.conf`**. Valid policy settings include:

for **`setkey`**:

```
-P direction discard
-P direction ipsec request ...
-P direction none
```

for **/etc/inetd.conf**:

direction **bypass**
direction **entrust**
direction **ipsec** *request* **...**

where:

direction The direction in which the policy is applied. It's either **in** or **out**.

bypass (**/etc/inetd.conf** only) Bypass the IPsec processing and transmit the packet in clear text. This option is for privileged sockets.

discard (**setkey** only) Discard the packet matching indexes.

entrust (**/etc/inetd.conf** only) Consult the Security Policy Database (SPD) in the stack. The SPD is set by **setkey** (see the *Utilities Reference*).

ipsec *request ...*

Put the IPsec operation into the packet. You can specify one or more *request* strings using the following format:

*protocol***/***mode***/***src***-***dst***[/***level***]**

For detailed descriptions of the arguments in the *request* string, see below.

none (**setkey** only) Don't put the IPsec operation into the packet.

Arguments for *request*

protocol One of:

- **ah** — Authentication Header. Guarantees the integrity of the IP packets and protects them from intermediate alteration or impersonation, by attaching cryptographic checksums computed by one-way hash functions.
- **esp** — Encapsulated Security Payload. Protects the IP payload from wire-tapping by encrypting it with secret key cryptography algorithms.
- **ipcomp** — IP Payload Compression Protocol.

mode Security protocol to be used, which is one of:

- **transport** — Protects peer-to-peer communication between end nodes.
- **tunnel** — Includes IP-in-IP encapsulation operations and is designed for security gateways, like VPN configurations.

dst, *src* The "receiving node" (*dst*) and "sending node" (*src*) endpoint addresses of the Security Association (SA). When the direction specified is **in**, *dst* would represent this node and *src* the other node (peer).

If **transport** is specified as the *mode*, you can omit these values.

level One of:

- **default** — The stack should consult the system default policy that's set by the **sysctl** utility.
- **require** — An SA is required whenever the kernel deals with the packet.
- **use** — Use an SA if it's available; otherwise, keep the normal operation.
- **unique** — (**setkey** only) Similar to **require**, but adds the restriction that the SA for outbound traffic is used only for this policy.

You may need the identifier in order to relate the policy and the SA when you define the SA by manual keying. You can put the decimal number as the identifier after **unique**, such as:

```
unique:  number
```

The value of *number* must be between 1 and 32767. If the request string is kept unambiguous, the *level* and slash prior to *level* can be omitted. However, you should specify them explicitly to avoid unintended behaviors.

If the *level* isn't specified in the **setkey** command, **unique** is used by default.

Caveats:

The IPsec support is subject to change as the IPsec protocols develop.

There's no single standard for policy engine API, so the policy engine API described herein is just for KAME implementation.

The AH tunnel may not work as you might expect. If you configure the **require** policy against AH tunnel for inbound, tunneled packets will be rejected. This is because AH authenticates the encapsulating (outer) packet, not the encapsulated (inner) packet.

Under certain conditions, a truncated result may be returned from the socket manager from SADB_DUMP and SADB_SPDDUMP operations on a PF_KEY socket. This occurs if there are too many database entries in the socket manager and the socket buffer for the PF_KEY socket is too small. If you manipulate many IPsec key/policy database entries, increase the size of socket buffer.

See also:

ICMP, ICMP6, INET6, IP, IPv6 protocols

ioctl(), socket(), sysctl()

/etc/inetd.conf, **setkey** in the *Utilities Reference*.

RFC 2367, *RFC 1826*, *RFC 2402*, *RFC 2403*

Detailed documentation about the IP security protocol may be found at the IPsec FAQ website at **`http://www.netbsd.org/Documentation/network/ipsec/`**.

ipsec_dump_policy()

Generate a readable string from an IPsec policy specification

Synopsis:

```
#include <netinet6/ipsec.h>

char* ipsec_dump_policy(char *buf,
                        char *delim);
```

Arguments:

buf A pointer to an IPsec policy structure **struct sadb_x_policy**.

delim Delimiter string, usually a NULL which indicates a space (“ ”).

Library:

libipsec

Description:

The function *ipsec_dump_policy()* generates a readable string from an IPSEC policy specification. Please refer to *ipsec_set_policy()* for details about the policies.

The *ipsec_dump_policy()* function converts IPsec policy structure into a readable form. Therefore, *ipsec_dump_policy()* is the inverse of *ipsec_set_policy()*. If you set *delim* to NULL, a single whitespace is assumed. The function *ipsec_dump_policy()* returns a pointer to a dynamically allocated string. It is the caller’s responsibility to reclaim the region, by using *free()*.

Returns:

A pointer to dynamically allocated string, or NULL if an error occurs.

Examples:

See *ipsec_set_policy()*.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

IPsec, *ipsec_get_policylen()*, *ipsec_set_policy()*, *ipsec_strerror()*

`setkey` in the *Utilities Reference*

ipsec_get_policylen()

Get the length of the IPsec policy

Synopsis:

```
#include <netinet6/ipsec.h>

int ipsec_get_policylen(char *buf);
```

Arguments:

buf A pointer to an IPsec policy structure **struct sadb_x_policy**.

Library:

libipsec

Description:

The function *ipsec_get_policylen()* gets the length of the IPsec policy. Please refer to *ipsec_set_policy()* for details about the policies.

You may want the length of the generated buffer when calling *setsockopt()*. The function *ipsec_get_policylen()* returns the length.

Returns:

The size of the buffer, or a negative value if an error occurs.

Examples:

See *ipsec_set_policy()*.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

IPsec, *ipsec_dump_policy()*, *ipsec_set_policy()*, *ipsec_strerror()*

`setkey` in the *Utilities Reference*

ipsec_strerror()

Error code for IPsec policy manipultion library

Synopsis:

```
#include <netinet6/ipsec.h>

const char *
ipsec_strerror(void);
```

Library:

libipsec

Description:

This *ipsec_strerror()* function is used to obtain the error message string from the last failed ipsec call.

Returns:

A pointer to an error message.

☞ Don't modify the string that this function returns.

Examples:

```
#include <netinet6/ipsec.h>
#include <sys/socket.h>
#include <stdio.h>
#include <malloc.h>
#include <string.h>

int
main(void)
{
   char *sadb;
   char *policy = "in discard";
   int len;

   sadb = ipsec_set_policy(policy, strlen(policy));

   if (sadb == NULL) {
      fprintf(stderr, "ipsec_set_policy: %s\n", ipsec_strerror());
      return 1;
   }
```

```
   len = ipsec_get_policylen(sadb);
   printf("len: %d\n", len);

   policy = NULL;
   policy = ipsec_dump_policy(sadb, NULL);

   if (policy == NULL) {
      fprintf(stderr, "ipsec_dump_policy: %s\n", ipsec_strerror());
      return 1;
   }

   printf("policy: %s\n", policy);

   free(policy);
   free(sadb);

   return 0;
}
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

IPsec, *ipsec_dump_policy()*, *ipsec_get_policylen()*, *ipsec_set_policy()*, **setkey**

ipsec_set_policy()

Generate an IPsec policy specification structure from a readable string

Synopsis:

```
#include <netinet6/ipsec.h>

char* ipsec_set_policy(char *policy,
                       int len);
```

Arguments:

len The length of the policy string.

policy A string that describes a **struct sadb_x_policy** and optionally a **struct sadb_x_ipsecrequest**, formatted as described below.

Library:

libipsec

Description:

The function *ipsec_set_policy()* generates an IPsec policy specification structure, namely a **struct sadb_x_policy** and potentially a **struct sadb_x_ipsecrequest** from a human-readable policy specification. This function returns a pointer to the IPsec policy specification structure.

You should release the buffer returned by *ipsec_set_policy()* by calling *free()*. See the example below.

The policy is formatted as one of the following:

direction **discard**

The direction must be **in** or **out**. It specifies which direction the policy needs to be applied. With the discard policy, packets are dropped if they match the policy.

direction **entrust**

Consultation to SPD — defined by **setkey**.

direction **bypass**

Bypass the IPsec processing, i.e. packets are transmitted in clear. This is for privileged sockets.

direction **ipsec** request ...

The matching packets are subject to IPsec processing. The **ipsec** string can be followed by one or more request strings, which are formatted as below:

protocol / *mode* / *src* - *dst* [/*level*]

protocol	Either **ah**, **esp**, or **ipcomp**.
mode	Either **transport** or **tunnel**.
src and *dst*	The IPsec endpoints; *src* is the sending node and *dst* is the receiving node. Therefore, when direction is **in**, *dst* is this node and *src* is the other node (peer).
level	Either **default**, **use**, **require** or **unique**.

- **default** — the kernel should consult the system default policy defined by *sysctl()*.
- **use** — a relevant SA (security association) is used when available, since the kernel may perform IPsec operation against packets when possible. In this case, packets are transmitted in clear (when SA is not available), or encrypted (when SA is available).
- **require** — a relevant SA is required, since the kernel must perform IPsec operation against packets.
- **unique** is the same as **require**. However, it adds the restriction that the SA for outbound traffic is used only for this policy. You may need the identifier in order to relate the policy and the SA when you define the SA by manual keying. You put the decimal number as the identifier like:

unique: *number*
where *number* must be between 1 and 32767. If the request string is kept unambiguous, you can omit the *level* and the slash ("/") prior to *level*. However, you should specify them explicitly to avoid unintended behavior. If *level* is omitted, it will be interpreted as default.

Here's an example of policy information:

```
in discard
out ipsec esp/transport//require
in ipsec ah/transport//require
out ipsec esp/tunnel/10.1.1.2-10.1.1.1/use
in ipsec ipcom/transport//use esp/transport//use
```

It differs from the specification of **setkey**, where both **entrust** and **bypass** are not used. Please refer to **setkey** for detail.

Returns:

A pointer to the allocated policy specification, or NULL if an error occurs.

Examples:

```
#include <netinet6/ipsec.h>
#include <sys/socket.h>
#include <stdio.h>
#include <malloc.h>
#include <string.h>

int
main(void)
{
   char *sadb;
   char *policy = "in discard";
   int len;

   sadb = ipsec_set_policy(policy, strlen(policy));

   if (sadb == NULL) {
```

```
        fprintf(stderr, "ipsec_set_policy: %s\n", ipsec_strerror());
        return 1;
    }

    len = ipsec_get_policylen(sadb);
    printf("len: %d\n", len);

    policy = NULL;
    policy = ipsec_dump_policy(sadb, NULL);

    if (policy == NULL) {
        fprintf(stderr, "ipsec_dump_policy: %s\n", ipsec_strerror());
        return 1;
    }

    printf("policy: %s\n", policy);

    free(policy);
    free(sadb);

    return 0;
}
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

IPsec, *ipsec_dump_policy()*, *ipsec_get_policylen()*, *ipsec_strerror()*

setkey in the *Utilities Reference*

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>

int socket( AF_INET6,
            SOCK_RAW,
            proto);
```

Description:

The IP6 protocol is the network-layer protocol used by the Internet Protocol version 6 family (AF_INET6). Options may be set at the IP6 level when using higher-level protocols based on IP6 (such as TCP and UDP). It may also be accessed through a "raw socket" when developing new protocols, or special-purpose applications.

There are several IP6-level *setsockopt()*/*getsockopt()* options. They are separated into the basic IP6 sockets API (defined in *RFC2553*), and the advanced API (defined in *RFC2292*). The basic API looks very similar to the API presented in IP. The advanced API uses ancillary data and can handle more complex cases.

☞ Specifying some of the socket options requires **root** privileges.

Basic IP6 sockets API

You can use the IPV6_UNICAST_HOPS option to set the hoplimit field in the IP6 header on unicast packets. If you specify -1, the socket manager uses the default value. If you specify a value of 0 to 255, the packet uses the specified value as it hoplimit. Other values are considered invalid and result in an error code of EINVAL. For example:

```
int hlim = 60;    /* max = 255 */
setsockopt( s, IPPROTO_IPV6, IPV6_UNICAST_HOPS,
            &hlim, sizeof(hlim) );
```

The IP6 multicasting is supported only on AF_INET6 sockets of type SOCK_DGRAM and SOCK_RAW, and only on networks where the interface driver supports multicasting.

The IPV6_MULTICAST_HOPS option changes the hoplimit for outgoing multicast datagrams in order to control the scope of the multicasts:

```
unsigned int hlim; /* range: 0 to 255, default = 1 */
setsockopt( s, IPPROTO_IPV6, IPV6_MULTICAST_HOPS,
            &hlim, sizeof(hlim) );
```

Datagrams with a hoplimit of 1 aren't forwarded beyond the local network. Multicast datagrams with a hoplimit of 0 won't be transmitted on any network, but may be delivered locally if the sending host belongs to the destination group and if multicast loopback hasn't been disabled on the sending socket (see below). Multicast datagrams with a hoplimit greater than 1 may be forwarded to other networks if a multicast router is attached to the local network.

For hosts with multiple interfaces, each multicast transmission is sent from the primary network interface. The IPV6_MULTICAST_IF option overrides the default for subsequent transmissions from a given socket:

```
unsigned int outif;
outif = if_nametoindex("ne0");
setsockopt( s, IPPROTO_IPV6, IPV6_MULTICAST_IF,
            &outif, sizeof(outif) );
```

(The *outif* argument is an interface index of the desired interface, or 0 to specify the default interface.)

If a multicast datagram is sent to a group to which the sending host itself belongs (on the outgoing interface), a copy of the datagram is, by default, looped back by the IP6 layer for local delivery. The IPV6_MULTICAST_LOOP option gives the sender explicit control over whether or not subsequent datagrams are looped back:

```
u_char loop;  /* 0 = disable, 1 = enable (default) */
setsockopt( s, IPPROTO_IPV6, IPV6_MULTICAST_LOOP,
            &loop, sizeof(loop));
```

This option improves performance for applications that may have no more than one instance on a single host (such as a router daemon), by eliminating the overhead of receiving their own transmissions. Don't use the IPV6_MULTICAST_LOOP option if there might be more than one instance of your application on a single host (e.g. a conferencing program), or if the sender doesn't belong to the destination group (e.g. a time-querying program).

A multicast datagram sent with an initial hoplimit greater than 1 may be delivered to the sending host on a different interface from that on which it was sent, if the host belongs to the destination group on that other interface. The loopback control option has no effect on such a delivery.

A host must become a member of a multicast group before it can receive datagrams sent to the group. To join a multicast group, use the IPV6_JOIN_GROUP option:

```
struct ipv6_mreq mreq6;
setsockopt( s, IPPROTO_IPV6, IPV6_JOIN_GROUP,
            &mreq6, sizeof(mreq6) );
```

Note that the *mreq6* argument has the following structure:

```
struct ipv6_mreq {
  struct in6_addr ipv6mr_multiaddr;
  unsigned int ipv6mr_interface;
};
```

Set the *ipv6mr_interface* member to 0 to choose the default multicast interface, or set it to the interface index of a particular multicast-capable interface if the host is multihomed. Membership is associated with a single interface; programs running on multihomed hosts may need to join the same group on more than one interface.

To drop a membership, use:

```
struct ipv6_mreq mreq6;
setsockopt( s, IPPROTO_IPV6, IPV6_LEAVE_GROUP,
            &mreq6, sizeof(mreq6) );
```

The *mreq6* argument contains the same values as used to add the membership. Memberships are dropped when the socket is closed or the process exits.

The IPV6_PORTRANGE option controls how ephemeral ports are allocated for SOCK_STREAM and SOCK_DGRAM sockets. For example:

```
int range = IPV6_PORTRANGE_LOW;  /* see <netinet/in.h> */
setsockopt( s, IPPROTO_IPV6, IPV6_PORTRANGE, &range,
            sizeof(range) );
```

The IPV6_BINDV6ONLY option controls the behavior of the AF_INET6 wildcard listening socket. The following example sets the option to 1:

```
int on = 1;
setsockopt( s, IPPROTO_IPV6, IPV6_BINDV6ONLY,
            &on, sizeof(on) );
```

If you set the IPV6_BINDV6ONLY option to 1, the AF_INET6 wildcard listening socket accepts IP6 traffic only. If set to 0, the socket accepts IPv4 traffic as well, as if it were from an IPv4 mapped address, such as **`::ffff:10.1.1.1`**. Note that if you set the option to 0, IPv4 access control gets much more complicated. For example, even if you have no listening AF_INET socket on port X, you'll end up accepting IPv4 traffic by an AF_INET6 listening socket on the same port. The default value for this flag is copied at socket-instantiation time, from the *net.inet6.ip6.bindv6only* variable from the **`sysctl`** utility. The option affects TCP and UDP sockets only.

Advanced IP6 sockets API

The advanced IP6 sockets API lets applications specify or obtain details about the IP6 header and extension headers on packets. The advanced API uses ancillary data for passing data to or from the socket manager.

There are also *setsockopt()* / *getsockopt()* options to get optional information on incoming packets:

- IPV6_PKTINFO

- IPV6_HOPLIMIT
- IPV6_HOPOPTS
- IPV6_DSTOPTS
- IPV6_RTHDR

```
int  on = 1;

setsockopt( fd, IPPROTO_IPV6, IPV6_PKTINFO,
            &on, sizeof(on) );
setsockopt( fd, IPPROTO_IPV6, IPV6_HOPLIMIT,
            &on, sizeof(on) );
setsockopt( fd, IPPROTO_IPV6, IPV6_HOPOPTS,
            &on, sizeof(on) );
setsockopt( fd, IPPROTO_IPV6, IPV6_DSTOPTS,
            &on, sizeof(on) );
setsockopt( fd, IPPROTO_IPV6, IPV6_RTHDR,
            &on, sizeof(on) );
```

When any of these options are enabled, the corresponding data is returned as control information by *recvmsg()*, as one or more ancillary data objects.

If IPV6_PKTINFO is enabled, the destination IP6 address and the arriving interface index are available via **`struct in6_pktinfo`** on an ancillary data stream. You can pick the structure by checking for an ancillary data item by setting the *cmsg_level* argument to IPPROTO_IPV6 and the *cmsg_type* argument to IPV6_PKTINFO.

If IPV6_HOPLIMIT is enabled, the hoplimit value on the packet is made available to the application. The ancillary data stream contains an integer data item with a *cmsg_level* of IPPROTO_IPV6 and a *cmsg_type* of IPV6_HOPLIMIT.

The *inet6_option_space()* family of functions help you parse ancillary data items for IPV6_HOPOPTS and IPV6_DSTOPTS. Similarly, the *inet6_rthdr_space()* family of functions help you parse ancillary data items for IPV6_RTHDR.

The IPV6_HOPOPTS and IPV6_DSTOPTS values may appear multiple times on an ancillary data stream (note that the behavior is slightly different from the specification). Other ancillary data items appear no more than once.

You can pass ancillary data items with normal payload data, using the *sendmsg()* function. Ancillary data items are parsed by the socket manager, and are used to construct the IP6 header and extension headers. For the *cmsg_level* values listed above, the ancillary data format is the same as the inbound case.

Additionally, you can specify a IPV6_NEXTHOP data object. The IPV6_NEXTHOP ancillary data object specifies the next hop for the datagram as a socket address structure. In the **`cmsghdr`** structure containing this ancillary data, the *cmsg_level* argument is IPPROTO_IPV6, the *cmsg_type* argument is IPV6_NEXTHOP, and the first byte of *cmsg_data* is the first byte of the socket address structure.

If the socket address structure contains an IP6 address (e.g. the *sin6_family* argument is AF_INET6), then the node identified by that address must be a neighbor of the sending host. If that address equals the destination IP6 address of the datagram, then this is equivalent to the existing SO_DONTROUTE socket option.

For applications that don't, or can't use the *sendmsg()* or the *recvmsg()* function, the IPV6_PKTOPTIONS socket option is defined. Setting the socket option specifies any of the optional output fields:

```
setsockopt( fd, IPPROTO_IPV6, IPV6_PKTOPTIONS,
            &buf, len );
```

The *buf* argument points to a buffer containing one or more ancillary data objects; the *len* argument is the total length of all these objects. The application fills in this buffer exactly as if the buffer were being passed to the *sendmsg()* function as control information.

The options set by calling *setsockopt()* for IPV6_PKTOPTIONS are called "sticky" options because once set, they apply to all packets sent on that socket. The application can call *setsockopt()* again to change

all the sticky options, or it can call *setsockopt()* with a length of 0 to remove all the sticky options for the socket.

The corresponding receive option:

```
getsockopt( fd, IPPROTO_IPV6, IPV6_PKTOPTIONS,
            &buf, &len );
```

returns a buffer with one or more ancillary data objects for all the optional receive information that the application has previously specified that it wants to receive. The *buf* argument points to the buffer that the call fills in. The *len* argument is a pointer to a value-result integer; when the function is called, the integer specifies the size of the buffer pointed to by *buf*, and on return this integer contains the actual number of bytes that were stored in the buffer. The application processes this buffer exactly as if it were returned by *recvmsg()* as control information.

Advanced API and TCP sockets

When using *getsockopt()* with the IPV6_PKTOPTIONS option and a TCP socket, only the options from the most recently received segment are retained and returned to the caller, and only after the socket option has been set. The application isn't allowed to specify ancillary data in a call to *sendmsg()* on a TCP socket, and none of the ancillary data described above is ever returned as control information by *recvmsg()* on a TCP socket.

Conflict resolution

In some cases, there are multiple APIs defined for manipulating an IP6 header field. A good example is the outgoing interface for multicast datagrams: it can be manipulated by IPV6_MULTICAST_IF in the basic API, by IPV6_PKTINFO in the advanced API, and by the *sin6_scope_id* field of the socket address structure passed to the *sendto()* function.

In QNX Neutrino, when conflicting options are given to the socket manager, the socket manager gets the value in the following order:

1. options specified by using ancillary data

2 options specified by a sticky option of the advanced API

3 options specified by using the basic API

4 options specified by a socket address.

☞ The conflict resolution is undefined in the API specification and depends on the implementation.

Raw IP6 Sockets

Raw IP6 sockets are connectionless, and are normally used with *sendto()* and *recvfrom()*, although you can also use *connect()* to fix the destination for future packets (in which case you can use *read()* or *recv()*, and *write()* or *send()*).

If *proto* is 0, the default protocol IPPROTO_RAW is used for outgoing packets, and only incoming packets destined for that protocol are received. If *proto* is nonzero, that protocol number is used on outgoing packets and to filter incoming packets.

Outgoing packets automatically have an IP6 header prepended to them (based on the destination address and the protocol number the socket is created with). Incoming packets are received without the IP6 header or extension headers.

All data sent via raw sockets *must* be in network byte order; all data received via raw sockets is in network-byte order. This differs from the IPv4 raw sockets, which didn't specify a byte ordering and typically used the host's byte order.

Another difference from IPv4 raw sockets is that complete packets (i.e. IP6 packets with extension headers) can't be read or written using the IP6 raw sockets API. Instead, ancillary data objects are used to transfer the extension headers, as described above.

All fields in the IP6 header that an application might want to change (i.e. everything other than the version number) can be modified using ancillary data and/or socket options by the application for output. All fields in a received IP6 header (other than the version number and

Next Header fields) and all extension headers are also made available to the application as ancillary data on input. Hence, there's no need for a socket option similar to the IPv4 IP_HDRINCL socket option.

When writing to a raw socket, the socket manager automatically fragments the packet if the size exceeds the path MTU, inserting the required fragmentation headers. On input, the socket manager reassembles received fragments, so the reader of a raw socket never sees any fragment headers.

Most IPv4 implementations give special treatment to a raw socket created with a third argument to *socket()* of IPPROTO_RAW, whose value is normally 255. We note that this value has no special meaning to an IP6 raw socket (and the IANA currently reserves the value of 255 when used as a next-header field).

For ICMP6 raw sockets, the socket manager calculates and inserts the mandatory ICMP6 checksum.

For other raw IP6 sockets (i.e. for raw IP6 sockets created with a third argument other than IPPROTO_ICMPV6), the application must:

1. Set the new IPV6_CHECKSUM socket option to have the socket manager compute and store a pseudo header checksum for output.
2. Verify the received pseudo header checksum on input, discarding the packet if the checksum is in error.

This option prevents applications from having to perform source-address selection on the packets they send. The checksum incorporates the IP6 pseudo-header, defined in Section 8.1 of *RFC 2460*. This new socket option also specifies an integer offset into the user data of where the checksum is located.

```
int offset = 2;
setsockopt( fd, IPPROTO_IPV6, IPV6_CHECKSUM,
            &offset, sizeof(offset));
```

By default, this socket option is disabled. Setting the offset to -1 also disables the option. Disabled means:

1. The socket manager won't calculate and store a checksum for outgoing packets.
2. The socket manager kernel won't verify a checksum for received packets.

☞

- Since the checksum is always calculated by the socket manager for an ICMP6 socket, applications can't generate ICMPv6 packets with incorrect checksums (presumably for testing purposes) using this API.
- The IPV6_NEXTHOP object/option isn't fully implemented.

See also:

getsockopt(), ICMP6 protocol, INET6 protocol, *recv()*, *send()*, *setsockopt()*

isalnum()

Test a character to see if it's alphanumeric

Synopsis:

```
#include <ctype.h>

int isalnum( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *isalnum()* function tests if the argument *c* is an alphanumeric character (**a** to **z**, **A** to **Z**, or **0** to **9**). An alphanumeric character is any character for which *isalpha()* or *isdigit()* is true.

Returns:

Nonzero if *c* is a letter or decimal digit; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

int main( void )
{
    if( isalnum( getchar() ) ) {
        printf( "That's alpha-numeric!\n" );
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is only valid for **`char`** arguments and EOF.

See also:

isalpha(), *iscntrl()*, *isdigit()*, *isgraph()*, *islower()*, *isprint()*, *ispunct()*, *isspace()*, *isupper()*, *isxdigit()*, *tolower()*, *toupper()*

isalpha()

Test a character to see if it's alphabetic

Synopsis:

```
#include <ctype.h>

int isalpha( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *isalpha()* function tests if the argument *c* is an alphabetic character (**a** to **z** and **A** to **Z**). An alphabetic character is any character for which *isupper()* or *islower()* is true.

Returns:

Nonzero if *c* is an alphabetic character; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

int main( void )
{
    if( isalpha( getchar() ) ) {
      printf( "That's alphabetic\n" );
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), iscntrl(), isdigit(), isgraph(), islower(), isprint(), ispunct(), isspace(), isupper(), isxdigit(), tolower(), toupper()

isascii()

Test a character to see if it's a 7-bit ASCII character

Synopsis:

```
#include <ctype.h>

int isascii( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *isascii()* function tests for an ASCII character (in the range 0 to 127).

Returns:

Nonzero if *c* is an ASCII character; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char the_chars[] = { 'A', 0x80, 'Z' };

#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( isascii( the_chars[i] ) ) {
            printf( "Char %c is an ASCII character\n",
                the_chars[i] );
        } else {
            printf( "Char %c is not an ASCII character\n",
                the_chars[i] );
        }
```

```
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
Char A is an ASCII character
Char   is not an ASCII character
Char Z is an ASCII character
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalpha(), isalnum(), iscntrl(), isdigit(), isgraph(), islower(), isprint(), ispunct(), isspace(), isupper(), isxdigit(), tolower(), toupper()

isatty()

Test to see if a file descriptor is associated with a terminal

Synopsis:

```
#include <unistd.h>

int isatty( int fildes );
```

Arguments:

fildes The file descriptor that you want to test.

Library:

libc

Description:

The *isatty()* function allows the calling process to determine if the file descriptor *fildes* is associated with a terminal.

Returns:

0 The *fildes* file descriptor doesn't refer to a terminal.

1 The *fildes* file descriptor refers to a terminal.

Examples:

```
/*
 * The following program exits with a status of
 * EXIT_SUCCESS if stderr is a tty; otherwise,
 * EXIT_FAILURE
 */
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main( void )
  {
    return( isatty( 3 ) ? EXIT_SUCCESS : EXIT_FAILURE );
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

open()

iscntrl()

Test a character to see if it's a control character

Synopsis:

```
#include <ctype.h>

int iscntrl( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *iscntrl()* function tests for any control character. An ASCII control character is any character whose value is between 0 and 31.

Returns:

Nonzero if *c* is a control character; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char the_chars[] = { 'A', 0x09, 'Z' };

#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( iscntrl( the_chars[i] ) ) {
            printf( "Char %c is a Control character\n",
                the_chars[i] );
        } else {
            printf( "Char %c is not a Control character\n",
                the_chars[i] );
        }
```

```
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
Char A is not a Control character
Char     is a Control character
Char Z is not a Control character
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), *isalpha()*, *isdigit()*, *isgraph()*, *islower()*, *isprint()*, *ispunct()*, *isspace()*, *isupper()*, *isxdigit()*, *tolower()*, *toupper()*

isdigit()

Test a character to see if it's a decimal digit

Synopsis:

```
#include <ctype.h>

int isdigit( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *isdigit()* function tests for a decimal digit (characters `0` through `9`).

Returns:

Nonzero if *c* is a decimal digit; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char the_chars[] = { 'A', '5', '$' };

#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( isdigit( the_chars[i] ) ) {
            printf( "Char %c is a digit character\n",
                the_chars[i] );
        } else {
            printf( "Char %c is not a digit character\n",
                the_chars[i] );
        }
```

```
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
Char A is not a digit character
Char 5 is a digit character
Char $ is not a digit character
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), *isalpha()*, *iscntrl()*, *isgraph()*, *islower()*, *isprint()*, *ispunct()*, *isspace()*, *isupper()*, *isxdigit()*, *tolower()*, *toupper()*

isfdtype()

Determine whether a file descriptor refers to a socket

Synopsis:

```
#include <sys/stat.h>

int isfdtype( int filedes,
              int fdtype );
```

Arguments:

fildes The file descriptor that you want to test.

fdtype The properties you want to test for. The valid values for *fdtype* include:

- S_IFSOCK — test whether *filedes* is a socket.

Library:

libc

Description:

The *isfdtype()* function determines whether the file descriptor *filedes* has the properties identified by *fdtype*.

Returns:

1 The *filedes* file descriptor matches *fdtype*.

0 The *filedes* file descriptor doesn't match *fdtype*.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid file descriptor *filedes*.

Classification:

POSIX 1003.1g (draft)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

isatty(), socket(), stat()

isgraph()

Test a character to see if it's any printable character except a space

Synopsis:

```
#include <ctype.h>

int isgraph( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *isgraph()* function tests for any printable character except a space (`' '`). The *isprint()* function is similar, except that the space character is also included.

Returns:

Nonzero if *c* is a printable character (except a space); otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char the_chars[] = { 'A', 0x09, ' ', 0x7d };

#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( isgraph( the_chars[i] ) ) {
            printf( "Char %c is a printable character\n",
                the_chars[i] );
        } else {
            printf( "Char %c is not a printable character\n",
```

```
                the_chars[i] );
        }
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
Char A is a printable character
Char     is not a printable character
Char   is not a printable character
Char } is a printable character
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), *isalpha()*, *iscntrl()*, *isdigit()*, *islower()*, *isprint()*, *ispunct()*, *isspace()*, *isupper()*, *isxdigit()*, *tolower()*, *toupper()*

isinf(), *isinff()*

Test for infinity

Synopsis:

```
#include <math.h>

int isinf ( double x );

int isinff ( float x );
```

Arguments:

x The number that you want to test.

Library:

libm

Description:

The *isinf()* and *isinff()* functions test to see if a number is “infinity.”

Returns:

1 The value of *x* is infinity.

≠ 1 The value of *x* isn’t infinity.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv)
{
    double a, b, c, d;

    a = 2;
    b = -0.5;
    c = NAN;
    fp_exception_mask(_FP_EXC_DIVZERO, 1);
    d = 1.0/0.0;
    printf("%f is %s \n", a,
```

```
            (isinf(a)) ? "infinite" : "not infinite");
    printf("%f is %s \n", b,
            (isinf(b)) ? "infinite" : "not infinite");
    printf("%f is %s \n", c,
            (isinf(c)) ? "infinite" : "not infinite");
    printf("%f is %s \n", d,
            (isinf(d)) ? "infinite" : "not infinite");

    return(0);
}
```

produces the output:

```
2.000000 is not infinite
-0.500000 is not infinite
NAN is not infinite
Inf is infinite
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

sin(), sinh()

islower()

Test a character to see if it's a lowercase letter

Synopsis:

```
#include <ctype.h>

int islower( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *islower()* function tests for any lowercase letter **a** through **z**.

Returns:

Nonzero if *c* is a lowercase letter; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char the_chars[] = { 'A', 'a', 'z', 'Z' };

#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( islower( the_chars[i] ) ) {
            printf( "Char %c is a lowercase character\n",
                the_chars[i] );
        } else {
            printf( "Char %c is not a lowercase character\n",
                the_chars[i] );
        }
    }
```

```
    return EXIT_SUCCESS;
}
```

produces the output:

```
Char A is not a lowercase character
Char a is a lowercase character
Char z is a lowercase character
Char Z is not a lowercase character
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), *isalpha()*, *iscntrl()*, *isdigit()*, *isgraph()*, *isprint()*, *ispunct()*, *isspace()*, *isupper()*, *isxdigit()*, *tolower()*, *toupper()*

isnan(), *isnanf()*

Test for not-a-number (NAN)

Synopsis:

```
#include <math.h>

int isnan ( double x );

int isnanf ( float x );
```

Arguments:

x The number you want to test.

Library:

libm

Description:

The *isnan()* and *isnanf()* functions determine if *x* is Not-A-Number (NAN).

Returns:

1 The value of *x* is NAN.

≠ 1 The value of *x* is a number.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv)
{
  double a, b, c, d;

  a = 2;
  b = -0.5;
  c = NAN;
```

```
  fp_exception_mask(_FP_EXC_DIVZERO, 1);
  d = 1.0/0.0;
  printf("%f is %s \n", a,
         (isnan(a)) ? "not a number" : "a number");
  printf("%f is %s \n", b,
         (isnan(b)) ? "not a number" : "a number");
  printf("%f is %s \n", c,
         (isnan(c)) ? "not a number" : "a number");
  printf("%f is %s \n", d,
         (isnan(d)) ? "not a number" : "a number");
  return EXIT_SUCCESS;
}
```

produces the output:

```
2.000000 is a number
-0.500000 is a number
NAN is not a number
Inf is a number
```

Classification:

isnan() is standard Unix; *isnanf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

finite()

isprint()

Test a character to see if it's any printable character, including a space

Synopsis:

```
#include <ctype.h>

int isprint( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *isprint()* function tests for any printable character, including a space (`' '`). The *isgraph()* function is similar, except that the space character is excluded from the character set being tested.

Returns:

Nonzero if *c* is a printable character; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char the_chars[] = { 'A', 0x09, ' ', 0x7d };

#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( isprint( the_chars[i] ) ) {
            printf( "Char %c is a printable character\n",
                the_chars[i] );
        } else {
            printf( "Char %c is not a printable character\n",
```

```
                the_chars[i] );
        }
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
Char A is a printable character
Char     is not a printable character
Char   is a printable character
Char } is a printable character
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), *isalpha()*, *iscntrl()*, *isdigit()*, *isgraph()*, *islower()*, *ispunct()*, *isspace()*, *isupper()*, *isxdigit()*, *tolower()*, *toupper()*

ispunct()

Test a character to see if it's any punctuation character

Synopsis:

```
#include <ctype.h>

int ispunct( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *ispunct()* function tests for any punctuation character such as a comma (**,**) or a period (**.**).

Returns:

Nonzero if *c* is punctuation; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char the_chars[] = { 'A', '!', '.', ',', ':', ';' };

#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( ispunct( the_chars[i] ) ) {
            printf( "Char %c is a punctuation character\n",
                the_chars[i] );
        } else {
            printf( "Char %c is not a punctuation character\n",
                the_chars[i] );
        }
```

```
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
Char A is not a punctuation character
Char ! is a punctuation character
Char . is a punctuation character
Char , is a punctuation character
Char : is a punctuation character
Char ; is a punctuation character
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), *isalpha()*, *iscntrl()*, *isdigit()*, *isgraph()*, *islower()*, *isprint()*, *isspace()*, *isupper()*, *isxdigit()*, *tolower()*, *toupper()*

isspace()

Test a character to see if it's a whitespace character

Synopsis:

```
#include <ctype.h>

int isspace( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *isspace()* function tests for the following whitespace characters:

' '	space
'\f'	form feed
'\n'	newline or linefeed
'\r'	carriage return
'\t'	horizontal tab
'\v'	vertical tab

Returns:

Nonzero if *c* is a whitespace character; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char the_chars[] = { 'A', 0x09, ' ', 0x7d };
```

```
#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( isspace( the_chars[i] ) ) {
            printf( "Char %c is a space character\n",
                the_chars[i] );
        } else {
            printf( "Char %c is not a space character\n",
                the_chars[i] );
        }
    }

    return EXIT_SUCCESS;
}
```

This program produces the output:

```
Char A is not a space character
Char     is a space character
Char   is a space character
Char } is not a space character
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), isalpha(), iscntrl(), isdigit(), isgraph(), islower(), isprint(), ispunct(), isupper(), isxdigit(), tolower(), toupper()

isupper()

Test a character to see if it's an uppercase letter

Synopsis:

```
#include <ctype.h>

int isupper( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *isupper()* function tests for any uppercase letter **A** through **Z**.

Returns:

Nonzero if *c* is an uppercase letter; otherwise, zero.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <ctype.h>

char the_chars[] = { 'A', 'a', 'z', 'Z' };

#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( isupper( the_chars[i] ) ) {
            printf( "Char %c is an uppercase character\n",
                the_chars[i] );
        } else {
            printf( "Char %c is not an uppercase character\n",
                the_chars[i] );
        }
    }
```

```
    return EXIT_SUCCESS;
}
```

produces the output:

```
Char A is an uppercase character
Char a is not an uppercase character
Char z is not an uppercase character
Char Z is an uppercase character
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), isalpha(), iscntrl(), isdigit(), isgraph(), islower(), isprint(), ispunct(), isspace(), isxdigit(), tolower(), toupper()

iswalnum()

Test a wide character to see if it's alphanumeric

Synopsis:

```
#include <wctype.h>

int iswalnum( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswalnum()* function tests if the argument *wc* is an alphanumeric wide character of the class **alpha** or **digit**. In the C locale, they're **a** to **z**, **A** to **Z**, **0** to **9**.

Returns:

A nonzero value if the character is a member of the class **alpha** or **digit**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

iswalpha()

Test a wide character to see if it's alphabetic

Synopsis:

```
#include <wctype.h>

int iswalpha( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswalpha()* function tests if the argument *wc* is an alphabetic wide character of the class **alpha**. In the C locale, they are: **a** to **z**, **A** to **Z**.

Returns:

A nonzero value if the character is a member of the class **alpha**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

iswcntrl()

Test a wide character to see if it's a control character

Synopsis:

```
#include <wctype.h>

int iswcntrl( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswcntrl()* function tests if the argument *wc* is a control wide character of the class **cntrl**. In the C locale, this class consists of the ASCII characters from 0 through 31.

Returns:

A nonzero value if the character is a member of the class **cntrl**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **`wchar_t`** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

iswctype()

Test a wide character to see if it's a given character class

Synopsis:

```
#include <wctype.h>

int iswctype( wint_t wc,
              wctype_t charclass );
```

Arguments:

wc	The wide character you want to test.
charclass	The character class you want to test for. Get this class by calling *wctype()*.

Library:

libc

Description:

The *iswctype()* function tests if the argument *wc* is a member of one or several character classes.

This function:	Is equivalent to:
`iswalnum( wc )`	`iswctype( wc , wctype( "alnum" ) )`
`iswalpha( wc )`	`iswctype( wc , wctype( "alpha" ) )`
`ispunct( wc )`	`iswctype( wc , wctype( "punct" ) )`

☞ The results are unreliable if you didn't use *wctype()* to obtain *charclass*, or if a call to *setlocale()* affects LC_CTYPE.

Returns:

A nonzero value if the character is a member of the specified character class (or classes), or zero if the character isn't a member or *charclass* is 0.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **`wchar_t`** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

iswdigit()

Test a wide character to see if it's a decimal digit

Synopsis:

```
#include <wctype.h>

int iswdigit( wint_t wc );
```

Arguments:

wc The wide character that you want to test.

Library:

libc

Description:

The *iswdigit()* function tests if the argument *wc* is a decimal digit wide character of the class **digit**. In the C locale, this class consists of the characters **0** through **9**.

Returns:

A nonzero value if the character is a member of the class **digit**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

Test a wide character to see if it's any printable character except space

Synopsis:

```
#include <wctype.h>

int iswgraph( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswgraph()* function tests if the argument *wc* is a graphical wide character of the class **graph**. In the C locale, this class consists of all the printable characters, except the space character.

Returns:

A nonzero value if the character is a member of the class **graph**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

iswlower()

Test a wide character to see if it's a lowercase letter

Synopsis:

```
#include <wctype.h>

int iswlower( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswlower()* function tests if the argument *wc* is a lowercase wide character of the class **lower**. In the C locale, this class consists of the characters from **a** through **z**.

Returns:

A nonzero value if the character is a member of the class **lower**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

Test a wide character to see if it's any printable character, including space

Synopsis:

```
#include <wctype.h>

int iswprint( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswprint()* function tests if the argument *wc* is a printable wide character of the class **print**. In the C locale, this class consists of all the printable characters, including the space character.

Returns:

A nonzero value if the character is a member of the class **print**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

iswpunct()

Test a wide character to see if it's any punctuation character

Synopsis:

```
#include <wctype.h>

int iswpunct( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswpunct()* function tests if the argument *wc* is a punctuation wide character of the class **punct**. In the C locale, this class includes the comma (**,**) and the period (**.**), among others.

Returns:

A nonzero value if the character is a member of the class **punct**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

iswspace()

Test a wide character to see if it's a whitespace character

Synopsis:

```
#include <wctype.h>

int iswspace( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswspace()* function tests if the argument *wc* is a whitespace wide character of the class **space**. In the C locale, this class includes the space character, **\f** (form feed), **\n** (newline or linefeed), **\r** (carriage return), **\t** (horizontal tab), and **\v** (vertical tab).

Returns:

A nonzero value if the character is a member of the class **space**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

iswupper()

Test a character to see if it's an uppercase letter

Synopsis:

```
#include <wctype.h>

int iswupper( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswupper()* function tests if the argument *wc* is an uppercase wide character of the class **upper**. In the C locale, this class includes the characters from **A** through **Z**.

Returns:

A nonzero value if the character is a member of the class **upper**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

iswxdigit()

Test a wide character to see if it's a hexadecimal digit

Synopsis:

```
#include <wctype.h>

int iswxdigit( wint_t wc );
```

Arguments:

wc The wide character you want to test.

Library:

libc

Description:

The *iswxdigit()* function tests if the argument *wc* is a hexadecimal wide character of the class **xdigit**. In the C locale, this class includes the characters **0** to **9**, and **A** to **F**.

Returns:

A nonzero value if the character is a member of the class **xdigit**, or 0 otherwise.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The result is valid only for **wchar_t** arguments and WEOF.

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

isxdigit()

Test a character to see if it's a hexadecimal digit

Synopsis:

```
#include <ctype.h>

int isxdigit( int c );
```

Arguments:

c The character you want to test.

Library:

libc

Description:

The *isxdigit()* function tests for any hexadecimal-digit character. These characters are the digits 0 through 9 and the letters **a** through **f** (or **A** through **F**).

Returns:

Nonzero if *c* is a hexadecimal digit; otherwise, zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char the_chars[] = { 'A', '5', '$' };

#define SIZE sizeof( the_chars ) / sizeof( char )

int main( void )
{
    int i;

    for( i = 0; i < SIZE; i++ ) {
        if( isxdigit( the_chars[i] ) ) {
            printf( "Char %c is a hexadecimal digit",
                the_chars[i] );
        } else {
            printf( "Char %c is not a hexadecimal digit",
```

```
                the_chars[i] );
        }
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
Char A is a hexadecimal digit character
Char 5 is a hexadecimal digit character
Char $ is not a hexadecimal digit character
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), isalpha(), iscntrl(), isdigit(), isgraph(), islower(), isprint(), ispunct(), isspace(), isupper(), tolower(), toupper()

itoa()

Convert an integer into a string, using a given base

Synopsis:

```
#include <stdlib.h>

char* itoa( int value,
            char* buffer,
            int radix );
```

Arguments:

value The value to convert into a string.

buffer A buffer in which the function stores the string. The size of the buffer must be at least:

```
8 × sizeof( int ) + 1
```

bytes when converting values in base 2 (binary).

radix The base to use when converting the number.

If the value of *radix* is 10, and *value* is negative, then a minus sign is prepended to the result.

Library:

libc

Description:

The *itoa()* function converts the integer *value* into the equivalent string in base *radix* notation, storing the result in the specified *buffer*. The function terminates the string with a NUL character.

Returns:

A pointer to the resulting string.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char buffer[20];
    int base;

    for( base = 2; base <= 16; base += 2 ) {
        printf( "%2d %s\n", base,
            itoa( 12765, buffer, base ) );
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
 2 11000111011101
 4 3013131
 6 135033
 8 30735
10 12765
12 7479
14 491b
16 31dd
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atoi(), atol(), ltoa(), sscanf(), strtol(), strtoul(), ultoa(), utoa()

j0(), j0f()

Compute a Bessel function of the first kind

Synopsis:

```
#include <math.h>

double j0( double x );

float j0f( float x );
```

Arguments:

x The number that you want to compute the Bessel function for.

Library:

libbessel

Description:

Compute the Bessel function of the first kind for *x*.

Returns:

The result of the Bessel function of *x*.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <math.h>

int main( void )
{
    double x, y, z;

    x = j0( 2.4 );
    y = y1( 1.58 );
    z = jn( 3, 2.4 );
```

```
    printf( "j0(2.4) = %f, y1(1.58) = %f\n", x, y );
    printf( "jn(3,2.4) = %f\n", z );

    return EXIT_SUCCESS;
}
```

Classification:

j0() is standard Unix; *j0f()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, j1(), jn(), y0(), y1(), yn()

j1(), j1f()

Compute a Bessel function of the first kind

Synopsis:

```
#include <math.h>

double j1( double x );

float j1f( float x );
```

Arguments:

x The number that you want to compute the Bessel function for.

Library:

libbessel

Description:

Compute the Bessel function of the first kind for *x*.

Returns:

The result of the Bessel function of *x*.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Classification:

j1() is standard Unix; *j1f()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

errno, j0(), jn(), y0(), y1(), yn()

jn(), *jnf()*

Compute a Bessel function of the first kind

Synopsis:

```
#include <math.h>

double jn( int n, double x );

float jnf( int n, float x );
```

Arguments:

n, *x*	The numbers that you want to compute the Bessel function for.

Library:

libbessel

Description:

Compute the Bessel function of the first kind for *n* and *x*.

Returns:

The result of the Bessel function of *n* and *x*.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <math.h>

int main( void )
{
    double x, y, z;

    x = j0( 2.4 );
```

```
    y = y1( 1.58 );
    z = jn( 3, 2.4 );

    printf( "j0(2.4) = %f, y1(1.58) = %f\n", x, y );
    printf( "jn(3,2.4) = %f\n", z );

    return EXIT_SUCCESS;
}
```

Classification:

jn() is standard Unix; *jnf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, j0(), j1(), y0(), y1(), yn()

jrand48()

Generate a pseudo-random signed **long** *integer in a thread-safe manner*

Synopsis:

```
#include <stdlib.h>

long jrand48( unsigned short xsubi[3] );
```

Arguments:

xsubi An array that comprises the 48 bits of the initial value that you want to use.

Library:

libc

Description:

The *jrand48()* function uses a linear congruential algorithm and 48-bit integer arithmetic to generate a signed **long** integer uniformly distributed over the interval $[-2^{31}, 2^{31})$. It's a thread-safe version of *mrand48()*.

The *xsubi* array should contain the desired initial value; this makes *jrand48()* thread-safe, and lets you start a sequence of random numbers at any known value.

Returns:

A pseudo-random **long** integer.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

drand48(), *erand48()*, *lcong48()*, *lrand48()*, *mrand48()*, *nrand48()*, *seed48()*, *srand48()*

kill()

Send a signal to a process or a group of processes

Synopsis:

```
#include <sys/types.h>
#include <signal.h>

int kill( pid_t pid,
          int sig );
```

Arguments:

pid The ID of the process or process group that you want to send a signal to:

If *pid* is:	Then *sig* is sent to:
> 0	The single process with that process ID
0	All processes that are in the same process group as the sending process
< 0	Every process that's a member of the process group *-pid*

sig Zero, or the signal that you want to send. For a complete list of signals, see "POSIX signals" in the documentation for *SignalAction()*.

Library:

libc

Description:

The *kill()* function sends the signal *sig* to a process or group of processes specified by *pid*. If *sig* is zero, no signal is sent, but the *pid* is still checked for validity.

For a process to have permission to send a signal to a process, the real or effective user ID of the sending process must either:

- match the real or effective user ID of the receiving process

  Or:

- equal zero.

If the value of *pid* causes *sig* to be generated for the sending process, and if *sig* isn't blocked, either *sig* or at least one pending unblocked signal is delivered before the *kill* function returns.

This call doesn't block. However, in the network case, lower priority threads may run.

Returns:

Zero, or -1 if an error occurs (*errno* is set).

Errors:

EAGAIN	Insufficient system resources are available to deliver the signal.
EINVAL	The *sig* is invalid.
EPERM	The process doesn't have permission to send this signal to any receiving process.
ESRCH	The given *pid* doesn't exist.

Examples:

See *sigprocmask()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

getpid(), killpg(), setsid(), sigaction(), signal(), SignalKill(), sigqueue()

killpg()

Send a signal to a process group

Synopsis:

```
#include <sys/types.h>
#include <signal.h>

int killpg( pid_t pgrp,
            int sig );
```

Arguments:

pid The ID of the process group that you want to send a signal to.

sig Zero, or the signal that you want to send. For a complete list of signals, see "POSIX signals" in the documentation for *SignalAction()*.

Library:

libc

Description:

The *killpg()* function sends the signal *sig* to the process group specified by *pgrp*. If *sig* is zero, no signal is sent, but *pgrp* is still checked for validity.

If *pgrp* is greater than 1, *killpg (pgrp, sig)* is equivalent to *kill (–pgrp, sig)*.

Returns:

Zero, or -1 if an error occurs (*errno* is set).

Errors:

EAGAIN Insufficient system resources are available to deliver the signal.

EINVAL The signal *sig* is invalid or not supported.

EPERM	The process doesn't have permission to send this signal to any receiving process.
ESRCH	No process group can be found corresponding to the specified *pgrp* or *pgrp* is less than or equal to 1.

Examples:

See *sigprocmask()*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

getpid(), kill(), setsid(), sigaction(), signal(), SignalKill(), sigqueue()

labs()

Calculate the absolute value of a long integer

Synopsis:

```
#include <stdlib.h>

long labs( long j );
```

Arguments:

j The number you want the absolute value of.

Library:

libc

Description:

The *labs()* function returns the absolute value of its long-integer argument *j*.

Returns:

The absolute value of *j*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    long x, y;

    x = -50000;
    y = labs( x );
    printf( "labs( %d ) = %d\n", x, y );
    return EXIT_SUCCESS;
}
```

produces the output:

```
labs( -50000 ) = 50000
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

abs(), cabs(), fabs()

lchown()

Change the user ID and group ID of a file or symbolic link

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

int lchown( const char * path,
            uid_t owner,
            gid_t group );
```

Arguments:

path	The name of the file whose ownership you want to change.
owner	The user ID of the new owner.
group	The group ID of the new owner.

Library:

libc

Description:

The *lchown()* function changes the user ID and group ID of the file specified by *path* to be the numeric values contained in *owner* and *group*, respectively. It's similar to *chown()*, except in the case where the named file is a symbolic link. In this case, *lchown()* changes the ownership of the symbolic link file itself, while *chown()* changes the ownership of the file or directory to which the symbolic link refers.

Only processes with an effective user ID equal to the user ID of the file or with appropriate privileges (for example, the superuser) may change the ownership of a file.

In QNX Neutrino, the _POSIX_CHOWN_RESTRICTED flag is enforced. This means that only the superuser may change the ownership of a file. The group of a file may be changed by the superuser, or also by a process with the effective user ID equal to the user ID of the file, if (and only if) *owner* is equal to the user ID of the file and *group* is equal to the effective group ID of the calling process.

If the *path* argument refers to a regular file, the set-user-ID (S_ISUID) and set-group-ID (S_ISGID) bits of the file mode are cleared, if the function is successful.

If *lchown()* succeeds, the *st_ctime* field of the file is marked for update.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES Search permission is denied on a component of the path prefix.

ELOOP Too many levels of symbolic links or prefixes.

ENAMETOOLONG
The length of the *path* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT A component of the path prefix doesn't exist, or the *path* arguments points to an empty string.

ENOSYS The *lchown()* function isn't implemented for the filesystem specified in *path*.

ENOTDIR A component of the path prefix isn't a directory.

EPERM The effective user ID does not match the owner of the file, or the calling process does not have appropriate privileges.

EROFS The named file resides on a read-only filesystem.

Examples:

```
/*
 * Change the ownership of a list of files
 * to the current user/group
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <unistd.h>

int main( int argc, char **argv )
  {
    int i;
    int ecode = 0;

    for( i = 1; i < argc; i++ ) {
      if( lchown( argv[i], getuid(), getgid() ) == -1 ) {
        perror( argv[i] );
        ecode++;
      }
    }
    return( ecode );
  }
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chmod(), chown(), errno, fchown(), fstat(), open(), stat()

lcong48()

Initialize a sequence of pseudo-random numbers

Synopsis:

```
#include <stdlib.h>

void lcong48( unsigned short int param[7] );
```

Arguments:

param An array of 7 short integers that are used to initialize the sequence;

- The first three entries are used to initialize the seed.
- The next three are used to initialize the multiplicand.
- The last entry is used to initialize the addend. You can't use values greater than **0xFFFF** as the addend.

Library:

libc

Description:

The *lcong48()* function gives you full control over the multiplicand and addend used in *drand48()*, *erand48()*, *lrand48()*, *nrand48()*, *mrand48()*, and *jrand48()*, and the seed used in *drand48()*, *lrand48()*, and *mrand48()*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

drand48(), *erand48()*, *jrand48()*, *lrand48()*, *mrand48()*, *nrand48()*, *seed48()*, *srand48()*

ldexp(), ldexpf()

Multiply a floating-point number by an integral power of 2

Synopsis:

```
#include <math.h>

double ldexp( double x,
              int exp );

float ldexp( float x,
             int exp );
```

Arguments:

x	A floating-point number.
exp	The exponent of 2 to multiply *x* by.

Library:

libm

Description:

These functions multiply the floating-point number *x* by 2^{exp}.

A range error may occur.

Returns:

$x \times 2^{exp}$

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
```

```
int main( void )
{
    double value;

    value = ldexp( 4.7072345, 5 );
    printf( "%f\n", value );

    return EXIT_SUCCESS;
}
```

produces the output:

```
150.631504
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

frexp(), modf()

ldiv()

Perform division on long integers

Synopsis:

```
#include <stdlib.h>

ldiv_t ldiv( long int numer,
             long int denom );
```

Arguments:

numer The numerator.

denom The denominator.

Library:

libc

Description:

The *ldiv()* function calculates the quotient and remainder of:

numer ÷ *denom*

Returns:

A structure of type **ldiv_t** that contains the following members:

```
typedef struct {
    long int quot;     /* quotient  */
    long int rem;      /* remainder */
} ldiv_t;
```

Examples:

```
#include <stdio.h>
#include <stdlib.h>

void print_time( long ticks )
{
    ldiv_t sec_ticks;
    ldiv_t min_sec;
```

```
    sec_ticks = ldiv( ticks, 100 );
    min_sec = ldiv( sec_ticks.quot, 60 );

    printf( "It took %d minutes and %d seconds.\n",
         min_sec.quot, min_sec.rem );
}

int main( void )
{
    print_time( 86712 );

    return EXIT_SUCCESS;
}
```

produces the output:

```
It took 14 minutes and 27 seconds.
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

div()

lfind()

Find an entry in a linear search table

Synopsis:

```
#include <search.h>

void * lfind( const void * key,
              const void * base,
              unsigned * num,
              unsigned width,
              int ( * compare)(
                  const void * element1,
                  const void * element2 ) );
```

Arguments:

key	The object to search for.
base	A pointer to the first element in the table.
num	A pointer to an integer containing the current number of elements in the table.
width	The size of an element, in bytes.
compare	A pointer to a user-supplied function that *lfind()* calls to compare an array element with the *key*. The arguments to the comparison function are: • *element1* — the same pointer as *key* • *element2* — a pointer to one of the array elements. The comparison function must return 0 if *element1* equals *element2*, or a nonzero value if the elements aren't equal.

Library:

libc

Description:

The *lfind()* function returns a pointer into a table indicating where an entry may be found.

The *lfind()* function is the same as *lsearch()*, except that if the entry isn't found, it isn't added to the table, and a NULL pointer is returned.

Returns:

A pointer to the matching element, or NULL if there's no match or an error occurred.

Examples:

This example program lets you know if the first command-line argument is a C keyword (assuming you fill in the *keywords* array with a complete list of C keywords):

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <search.h>

static const char *keywords[] = {
    "auto",
    "break",
    "case",
    "char",
    /* . */
    /* . */
    /* . */
    "while"
};

int compare( const void *, const void * );

int main( int argc, const char *argv[] )
{
    unsigned num = 5;
    char *ptr;

    if( argc <= 1 ) return EXIT_FAILURE;

    ptr = lfind( &argv[1], keywords, &num, sizeof(char **), compare );
    if( ptr == NULL ) {
        printf( "'%s' is not a C keyword\n", argv[1] );

        return EXIT_FAILURE;
    } else {
```

```
        printf( "'%s' is a C keyword\n", argv[1] );

        return EXIT_SUCCESS;
    }

    /* You'll never get here. */
    return EXIT_SUCCESS;
}

int compare( const void *op1, const void *op2 )
{
    const char **p1 = (const char **) op1;
    const char **p2 = (const char **) op2;

    return( strcmp( *p1, *p2 ) );
}
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

bsearch(), lsearch()

Synopsis:

```
#include <math.h>

double lgamma( double x );

double lgamma_r( double x,
                 int* signgamp);

float lgammaf( float x );

float lgammaf_r( float x,
                 int* signgamp);
```

Arguments:

x	An arbitrary number.
signgam	(*lgamma_r()*, *lgammaf_r()* only) A pointer to a location where the function can store the sign of Γ(*x*).

Library:

libm

Description:

The *lgamma()* and *lgamma_r()* functions return the natural log (**ln**) of the Γ function and are equivalent to *gamma()*. These functions return **ln**|Γ(*x*)|, where Γ(*x*) is defined as follows:

For $x > 0$: $\int_0^\infty e^{-t} t^{x-1} dt$

For $x < 1$: n / (Γ(1-*x*) * *sin*(n*x*))

The results converge when *x* is between 0 and 1. The Γ function has the property:

$\Gamma(N) = \Gamma(N-1) \times N$

The *lgamma** functions compute the log because the Γ function grows very quickly.

The *lgamma()* and *lgammaf()* functions use the external integer *signgam* to return the sign of Γ(*x*), while *lgamma_r()* and *lgammaf_r()* use the user-allocated space addressed by *signgamp*.

The *signgam* variable isn't set until *lgamma()* or *lgammaf()* returns. For example, don't use the expression:

```
g = signgam * exp( lgamma( x ));
```

to compute $g = \Gamma(x)'$. Instead, compute *lgamma()* first:

```
lg = lgamma(x);
g = signgam * exp( lg );
```

Note that Γ(*x*) must overflow when *x* is large enough, underflow when -*x* is large enough, and generate a division by 0 exception at the singularities *x* a nonpositive integer.

Returns:

$\ln|\Gamma(x)|$

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>
```

```
int main(int argc, char** argv)
{
    double a, b;

    errno = EOK;
    a = 0.5;
    b = lgamma(a);
    printf("lgamma(%f) = %f %d \n", a, b, errno);

    return(0);
}
```

produces the output:

```
lgamma(0.500000) = 0.572365 0
```

Classification:

lgamma() is standard Unix; *lgamma_r()*, *lgammaf()*, and *lgammaf_r()* are ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

gamma()

link()

Create a link to an existing file

Synopsis:

```
#include <unistd.h>

int link( const char* existing,
          const char* new );
```

Arguments:

existing	The path of an existing file.
new	The path for the new link.

Library:

libc

Description:

The *link()* function creates a new directory entry named by *new* to refer to (that is, to be a link to) an existing file named by *existing*. The function atomically creates a new link for the existing file, and increments the link count of the file by one.

This implementation doesn't support using *link()* on directories or the linking of files across filesystems (different logical disks).

If the function fails, no link is created, and the link count of the file remains unchanged.

If *link()* succeeds, the *st_ctime* field of the file and the *st_ctime* and *st_mtime* fields of the directory that contains the new entry are marked for update.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EACCES — A component of either path prefix denies search permission, or the link named by *new* is in a directory with a mode that denies write permission.

EEXIST — The link named by *new* already exists.

ELOOP — Too many levels of symbolic links or prefixes.

EMLINK — The number of links to the file named by *existing* would exceed LINK_MAX.

ENAMETOOLONG — The length of the *existing* or *new* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT — This error code can mean the following:

- A component of either path prefix doesn't exist.
- The file named by *existing* doesn't exist.
- Either *existing* or *new* points to an empty string.

ENOSPC — The directory that would contain the link can't be extended.

ENOSYS — The *link()* function isn't implemented for the filesystem specified in *existing* or *new*.

ENOTDIR — A component of either path prefix isn't a directory.

EPERM — The file named by *existing* is a directory.

EROFS — The requested link requires writing in a directory on a read-only file system.

EXDEV — The link named by *new* and the file named by *existing* are on different logical disks.

Examples:

```
/*
 * The following program performs a rename
 * operation of argv[1] to argv[2].
 * Please note that this example,  unlike the
 * library function rename(), ONLY works if
 * argv[2] doesn't already exist.
 */
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>

int main( int argc, char** argv )
  {
    /* Create a link of argv[1] to argv[2].
     */
    if( link( argv[1], argv[2] ) == -1 ) {
      perror( "link" );
      return( EXIT_FAILURE );
    }
    if( unlink( argv[1] ) == -1 ) {
      perror( argv[1] );
      return( EXIT_FAILURE );
    }
    return( EXIT_SUCCESS );
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, rename(), symlink(), unlink()

lio_listio()

Initiate a list of I/O requests

Synopsis:

```
#include <aio.h>

int lio_listio( int mode,
                struct aiocb* const list[],
                int nent,
                struct sigevent* sig );
```

Arguments:

mode The mode of operation; one of:

- LIO_WAIT — *lio_listio()* behaves synchronously, waiting until all I/O is completed, and ignores the *sig* argument.
- LIO_NOWAIT — *lio_listio()* behaves asynchronously, returning immediately, and the signal specified by the *sig* argument is delivered to the calling process when all the I/O operations from this function complete.

list An array of pointers to **aiocb** structures that specify the I/O operations that you want to initiate. The array may contain NULL pointers, which the function ignores.

nent The number of entries in the *list* array. This must not exceed the system-wide limit, _POSIX_AIO_MAX.

sig NULL, or a pointer to a **sigevent** structure that specifies the signal that you want to deliver to the calling process when all of the I/O operations complete. The function ignores this argument if *mode* is LIO_WAIT.

Library:

libc

Description:

The *lio_listio()* function lets the calling process, lightweight process (LWP), or thread initiate a list of I/O requests within a single function call.

The *aio_lio_opcode* field of each **aiocb** structure in *list* specifies the operation to be performed (see **<aio.h>**):

- LIO_READ requests *aio_read()*.
- LIO_WRITE requests *aio_write()*.
- LIO_NOP causes the list entry to be ignored.

If *mode* is LIO_NOWAIT, *lio_listio()* uses the **sigevent** structure pointed to by *sig* to define both the signal to be generated and how the calling process is notified when the I/O operations are complete:

- If *sig* is NULL, or the *sigev_signo* member of the **sigevent** structure is zero, then no signal delivery occurs. Otherwise, the signal number indicated by *sigev_signo* is delivered when all the requests in the list have completed.
- If *sig->sigev_notify* is SIGEV_NONE, no signal is posted upon I/O completion, but the error status and the return status for the operation are set appropriately.
- If *sig->sigev_notify* is SIGEV_SIGNAL, the signal specified in *sig->sigev_signo* is sent to the process. If the SA_SIGINFO flag is set for that signal number, the signal is queued to the process, and the value specified in *sig->sigev_value* is the *si_value* component of the generated signal.

For regular files, no data transfer occurs past the offset maximum established in the open file description associated with *aiocbp->aio_fildes*.

The behavior of this function is altered according to the definitions of synchronized I/O data integrity completion and synchronized I/O file integrity completion if synchronized I/O is enabled on the file

associated with *aio_fildes*. (see the definitions of O_DSYNC and O_SYNC in the description of *fcntl()*.)

Returns:

If the *mode* argument is LIO_NOWAIT, and the I/O operations are successfully queued, *lio_listio()* returns 0; otherwise, it returns -1, and sets *errno*.

If the *mode* argument is LIO_WAIT, and all the indicated I/O has completed successfully, *lio_listio()* returns 0; otherwise, it returns -1, and sets *errno*.

In either case, the return value indicates only the success or failure of the *lio_listio()* call itself, not the status of the individual I/O requests. In some cases, one or more of the I/O requests contained in the list may fail. Failure of an individual request doesn't prevent completion of any other individual request. To determine the outcome of each I/O request, examine the error status associated with each **aiocb** control block. Each error status so returned is identical to that returned as a result of calling *aio_read()* or *aio_write()*.

Errors:

EAGAIN — The resources necessary to queue all the I/O requests weren't available. The error status for each request is recorded in the *aio_error* member of the corresponding **aiocb** structure, and can be retrieved using *aio_error()*.

The number of entries, *nent*, exceeds the system-wide limit, _POSIX_AIO_MAX.

EINVAL — The *mode* argument is invalid.

The value of *nent* is greater than _POSIX_AIO_LISTIO_MAX.

EINTR — A signal was delivered while waiting for all I/O requests to complete during an LIO_WAIT operation. However, the outstanding I/O requests aren't canceled. Use *aio_fsync()* to determine if any request was initiated;

aio_return() to determine if any request has completed; or *aio_error()* to determine if any request was canceled.

EIO — One or more of the individual I/O operations failed. Use *aio_error()* with each **aiocb** structure to determine which request(s) failed.

ENOSYS — The *lio_listio()* function isn't supported by this implementation.

If either *lio_listio()* succeeds in queuing all of its requests, or *errno* is set to EAGAIN, EINTR, or EIO, then some of the I/O specified from the list may have been initiated. In this event, each **aiocb** structure contains errors specific to the *read()* or *write()* function being performed:

EAGAIN — The requested I/O operation wasn't queued due to resource limitations.

ECANCELED — The requested I/O was canceled before the I/O completed due to an explicit *aio_cancel()* request.

EINPROGRESS — The requested I/O is in progress.

The following additional error codes may be set for each **aiocb** control block:

EOVERFLOW — The *aiocbp->aio_lio_opcode* is LIO_READ, the file is a regular file, *aiocbp->aio_nbytes* is greater than 0, and the *aiocbp->aio_offset* is before the end-of-file and is greater than or equal to the offset maximum in the open file description associated with *aiocbp->aio_fildes*.

EFBIG — The *aiocbp->aio_lio_opcode* is LIO_WRITE, the file is a regular file, *aiocbp->aio_nbytes* is greater than 0, and the *aiocbp->aio_offset* is greater than or equal to the offset maximum in the open file description associated with *aiocbp->aio_fildes*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

aio_cancel(), *aio_error()*, *aio_fsync()*, *aio_read()*, *aio_return()*, *aio_write()*, *close()*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *exit()*, *fcntl()*, *fork()*, *lseek()*, *read()*, **`sigevent`**, *write()*

listen()

Listen for connections on a socket

Synopsis:

```
#include <sys/socket.h>

int listen( int s,
            int backlog );
```

Arguments:

s	The descriptor for the socket that you want to listen on. You can create a socket by calling *socket()*.
backlog	The maximum length that the queue of pending connections may grow to.

Library:

libsocket

Description:

The *listen()* function listens for connections on a socket and puts the socket into the LISTEN state. For connections to be accepted, you must:

1. Create a socket by calling *socket()*.
2. Indicate a willingness to accept incoming connections and a queue limit for them by calling *listen()*.
3. Call *accept()* to accept the connections.

If a connection request arrives with the queue full, the client may receive an error with an indication of ECONNREFUSED. But if the underlying protocol supports retransmission, the request may be ignored so that retries may succeed.

The *listen()* call applies only to SOCK_STREAM sockets.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid descriptor *s*.

EOPNOTSUPP

The socket isn't of a type that supports the *listen()* operation.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

accept(), *connect()*, *socket()*

localeconv()

Set numeric formatting according to the current locale

Synopsis:

```
#include <locale.h>

struct lconv * localeconv( void );
```

Library:

libc

Description:

The *localeconv()* function gets the values appropriate for formatting numeric quantities using the current locale. It returns a pointer to a **struct lconv** with the following members:

char * *decimal_point*

The decimal-point character used for nonmonetary quantities.

char * *thousands_sep*

The character used to separate groups of digits on the left of the decimal-point character formatted nonmonetary quantities.

char * *int_curr_symbol*

The international currency symbol for the current locale. The first three characters contain the alphabetic international currency symbol in accordance with those specified in *ISO 4217: Codes for the Representation of Currency and Funds*. The fourth character (immediately preceding the NUL character) is the character used to separate the international currency symbol from the monetary quantity.

char * *currency_symbol*

The local currency symbol applicable to the current locale.

char * *mon_decimal_point*

The decimal-point character used to format monetary quantities.

char * *mon_thousands_sep*

The character used to separate groups of digits on the left of the decimal-point character in formatted monetary quantities.

char * *mon_grouping*

A string whose elements indicate the size of each group of digits in formatted monetary quantities.

char * *grouping*

A string whose elements indicate the size of each group of digits in formatted nonmonetary quantities.

char * *positive_sign*

The string used to indicate a nonnegative monetary quantity.

char * *negative_sign*

The string used to indicate a negative monetary quantity.

char *int_frac_digits*

The number of fractional digits (to the right of the decimal point) to display in an internationally formatted monetary quantity.

char *frac_digits*

The number of fractional digits (to the right of the decimal point) to display in a formatted monetary quantity.

char *p_cs_precedes*

Set to 1 or 0 if the *currency_symbol* precedes or follows the value for a nonnegative monetary quantity.

char *p_sep_by_space*

Set to 1 or 0 if the *currency_symbol* is or isn't separated by a space from the value for a nonnegative monetary quantity.

char *n_cs_precedes*

Set to 1 or 0 if the *currency_symbol* precedes or follows the value for a negative monetary quantity.

char *n_sep_by_space*

Set to 1 or 0 if the *currency_symbol* is or isn't separated by a space from the value for a negative monetary quantity.

char *p_sign_posn*

The position of the *positive_sign* for a nonnegative monetary quantity.

char *n_sign_posn*

The position of the *positive_sign* for a negative monetary quantity.

The *grouping* and *mon_grouping* members have the following values:

CHAR_MAX	Perform no further grouping.
0	Repeat the previous element used for the remainder of the digits.
other	The value is the number of digits that comprise the current group. Examine the next element to determine the size of the next group of digits (to the left of the current group).

The *p_sign_posn* and *n_sign_posn* members have the following values:

0	Parentheses surround the quantity and *currency_symbol*.
1	The sign string precedes the quantity and *currency_symbol*.
2	The sign string follows the quantity and *currency_symbol*.
3	The sign string immediately precedes the quantity and *currency_symbol*.
4	The sign string immediately follows the quantity and *currency_symbol*.

Returns:

A pointer to the **struct lconv**.

Examples:

```
#include <stdio.h>
#include <locale.h>
#include <stdlib.h>

int main( void )
{
    struct lconv *lc;

    lc = localeconv();
    printf( "decimal_point (%s)\n",
        lc->decimal_point );

    printf( "thousands_sep (%s)\n",
        lc->thousands_sep );

    printf( "int_curr_symbol (%s)\n",
        lc->int_curr_symbol );

    printf( "currency_symbol (%s)\n",
        lc->currency_symbol );

    printf( "mon_decimal_point (%s)\n",
        lc->mon_decimal_point );

    printf( "mon_thousands_sep (%s)\n",
        lc->mon_thousands_sep );

    printf( "mon_grouping (%s)\n",
        lc->mon_grouping );

    printf( "grouping (%s)\n",
        lc->grouping );

    printf( "positive_sign (%s)\n",
        lc->positive_sign );

    printf( "negative_sign (%s)\n",
        lc->negative_sign );

    printf( "int_frac_digits (%d)\n",
        lc->int_frac_digits );

    printf( "frac_digits (%d)\n",
        lc->frac_digits );
```

```
    printf( "p_cs_precedes (%d)\n",
        lc->p_cs_precedes );

    printf( "p_sep_by_space (%d)\n",
        lc->p_sep_by_space );

    printf( "n_cs_precedes (%d)\n",
        lc->n_cs_precedes );

    printf( "n_sep_by_space (%d)\n",
        lc->n_sep_by_space );

    printf( "p_sign_posn (%d)\n",
        lc->p_sign_posn );

    printf( "n_sign_posn (%d)\n",
        lc->n_sign_posn );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

isalpha(), isascii(), printf(), scanf(), setlocale(), strcat(), strchr(), strcmp(), strcoll(), strcpy(), strftime(), strlen(), strpbrk(), strspn(), strtod(), strtok(), strxfrm()

localtime()

Convert calendar time to local time

Synopsis:

```
#include <time.h>

struct tm *localtime( const time_t *timer );
```

Arguments:

timer A pointer to a **time_t** object that contains the calendar time that you want to convert.

Library:

libc

Description:

The *localtime()* function converts the calendar time pointed to by *timer* into local time, storing the information in a **struct tm**. Whenever you call *localtime()*, it calls *tzset()*.

You typically get a calendar time by calling *time()*. That time is Coordinated Universal Time (UTC, formerly known as Greenwich Mean Time or GMT).

The *localtime()* function places the converted time in a static structure that's reused each time you call *localtime()*. Use *localtime_r()* if you want a thread-safe version.

You typically use the **date** command to set the computer's internal clock using Coordinated Universal Time (UTC). Use the **TZ** environment variable or **_CS_TIMEZONE** configuration string to establish the local time zone. For more information, see "Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*.

Returns:

A pointer to the static **struct tm** containing the time information.

Classification:

ANSI, POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

asctime(), asctime_r(), clock(), ctime(), ctime_r(), difftime(), gmtime(), gmtime_r(), mktime(), localtime_r(), strftime(), time(), **tm**, *tzset()*

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

localtime_r()

Convert calendar time to local time

Synopsis:

```
#include <time.h>

struct tm* localtime_r( const time_t* timer,
                        struct tm* result );
```

Arguments:

timer A pointer to a **time_t** object that contains the calendar time that you want to convert.

result A pointer to a **tm** structure where the function can store the converted time.

Library:

libc

Description:

The *localtime_r()* function converts the calendar time pointed to by *timer* into local time, storing the information in the **struct tm** that *result* points to. Whenever you call *localtime_r()*, it calls *tzset()*.

You typically get a calendar time by calling *time()*. That time is Coordinated Universal Time (UTC, formerly known as Greenwich Mean Time or GMT).

You typically use the **date** command to set the computer's internal clock using Coordinated Universal Time (UTC). Use the **TZ** environment variable or **_CS_TIMEZONE** configuration string to establish the local time zone. For more information, see "Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*.

Returns:

A pointer to *result*, the **struct tm**.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

asctime(), asctime_r(), clock(), ctime(), ctime_r(), difftime(), gmtime(), gmtime_r(), localtime(), mktime(), strftime(), time(), **tm**, *tzset()*

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

lockf()

Lock or unlock a section of a file

Synopsis:

```
#include <unistd.h>

int lockf( int filedes,
           int function,
           off_t size );
```

Arguments:

fildes The file descriptor for the file that you want to lock. Open the file with write-only permission (O_WRONLY) or with read/write permission (O_RDWR).

function A control value that specifies the action to be taken. The permissible values (defined in **<unistd.h>**) are as follows:

F_LOCK	Lock a section for exclusive use if the section is available. A read-only lock is one of O_RDONLY, O_WRONLY, or O_RDWR. An exclusive lock is one of O_WRONLY, or O_RDWR. (For descriptions of the locks, see *open()*).
F_TEST	Test a specified section for locks obtained by other processes.
F_TLOCK	Test and lock a section for exclusive use if the section is available.
F_ULOCK	Remove locks from a specified section of the file.

size The number of contiguous bytes that you want to lock or unlock. The section to be locked or unlocked starts at the current offset in the file and extends forward for a positive *size* or backward for a negative *size* (the preceding bytes up to but not including the current offset). If *size* is 0, the section from the current offset

through the largest possible file offset is locked (that is, from the current offset through to the present or any future end-of-file). An area need not be allocated to the file to be locked because locks may exist past the end-of-file.

Library:

libc

Description:

You can use the *lockf()* function to lock a section of a file, using advisory-mode locks. If other threads call *lockf()* to try to lock the locked file section, those calls either return an error value or block until the section becomes unlocked.

All the locks for a process are removed when the process terminates. Record locking with *lockf()* is supported for regular files and may be supported for other files.

The sections locked with F_LOCK or F_TLOCK may in whole or in part, contain or be contained by a previously locked section for the same process. When this occurs, or if adjacent locked sections occur, the sections are combined into a single locked section.

File locks are released on the first close by the locking process of any file descriptor for the file.

F_ULOCK requests may release (wholly or in part) one or more locked sections controlled by the process. Locked sections are unlocked starting at the current file offset through *size* bytes or to the end of file if *size* is (**off_t**)0. When all of a locked section isn't released (that is, when the beginning or end of the area to be unlocked falls within a locked section), the remaining portions of that section are still locked by the process. Releasing the center portion of a locked section causes the remaining locked beginning and end portions to become two separate locked sections.

A potential for deadlock occurs if the threads of a process controlling a locked section are blocked by accessing another process's locked

section. If the system detects that deadlock could occur, *lockf()* fails with EDEADLK.

The interaction between *fcntl()* and *lockf()* locks is unspecified. Blocking on a section is interrupted by any signal.

If *size* is the maximum value of type **off_t** and the process has an existing lock of size 0 in this range (indicating a lock on the entire file), then an F_ULOCK request is treated the same as an F_ULOCK request of size 0. Otherwise an F_ULOCK request attempts to unlock only the requested section. Attempting to lock a section of a file that's associated with a buffered stream produces unspecified results.

Returns:

0 Success.

-1 An error occurred (*errno* is set). Existing locks aren't changed.

Errors:

EACCES or EAGAIN
: The *function* argument is F_TLOCK or F_TEST and the section is already locked by another process.

EAGAIN
: The *function* argument is F_LOCK or F_TLOCK and the file is mapped with *mmap()*.

EBADF
: The *fildes* argument isn't a valid open file descriptor; or *function* is F_LOCK or F_TLOCK and *fildes* isn't a valid file descriptor open for writing.

EDEADLK
: The *function* argument is F_LOCK and a deadlock is detected.

EINTR
: A signal was caught during execution of the function.

EINVAL
: The *function* argument isn't one of F_LOCK, F_TLOCK, F_TEST or F_ULOCK; or *size* plus the current file offset is less than 0.

ENOMEM	The system can't allocate sufficient memory to store lock resources.
EOPNOTSUPP or EINVAL	The implementation doesn't support the locking of files of the type indicated by *fildes*.
EOVERFLOW	The offset of the first, or if *size* isn't 0 then the last, byte in the requested section can't be represented correctly in an object of type `off_t`.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

fcntl(), flock(), open()

log(), *logf()*

Compute the natural logarithm of a number

Synopsis:

```
#include <math.h>

double log( double x );

float logf( float x );
```

Arguments:

x The number that you want to compute the natural log of.

Library:

libm

Description:

The *log()* and *logf()* functions compute the natural logarithm (base *e*) of *x*:

$log_e\ x$

A domain error occurs if *x* is negative. A range error occurs if *x* is zero.

Returns:

The natural logarithm of *x*.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
```

```
int main( void )
{
    printf( "%f\n", log(.5) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
-0.693147
```

Classification:

log() is ANSI; *logf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *exp()*, *log10()*, *pow()*

log1p(), *log1pf()*

Log(1+x)

Synopsis:

```
#include <math.h>

double log1p ( double x );

float log1pf ( float x );
```

Arguments:

x The number that you want to add 1 to and compute the natural log of.

Library:

libm

Description:

The *log1p()* and *log1pf()* functions compute the value of *log*(1+*x*), where *x* > -1.0.

Returns:

If:	*log1p()* returns:
x = NAN	NAN
x < -1.0	-HUGE_VAL, or NAN (*errno* is set to EDOM).
x = -1.0	-HUGE_VAL (*errno* may be set to ERANGE).

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Classification:

log1p() is standard Unix; *log1pf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ilogb(), log(), logb(), log10()

log10(), *log10f()*

Compute the logarithm (base 10) of a number

Synopsis:

```
#include <math.h>

double log10( double x );

float log10f( float x );
```

Arguments:

x The number that you want to compute the log of.

Library:

libm

Description:

The *log10()* and *log10f()* functions compute the base 10 logarithm of *x*:

$log_{10}\ x$

A domain error occurs if *x* is negative. A range error occurs if *x* is zero.

Returns:

The base 10 logarithm of *x*.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
```

```
int main( void )
{
    printf( "%f\n", log10(.5) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
-0.301030
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *exp()*, *log()*, *pow()*

logb(), *logbf()*

Compute the radix-independent exponent

Synopsis:

```
#include <math.h>

double logb ( double x );

float logbf ( float x );
```

Arguments:

x The number that you want to compute the radix-independent exponent of.

Library:

libm

Description:

The *logb()* and *logbf()* functions compute the exponent part of *x*, which is the integral part of:

$log_r |x|$

as a signed floating point value, for nonzero finite *x*, where *r* is the radix of the machine's floating point arithmetic.

Returns:

The binary exponent of *x*, a signed integer converted to double-precision floating-point.

If *x* is:	*logb()* returns:
`0.0`	-HUGE_VAL (*errno* is set to EDOM)
`<0.0`	-HUGE_VAL (*errno* may be set to ERANGE)
±infinity	+infinity

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv)
{
    double a, b;

    a = 0.5;
    b = logb(a);
    printf("logb(%f) = %f (%f = 2^%f) \n", a, b, a, b);

    return(0);
}
```

produces the output:

```
logb(0.500000) = -1.000000 (0.500000 = 2^-1.000000)
```

Classification:

logb() is standard Unix; *logbf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ilogb(), log(), log10(), log1p()

login_tty()

Prepare for a login in a tty

Synopsis:

```
#include <unix.h>

int login_tty( int fd );
```

Arguments:

fd A file descriptor that you want to use as the controlling terminal for the current process.

Library:

libc

Description:

The *login_tty()* function prepares for a login on the tty *fd* (which may be a real tty device, or the slave of a pseudo-tty as returned by *openpty()*) by creating a new session, making *fd* the controlling terminal for the current process, setting *fd* to be the standard input, output, and error streams of the current process, and closing *fd*.

This function fails if *ioctl()* fails to set *fd* to the controlling terminal of the current process.

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

forkpty(), *ioctl()*, *openpty()*

longjmp()

Restore the environment saved by setjmp()

Synopsis:

```
#include <setjmp.h>

void longjmp( jmp_buf env,
              int return_value );
```

Arguments:

env	The environment saved by the most recent call to *setjmp()*.
return_value	The value that you want *setjmp()* to return.

Library:

libc

Description:

The *longjmp()* function restores the environment saved in *env* by the most recent call to the *setjmp()* function.

☞ Using *longjmp()* to jump out of a signal handler can cause unpredictable behavior, unless the signal was generated by the *raise()* function.

Returns:

After the *longjmp()* function restores the environment, program execution continues as if the corresponding call to *setjmp()* had just returned the value specified by *return_value*. If the value of *return_value* is 0, the value returned is 1.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <setjmp.h>
```

```
jmp_buf env;

void rtn( void )
{
    printf( "about to longjmp\n" );
    longjmp( env, 14 );
}

int main( void )
{
    int ret_val = 293;

    if( 0 == ( ret_val = setjmp( env ) ) ) {
        printf( "after setjmp %d\n", ret_val );
        rtn();
        printf( "back from rtn %d\n", ret_val );
    } else {
        printf( "back from longjmp %d\n", ret_val );
    }

    return EXIT_SUCCESS;
}
```

produces the following output:

```
after setjmp 0
about to longjmp
back from longjmp 14
```

Classification:

ANSI, POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

A strictly-conforming POSIX application can't assume that the *longjmp()* function is signal-safe on other platforms.

WARNING: *Don't* use *longjmp()* or *siglongjmp()* to restore an environment saved by a call to *setjmp()* or *sigsetjmp()* in another thread. If you're lucky, your application will crash; if not, it'll look as if it works for a while, until random scribbling on the stack causes it to crash.

See also:

setjmp(), *siglongjmp()*, *sigsetjmp()*

lrand48()

Generate a pseudo-random nonnegative **long** *integer*

Synopsis:

```
#include <stdlib.h>

long lrand48( void );
```

Library:

libc

Description:

The *lrand48()* function uses a linear congruential algorithm and 48-bit integer arithmetic to generate a nonnegative **long** integer uniformly distributed over the interval [0, 2^{31}].

Call one of *lcong48()*, *seed48()*, or *srand48()* to initialize the random-number generator before calling *drand48()*, *lrand48()*, or *mrand48()*,

The *nrand48()* function is a thread-safe version of *lrand48()*.

Returns:

A pseudo-random **long** integer.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

drand48(), erand48(), jrand48(), lcong48(), mrand48(), nrand48(), seed48(), srand48()

lsearch()

Perform a linear search in an array

Synopsis:

```
#include <search.h>

void * lsearch( const void * key,
                const void * base,
                unsigned * num,
                unsigned width,
                int ( * compare)(
                    const void * element1,
                    const void * element2 ) );
```

Arguments:

key	The object to search for.
base	A pointer to the first element in the table.
num	A pointer to an integer containing the current number of elements in the table.
width	The size of an element, in bytes.
compare	A pointer to a user-supplied function that *lsearch()* calls to compare an array element with the *key*. The arguments to the comparison function are: • *element1* — the same pointer as *key* • *element2* — a pointer to one of the array elements. The comparison function must return 0 if *element1* equals *element2*, or a nonzero value if the elements aren't equal.

Library:

libc

Description:

The *lsearch()* function searches a linear table and returns a pointer into the table indicating where the entry was found.

If *key* isn't found, it's added to the end of the array and *num* is incremented.

Returns:

A pointer to the element that was found or created, or NULL if an error occurred.

Examples:

This program builds an array of pointers to the *argv* arguments by searching for them in an array of NULL pointers. Because none of the items will be found, they'll all be added to the *array*.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <search.h>

int compare( const void *, const void * );

int main( int argc, const char **argv )
{
    int i;
    unsigned num = 0;

    char **array = (char **)calloc( argc, sizeof(char **) );

    for( i = 1; i < argc; ++i ) {
        lsearch( &argv[i], array, &num, sizeof(char **), compare );
    }

    for( i = 0; i < num; ++i ) {
        printf( "%s\n", array[i] );
    }

    return EXIT_SUCCESS;
}

int compare( const void *op1, const void *op2 )
{
    const char **p1 = (const char **) op1;
    const char **p2 = (const char **) op2;

    return( strcmp( *p1, *p2 ) );
}
```

Using the program above, this input:

```
one two one three four
```

produces the output:

```
one
two
three
four
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

bsearch(), lfind()

lseek(), lseek64()

Set the current file position at the operating-system level

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

off_t lseek( int filedes,
             off_t offset,
             int whence );

off64_t lseek64( int filedes,
                 off64_t offset,
                 int whence );
```

Arguments:

filedes The file descriptor of the file whose position you want to set.

offset The relative offset from the file position determined by the *whence* argument.

whence The position in the file. The possible values (defined in **<unistd.h>**) are:

SEEK_CUR	The new file position is computed relative to the current file position. The value of *offset* may be positive, negative or zero.
SEEK_END	The new file position is computed relative to the end of the file.
SEEK_SET	The new file position is computed relative to the start of the file. The value of *offset* must not be negative.

Library:

libc

Description:

These functions set the current file position for the file descriptor specified by *filedes* at the operating system level. File descriptors are returned by a successful execution of one of the *creat()*, *dup()*, *dup2()*, *fcntl()*, *open()* or *sopen()* functions.

An error occurs if the requested file position is before the start of the file.

If the requested file position is beyond the end of the file and data is written at this point, subsequent reads of data in the gap will return bytes whose value is equal to zero (`'\0'`) until data is actually written into the gap.

These functions don't extend the size of a file (see *chsize()*).

Returns:

The current file position, with `0` indicating the start of the file, or `-1` if an error occurs (*errno* is set).

Errors:

EBADF	The *filedes* argument isn't a valid file descriptor.
EINVAL	The *whence* argument isn't a proper value, or the resulting file offset is invalid.
ENOSYS	The *lseek()* function isn't implemented for the filesystem specified by *filedes*.
EOVERFLOW	The resulting file offset is a value that can't be represented correctly in an object of type `off_t`.
ESPIPE	The *filedes* argument is associated with a pipe or FIFO.

Examples:

Using the *lseek()* function, you can get the current file position (in fact, *tell()* is implemented this way). You can then use this value with another call to *lseek()* to reset the file position:

```
off_t file_posn;
int filedes;

/* get current file position */
file_posn = lseek( filedes, 0L, SEEK_CUR );

...

/* return to previous file position */
file_posn = lseek( filedes, file_posn, SEEK_SET );
```

If all records in the file are the same size, the position of the *n*th record can be calculated and read like this:

```
#include <sys/types.h>
#include <unistd.h>

int read_record( int filedes, long rec_numb,
                 int rec_size, char *buffer )
{
    if( lseek( filedes , rec_numb * rec_size,
               SEEK_SET ) == -1L ) {
        return -1;
    }

    return( read( filedes , buffer, rec_size ) );
}
```

The *read_record()* function in this example assumes records are numbered starting with zero, and that *rec_size* contains the size of a record in the file, including any record-separator characters.

Classification:

lseek() is POSIX 1003.1; *lseek64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chsize(), close(), creat(), dup(), dup2(), eof(), errno, execl(), execle(), execlp(), execlpe(), execv(), execve(), execvp(), execvpe(), fcntl(), fileno(), fstat(), isatty(), open(), read(), sopen(), stat(), tell(), umask(), write()

lstat(), lstat64()

Get information about a file or directory

Synopsis:

```
#include <sys/stat.h>

int lstat( const char* path,
           struct stat* buf );

int lstat64( const char* path,
             struct stat64* buf );
```

Arguments:

path The path of the file or directory that you want information about.

buf A pointer to a buffer where the function can store the information.

Library:

libc

Description:

These functions obtain information about the file or directory referenced in *path*. This information is placed in the structure located at the address indicated by *buf*.

The results of the *lstat()* function are the same as the results of *stat()* when used on a file that isn't a symbolic link. If the file is a symbolic link, *lstat()* returns information about the symbolic link, while *stat()* continues to resolve the pathname using the contents of the symbolic link, and returns information about the resulting file.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

See *stat()* for details.

Examples:

```
/*
 * Iterate through a list of files, and report
 * for each if it is a symbolic link
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/stat.h>
#include <unistd.h>

int main( int argc, char **argv )
  {
    int ecode = 0;
    int n;
    struct stat sbuf;

    for( n = 1; n < argc; ++n ) {
      if( lstat( argv[n], &sbuf ) == -1 ) {
        perror( argv[n] );
        ecode++;

      } else if( S_ISLNK( sbuf.st_mode ) ) {
        printf( "%s is a symbolic link\n", argv[n] );

      } else {
        printf( "%s is not a symbolic link\n", argv[n] );
      }
    }
    return( ecode );
  }
```

Classification:

lstat() is POSIX 1003.1a; *lstat64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	No

See also:

errno, fstat(), readlink(), stat()

ltoa(), *lltoa()*

Convert a long integer into a string, using a given base

Synopsis:

```
#include <stdlib.h>

char* ltoa( long value,
            char* buffer,
            int radix );

char* lltoa( int64_t value,
             char* buffer,
             int radix );
```

Arguments:

value The value to convert into a string.

buffer A buffer in which the function stores the string. The size of the buffer must be at least 33 bytes when converting values in base 2 (binary).

radix The base to use when converting the number. This value must be in the range:

$$2 \le radix \le 36$$

If the value of *radix* is 10, and *value* is negative, then a minus sign is prepended to the result.

Library:

libc

Description:

The *ltoa()* and *lltoa()* functions convert the given long integer *value* into the equivalent string in base *radix* notation, storing the result in the character array pointed to by *buffer*. A NUL character is appended to the result.

Returns:

A pointer to the result.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

void print_value( long value )
{
    int base;
    char buffer[33];

    for( base = 2; base <= 16; base = base + 2 ) {
        printf( "%2d %s\n", base,
            ltoa( value, buffer, base ) );
    }
}

int main( void )
{
    print_value( 12765 );

    return EXIT_SUCCESS;
}
```

produces the output:

```
 2 11000111011101
 4 3013131
 6 135033
 8 30735
10 12765
12 7479
14 491b
16 31dd
```

Classification:

ltoa() is QNX 4; *lltoa()* is Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atoi(), atol(), itoa(), sscanf(), strtol(), strtoul(), ultoa(), utoa()

ltrunc()

Truncate a file at a given position

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

off_t ltrunc( int fildes,
              off_t offset,
              int whence );
```

Arguments:

fildes The file descriptor of the file that you want to truncate.

offset The relative offset from the file position determined by the *whence* argument.

whence The position in the file. The possible values (defined in **<unistd.h>**) are:

SEEK_CUR	The new file position is computed relative to the current file position. The value of *offset* may be positive, negative or zero.
SEEK_END	The new file position is computed relative to the end of the file.
SEEK_SET	The new file position is computed relative to the start of the file. The value of *offset* must not be negative.

Library:

libc

Description:

The *ltrunc()* function attempts to truncate the file at a specified position. The file, referenced by the open file descriptor *fildes*, must have been opened O_WRONLY or O_RDWR. The truncation point is calculated using the value of *offset* as a relative offset from a file position determined by the value of the argument *whence*. The value

of *offset* may be negative, although a negative truncation point (one before the beginning of the file) is an error.

☞ The *ltrunc()* function ignores advisory locks that may have been set by *fcntl()*.

The calculated truncation point, if within the existing bounds of the file, determines the new file size; all data after the truncation point no longer exists. If the truncation point is past the existing end of file, the file size isn't changed. An error occurs if you attempt to truncate before the beginning of the file (that is, a negative truncation point).

☞ The current seek position isn't changed by this function under any circumstance, including the case where the current seek position is beyond the truncation point.

Returns:

Upon successful completion, this function returns the new file size. If a truncation point beyond the existing end of file was specified, the existing file size is returned, and the file size remains unchanged. Otherwise, *ltrunc()* returns a value of -1 and sets *errno* to indicate the error. The file size remains unchanged in the event of an error.

Errors:

EBADF	The *fildes* argument isn't a valid file descriptor, open for writing.
EINVAL	The *whence* argument isn't a proper value, or the resulting file size would be invalid.
ENOSYS	An attempt was made to truncate a file of a type that doesn't support truncation (for example, a file associated with the device manager).
ESPIPE	The *fildes* argument is associated with a pipe or FIFO.

Examples:

```
#include <stdio.h>
#include <fcntl.h>
#include <sys/types.h>
#include <unistd.h>

char buffer[1000];

int main( void )
{
    int fd, stat;

    fd = open( "test", O_CREAT | O_RDWR, 0666 );
    if( fd == -1 ) {
        fprintf( stderr, "Open error\n" );
        exit( -1 );
    }

    /* Create a 1000-byte file */
    write( fd, buffer, 1000 );

    /* Seek back to offset 500 and truncate the file */
    if( ltrunc( fd, 500, SEEK_SET ) == -1 ) {
        fprintf( stderr, "ltrunc error\n" );
        exit( -1 );
    }
    close( fd );
    fd = open( "test", O_CREAT | O_RDWR, 0666 );
    printf( "File size = %ld\n",
        lseek( fd, 0, SEEK_END ) );
    close( fd );

    return 0;
}
```

Classification:

QNX 4

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

Caveats:

The *ltrunc()* function *isn't portable*, and shouldn't be used in new code. Use *ftruncate()* instead.

See also:

errno, *ftruncate()*, *lseek()*

Synopsis:

```
int main( void );

int main( int argc,
          const char *argv[] );

int main( int argc,
          const char *argv[],
          char *envp[] );
```

Arguments:

The arguments depend on which form of *main()* that you use.

argc The number of entries in the *argv* array.

argv An array of pointers to strings that contain the arguments to the program.

envp An array of pointers to strings that define the environment for the program.

Library:

libc

Description:

The *main()* function is supplied by the user and is where program execution begins. The command line to the program is broken into a sequence of tokens separated by blanks, and are passed to *main()* as an array of pointers to character strings in *argv*. The number of arguments found is passed in the parameter *argc*.

The *argv*`[0]` argument is a pointer to a character string containing the program name. The last element of the array pointed to by *argv* is NULL (*argv[argc]* is NULL). Arguments containing blanks can be passed to *main()* by enclosing them in quote characters (which are

removed from that element in the *argv* vector). See your shell's documentation for details.

The *envp* argument points to an array of pointers to character strings that are the environment strings for the current process. This value is identical to the *environ* variable, which is defined in the **<stdlib.h>** header file.

Returns:

A value back to the calling program (usually the operating system).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv )
{
    int i;
    for( i = 0; i < argc; ++i ) {
        printf( "argv[%d] = %s\n", i, argv[i] );
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
argv[0] = ./mypgm
argv[1] = hhhhh
argv[2] = another arg
```

when the program **mypgm** is run from the shell:

```
$ ./mypgm hhhhh "another arg"
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abort(), *atexit()*, *_argc*, *_argv*, *_auxv*, *close()*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *_exit()*, *exit()*, *getenv()*, *putenv()*, *sigaction()*, *signal()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *system()*, *wait()*, *waitpid()*

mallinfo()

Get memory allocation information

Synopsis:

```
#include <malloc.h>

struct mallinfo mallinfo ( void );
```

Library:

libc

Description:

The *mallinfo()* function returns memory-allocation information in the form of a **struct mallinfo**:

```
struct mallinfo {
    int arena;     /* size of the arena */
    int ordblks;   /* number of big blocks in use */
    int smblks;    /* number of small blocks in use */
    int hblks;     /* number of header blocks in use */
    int hblkhd;    /* space in header block headers */
    int usmblks;   /* space in small blocks in use */
    int fsmblks;   /* memory in free small blocks */
    int uordblks; /* space in big blocks in use */
    int fordblks; /* memory in free big blocks */
    int keepcost; /* penalty if M_KEEP is used
                                -- not used */
};
```

Returns:

A **struct mallinfo**.

Classification:

ANSI

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

calloc(), free(), malloc(), realloc()

malloc()

Allocate memory

Synopsis:

```
#include <stdlib.h>

void* malloc( size_t size );
```

Arguments:

size The number of bytes to allocate.

Library:

libc

Description:

The *malloc()* function allocates a buffer of *size* bytes.

This function allocates memory in blocks of *_amblksiz* bytes (a global variable defined in **<stdlib.h>**).

Returns:

A pointer to the start of the allocated memory, or NULL if an error occurred (*errno* is set).

Errors:

ENOMEM Not enough memory.

EOK No error.

Examples:

```
#include <stdlib.h>

int main( void )
{
    char* buffer;

    buffer = (char* )malloc( 80 );
```

```
    if( buffer != NULL ) {
        /* do something with the buffer */
        ...

        free( buffer );
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

In QNX 4, nothing is allocated when you *malloc()* 0 bytes. Be careful if your code is ported between QNX 4 and QNX Neutrino.

See also:

calloc(), free(), realloc(), sbrk()

mallopt()

Control the memory allocation

Synopsis:

```
#include <malloc.h>

int mallopt( int cmd,
             int value );
```

Arguments:

cmd Supported arguments are:

- MALLOC_ARENA_SIZE — Sets the size of the requests to the system for additional core memory. The *value* argument is rounded up to the nearest page size. An argument of 0 returns the current arena size — any other argument sets the arena size, and returns the previous value.
- MALLOC_MONOTONIC_GROWTH — Changes the strategy for growing blocks using the *realloc()* function. Setting *value* to a nonzero number causes resize requests that don't fit in the existing block to grow the block by a minimum of 100%.

These arguments are silently ignored. They're included for compatibility reasons:

- M_GRAIN
- M_KEEP
- M_MMAP_THRESHOLD
- M_MMAP_MAX
- M_MXFAST
- M_NLBLKS
- M_TOP_PAD
- M_TRIM_THRESHOLD

value The allocation size.

Library:

libc

Description:

The *mallopt()* function controls the memory allocation.

Returns:

Unless otherwise specified, the *mallopt()* returns 0 on success, or -1 if an error occurs (*errno* is set).

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

calloc(), free(), mallinfo(), malloc(), realloc()

max()

Return the greater of two numbers

Synopsis:

```
#include <stdlib.h>

#define max(a,b) ...
```

Arguments:

a,b The numbers that you want to get the greater of.

Library:

libc

Description:

The *max()* function returns the greater of two values.

The *max()* function is for C programs only. For C+ and C++ programs, use the *__max()* or *__min()* macros.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    int a;

    a = max( 1, 10 );
    printf( "The value is: %d\n", a );
    return EXIT_SUCCESS;
}
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

min()

mblen()

Count the bytes in a multibyte character

Synopsis:

```
#include <stdlib.h>

int mblen( const char * s,
           size_t n );
```

Arguments:

s NULL (see below), or a pointer to a multibyte character.

n The maximum number of bytes that you want to count.

Library:

libc

Description:

The *mblen()* function counts the number of bytes in the multibyte character pointed to by *s*, to a maximum of *n* bytes.

The *mbrlen()* function is a restartable version of *mblen()*.

Returns:

- If *s* is NULL, *mblen()* determines whether or not the character encoding is state-dependent:

  0 The *mblen()* function uses locale-specific multibyte character encoding that's not state-dependent.

  ≠ 0 Character is state-dependent.

- If *s* isn't NULL:

  0 *s* points to the null character.

  -1 The next *n* bytes don't form a valid multibyte character.

  > 0 The number of bytes that comprise the multibyte character (if the next *n* or fewer bytes form a valid multibyte character).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    int len;
    char *mbs = "string";

    printf( "Character encodings do " );
    if( !mblen( NULL, 0 ) ) {
        printf( "not " );
    }
    printf( "have state-dependent \nencoding.\n" );

    len = mblen( "string", 6 );
    if( len != -1 ) {
        mbs[len] = '\0';
        printf( "Multibyte char '%s'(%d)\n", mbs, len );
    }

    return EXIT_SUCCESS;
}
```

This produces the output:

```
Character encodings do not have state-dependent
encoding.
Multibyte char 's'(1)
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

mbrlen()

Count the bytes in a multibyte character (restartable)

Synopsis:

```
#include <wchar.h>

size_t mbrlen( const char * s,
               size_t n,
               mbstate_t * ps);
```

Arguments:

s	A pointer to a multibyte character.
n	The maximum number of bytes that you want to count.
ps	An internal pointer that lets *mbrlen()* be a restartable version of *mblen()*; if *ps* is NULL, *mbrlen()* uses its own internal variable. You can call *mbsinit()* to determine the status of this variable.

Library:

libc

Description:

The *mbrlen()* function counts the bytes in the multibyte character pointed to by *s*, to a maximum of *n* bytes.

Returns:

(**size_t**)-2	The resulting conversion state indicates an incomplete multibyte character after all *n* characters were converted.
(**size_t**)-1	The function detected an encoding error before completing the next multibyte character, in which case the function *errno* to EILSEQ and leaves the resulting conversion state undefined.
0	The next completed character is a null character, in which case the resulting conversion state is the initial conversion state.

x	The number of bytes needed to complete the next multibyte character, in which case the resulting conversion state indicates that *x* bytes have been converted.

Errors:

EILSEQ	Invalid character sequence.
EINVAL	The *ps* argument points to an invalid object.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

Convert a multibyte character into a wide character (restartable)

Synopsis:

```
#include <wchar.h>

size_t mbrtowc( wchar_t * pwc,
                const char * s,
                size_t n,
                mbstate_t * ps );
```

Arguments:

pwc A pointer to a **wchar_t** object where the function can store the wide character.

s A pointer to the multibyte character that you want to convert.

n The maximum number of bytes in the multibyte character to convert.

ps An internal pointer that lets *mbrtowc()* be a restartable version of *mbtowc()*; if *ps* is NULL, *mbrtowc()* uses its own internal variable.

You can call *mbsinit()* to determine the status of this variable.

Library:

libc

Description:

The *mbrtowc()* function converts single multibyte characters pointed to by *s* into wide characters pointed to by *pwc*, to a maximum of *n* bytes (not characters).

This function is affected by LC_TYPE.

Returns:

(**size_t**)-2	After converting all *n* characters, the resulting conversion state indicates an incomplete multibyte character.
(**size_t**)-1	The function detected an encoding error before completing the next multibyte character; the function sets *errno* to EILSEQ and leaves the resulting conversion state undefined.
0	The next completed character is a null character; the resulting conversion state is the same as the initial one.
x	The number of bytes needed to complete the next multibyte character, in which case the resulting conversion state indicates that *x* bytes have been converted.

Errors:

EILSEQ	Invalid character sequence.
EINVAL	The *ps* argument points to an invalid object.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno

"Multibyte character functions," "Stream I/O functions," and "Wide-character functions" in the summary of functions chapter.

mbsinit()

Determine the status of the conversion object used for restartable mb() functions*

Synopsis:

```
#include <wchar.h>

int mbsinit( const mbstate_t * ps );
```

Arguments:

ps A pointer to the conversion object that you want to test.

Library:

libc

Description:

The following functions use an object of type **mbstate_t** so that they can be restarted:

- *mbrlen()*
- *mbrtowc()*
- *mbsrtowcs()*
- *mbstowcs()*
- *wcsrtombs()*
- *wcrtomb()*

The *mbsinit()* function determines whether or not the **mbstate_t** object pointed to by *ps* describes an initial conversion state.

If the object doesn't describe an initial conversion state, it isn't safe for you to use it in one of the above functions, other than the one you've already used it in.

Returns:

A nonzero value if *ps* is NULL or **ps* describes an initial conversion state; otherwise zero.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mbrlen(), *mbrtowc()*, *mbsrtowcs()*, *mbstowcs()*, *wcsrtombs()*, *wcrtomb()*

"Multibyte character functions" and "Wide-character functions" in the summary of functions chapter.

mbsrtowcs()

Convert a multibyte-character string into a wide-character string (restartable)

Synopsis:

```
#include <wchar.h>

size_t mbsrtowcs( wchar_t * dst,
                  const char ** src,
                  size_t n,
                  mbstate_t * ps );
```

Arguments:

dst A pointer to a buffer where the function can store the wide-character string.

src The string of multibyte characters that you want to convert.

n The maximum number of bytes that you want to convert.

ps An internal pointer that lets *mbsrtowcs()* be a restartable version of *mbstowcs()*; if *ps* is NULL, *mbsrtowcs()* uses its own internal variable.

You can call *mbsinit()* to determine the status of this variable.

Library:

libc

Description:

The *mbsrtowcs()* function converts a string of multibyte characters pointed to by *src* into the corresponding wide characters pointed to by *dst*, to a maximum of *n* bytes, including the terminating NULL character.

The function converts each character as if by a call to *mbtowc()* and stops early if:

- A sequence of bytes doesn't conform to a valid character

Or:

- Converting the next character would exceed the limit of *n* total bytes.

This function is affected by LC_TYPE.

Returns:

(**size_t**)-1	Failure; invalid wide-character code.
x	Success; the number of total bytes successfully converted, not including the terminating NULL byte.

Errors:

EILSEQ	Invalid character sequence.
EINVAL	The *ps* argument points to an invalid object.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno

"Multibyte character functions" and "Wide-character functions" in the summary of functions chapter.

mbstowcs()

Convert a multibyte-character string into a wide-character string

Synopsis:

```
#include <stdlib.h>

size_t mbstowcs( wchar_t * pwcs,
                 const char * s,
                 size_t n );
```

Arguments:

pwcs	A pointer to a buffer where the function can store the wide-character string.
s	The string of multibyte characters that you want to convert.
n	The maximum number of bytes that you want to convert.

Library:

libc

Description:

The *mbstowcs()* function converts a sequence of multibyte characters pointed to by *s* into their corresponding wide-character codes pointed to by *pwcs*, to a maximum of *n* bytes. It doesn't convert any multibyte characters beyond a NULL character.

This function is affected by LC_TYPE.

The *mbsrtowcs()* function is a restartable version of *mbstowcs()*.

Returns:

The number of array elements modified, not including the terminating zero code, if present, or **(size_t)-1** if an invalid multibyte character was encountered.

Errors:

EILSEQ Invalid character sequence.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char *wc = "string";
    wchar_t wbuffer[50];
    int i, len;

    len = mbstowcs( wbuffer, wc, 50 );
    if( len != -1 ) {
        wbuffer[len] = '\0';
        printf( "%s(%d)\n", wc, len );

        for( i = 0; i < len; i++ ) {
            printf( "/%4.4x", wbuffer[i] );
        }

        printf( "\n" );
    }

    return EXIT_SUCCESS;
}
```

This produces the output:

```
string(6)
/0073/0074/0072/0069/006e/0067
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

errno

"Multibyte character functions" and "Wide-character functions" in the summary of functions chapter.

mbtowc()

Convert a multibyte character into a wide character

Synopsis:

```
#include <stdlib.h>

int mbtowc( wchar_t * pwc,
            const char * s,
            size_t n );
```

Arguments:

pwc A pointer to a **wchar_t** object where the function can store the wide character.

s NULL (see below), or a pointer to the multibyte character that you want to convert.

n The maximum number of bytes in the multibyte character to convert.

Library:

libc

Description:

The *mbtowc()* function converts a single multibyte character pointed to by *s* into a wide-character code pointed to by *pwc*, to a maximum of *n* bytes. The function stops early if it encounters the NULL character.

This function is affected by LC_TYPE.

The *mbrtowc()* function is a restartable version of *mbtowc()*.

Returns:

- If *s* is NULL:

  0 The *mbtowc()* function uses UTF-8 multibyte character encoding that's not state-dependent.

  ≠ 0 Everything else.

- If *s* isn't NULL:

  0 The *s* argument points to the NUL character.

  > 0 The number of bytes that comprise the multibyte character, to a maximum of MB_CUR_MAX (if the next *n* or fewer bytes form a valid multibyte character).

  -1 The next *n* bytes don't form a valid multibyte character; *errno* is set.

Errors:

EILSEQ Invalid character sequence.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char *wc = "string";
    wchar_t wbuffer[10];
    int i, len;

    printf( "State-dependent encoding? " );
    if( mbtowc( wbuffer, NULL, 0 ) ) {
        printf( "Yes\n" );
    } else {
        printf( "No\n" );
    }

    len = mbtowc( wbuffer, wc, 2 );
    wbuffer[len] = '\0';
    printf( "%s(%d)\n", wc, len );

    for( i = 0; i < len; i++ ) {
        printf( "/%4.4x", wbuffer[i] );
    }

    printf( "\n" );

    return EXIT_SUCCESS;
}
```

This produces the output:

```
State-dependent encoding? No
string(1)
/0073
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno

"Multibyte character functions" and "Wide-character functions" in the summary of functions chapter

mcheck()

Enable memory allocation routine consistency checks

Synopsis:

```
#include <malloc.h>

int mcheck(
    void (* abort_fn)(enum mcheck_status status));
```

Arguments:

abort_fn A pointer to the callback function to invoke when an inconsistency in the memory-allocation routines is found, or NULL if you want to use the default callback routine.

The argument to the callback routine is one of the values of the **mcheck_status** enumeration described in the documentation for *mprobe()*.

The default abort callback prints a message to *stderr* and aborts the application.

Library:

libc

Description:

The *mcheck()* function enables consistency checks within the memory allocation routines. When enabled, consistency checks are periodically performed on allocated memory blocks as blocks are allocated or freed. If an inconsistency is found, the *abort* callback is called with the status identifying the type of inconsistency found.

☞ Consistency checking isn't performed on blocks that you allocated before calling *mcheck()*.

The level of checking provided depends on which version of the allocator you've linked the application with:

- C library — minimal consistency checking.

- Nondebug version of the **malloc** library — a slightly greater level of consistency checking.
- Debug version of the **malloc** library — extensive consistency checking, with tuning available through the use of the *mallopt()* function.

Returns:

-1 Checking is already enabled.

0 Checking wasn't already enabled.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mallopt(), mprobe()

Heap Analysis in the *Programmer's Guide*

mem_offset(), *mem_offset64()*

Get the offset of a mapped typed memory block

Synopsis:

```
#include <sys/mman.h>

int mem_offset( const void * addr,
                int fd,
                size_t length,
                off_t * offset,
                size_t * contig_len );

int mem_offset64( const void * addr,
                  int fd,
                  size_t length,
                  off64_t * offset,
                  size_t * contig_len );
```

Arguments:

addr	The address of the memory block whose offset and contiguous length you want to get.
fd	The file descriptor that identifies the typed memory object. This must be the descriptor that you used (in a call to *mmap()*) to establish the mapping that contains *addr*.
length	The length of the block of memory that you want the offset for.
offset	A pointer to a location where the function can store the offset of the memory block.
contig_len	A pointer to a location where the function can store either *length* or the length of the largest contiguous block of typed memory that's currently mapped to the calling process starting at *addr*, whichever is smaller.

Library:

libc

Description:

The *mem_offset()* and *mem_offset64()* functions set the variable pointed to by *offset* to the offset (or location), within a typed memory object, of the memory block currently mapped at *addr*.

If you use the *offset* and *contig_len* values obtained from calling *mem_offset()* in a call to *mmap()* with a file descriptor that refers to the same memory pool as *fd* (either through the same port or through a different port), the memory region that's mapped must be exactly the same region that was mapped at *addr* in the address space of the process that called *mem_offset()*.

QNX extension

If you specify *fd* as NOFD, *offset* is the offset into **/dev/mem** of *addr* (i.e. its physical address). If the memory object specified by *fd* isn't a typed memory object, or specified as NOFD, the call fails.

☞ If the physical address is not a valid *off_t* value, *mem_offset()* will fail with *errno* set to E2BIG. This is typically the case with many ARM systems, and you should use *mem_offset64()* to get the physical address.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES The process hasn't mapped memory at the given address *addr*.

EBADF Invalid open file descriptor *fildes*.

EINVAL	The file descriptor *fildes* doesn't correspond to the memory object mapped at *addr*.
ENODEV	The file descriptor *fildes* isn't connected to a memory object supported by this function.
ENOSYS	The *mem_offset()* function isn't supported by this implementation.

Examples:

```
#include <unistd.h>
#include <errno.h>
#include <sys/types.h>
#include <sys/mman.h>

paddr_t mphys(void *addr) {
        off64_t                 offset;

        if(mem_offset64(addr, NOFD, 1, &offset, 0) == -1) {
                return -1;
        }
        return offset;
}
```

Classification:

mem_offset() is POSIX 1003.1j (draft); *mem_offset64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mmap(), posix_mem_offset(), posix_mem_offset64()

memalign()

Allocate aligned memory

Synopsis:

```
#include <malloc.h>

void *memalign( size_t alignment,
                size_t size );
```

Arguments:

alignment	The alignment that you want to use for the memory. This must be a multiple of **`size( void *)`**.
size	The amount of memory you want to allocate, in bytes.

Library:

`libc`

Description:

The *memalign()* function allocates *size* bytes aligned on a boundary specified by *alignment*.

Returns:

A pointer to the allocated block, or NULL if an error occurred (*errno* is set).

Errors:

EINVAL	The value of *alignment* isn't a multiple of **`size( void *)`**.
ENOMEM	There's insufficient memory available with the requested alignment.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

free(), malloc(), posix_memalign()

memccpy()

Copy bytes between buffers until a given byte is found

Synopsis:

```
#include <string.h>

void* memccpy( void* dest,
               const void* src,
               int c,
               size_t cnt );
```

Arguments:

dest	A pointer to where you want the function to copy the data.
src	A pointer to the buffer that you want to copy data from.
c	The value that you want to stop copying at.
cnt	The maximum number of bytes to copy.

Library:

libc

Description:

The *memccpy()* function copies bytes from *src* to *dest*, up to and including the first occurrence of the character *c*, or until *cnt* bytes have been copied, whichever comes first.

Returns:

A pointer to the byte in *dest* following the character *c*, if one is found and copied; otherwise, NULL.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

char* msg = "This is the string: not copied";
```

```
int main( void )
{
    char buffer[80];

    memset( buffer, '\0', 80 );
    memccpy( buffer, msg, ':', 80 );

    printf( "%s\n", buffer );

    return EXIT_SUCCESS;
}
```

produces the output:

```
This is the string:
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), *memcmp()*, *memcpy()*, *memicmp()*, *memmove()*, *memset()*

memchr()

Find the first occurrence of a character in a buffer

Synopsis:

```
#include <string.h>

void* memchr(void* buf,
             int ch,
             size_t length );
```

Arguments:

buf	The buffer that you want to search.
ch	The character that you're looking for.
length	The number of bytes to search in the buffer.

Library:

libc

Description:

The *memchr()* function locates the first occurrence of *ch* (converted to an **unsigned char**) in the first *length* bytes of the buffer pointed to by *buf*.

Returns:

A pointer to the located character, or NULL if *ch* couldn't be found.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    char buffer[80];
    char* where;

    strcpy( buffer, "video x-rays" );
```

```
    where = (char *) memchr( buffer, 'x', 6 );
    if( where == NULL ) {
        printf( "'x' not found\n" );
    } else {
        printf( "%s\n", where );
    }

    where = (char *) memchr( buffer, 'r', 9 );
    if( where == NULL ) {
        printf( "'r' not found\n" );
    } else {
        printf( "%s\n", where );
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
'x' not found
rays
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), memcmp(), memcpy(), memicmp(), memmove(), memset() strchr(), strrchr(), wmemchr(), wmemcmp(), wmemcpy(), wmemmove(), wmemset()

memcmp()

Compare the bytes in two buffers

Synopsis:

```
#include <string.h>

int memcmp( const void* s1,
            const void* s2,
            size_t length );
```

Arguments:

s1, *s2*	Pointers to the buffers that you want to compare.
length	The number of bytes that you want to compare.

Library:

libc

Description:

The *memcmp()* function compares *length* bytes of the buffer pointed to by *s1* to the buffer pointed to by *s2*.

Returns:

`< 0`	The object pointed to by *s1* is less than the object pointed to by *s2*.
0	The object pointed to by *s1* is equal to the object pointed to by *s2*.
`> 0`	The object pointed to by *s1* is greater than the object pointed to by *s2*.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
```

```
    char buffer[80];
    int retval;

    strcpy( buffer, "World" );

    retval = memcmp( buffer, "hello", 5 );
    if( retval < 0 ) {
        printf( "Less than\n" );
    } else if( retval == 0 ) {
        printf( "Equal to\n");
    } else {
        printf( "Greater than\n");
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
Less than
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), memchr(), memcpy(), memicmp(), memmove(), memset()

memcpy()

Copy bytes from one buffer to another

Synopsis:

```
#include <string.h>

void* memcpy( void* dst,
              const void* src,
              size_t length );
```

Arguments:

dest	A pointer to where you want the function to copy the data.
src	A pointer to the buffer that you want to copy data from.
length	The number of bytes to copy.

Library:

libc

Description:

The *memcpy()* function copies *length* bytes from the buffer pointed to by *src* into the buffer pointed to by *dst*.

Copying overlapping buffers isn't guaranteed to work; use *memmove()* to to copy buffers that overlap.

Returns:

A pointer to the destination buffer (that is, the value of *dst*).

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    char buffer[80];
```

```
    memcpy( buffer, "Hello", 5 );
    buffer[5] = '\0';
    printf( "%s\n", buffer );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), *memchr()*, *memcmp()*, *memicmp()*, *memmove()*, *memset()*

memcpyv()

Copy a given number of structures

Synopsis:

```
#include <string.h>

size_t memcpyv( const struct iovec *dst,
                int dparts,
                int doff,
                const struct iovec *src,
                int sparts,
                int soff );
```

Arguments:

dst	An array of **iovec** structures that you want to copy the data to.
dparts	The number of entries in the *dst* array.
doff	The offset into the *dst* array at which to start copying.
src	An array of **iovec** structures that you want to copy the data from.
sparts	The number of entries in the *src* array.
soff	The offset into the *src* array at which to start copying.

Library:

libc

Description:

The function *memcpyv()* copies data pointed to by the *src* I/O vector, starting at offset *soff*, to *dst* structures, starting at offset *doff*. The number of I/O vector parts copied is specified in *sparts* and *dparts*.

Returns:

The number of bytes copied.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    const struct iovec *dest, *source;
    int dparts, doffset, sparts, soffset;
    size_t nbytes;

    nbytes = memcpyv ( dest, dparts, doffset,
                       source, sparts, soffset );
    printf ( "The number of bytes copied is %d. \n", nbytes );

    return EXIT_SUCCESS;
}
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), *memcpy()*

memicmp()

Compare two buffers, ignoring case

Synopsis:

```
#include <string.h>

int memicmp( const void* s1,
             const void* s2,
             size_t length );
```

Arguments:

s1, *s2*	Pointers to the buffers that you want to compare.
length	The number of bytes that you want to compare.

Library:

libc

Description:

The *memicmp()* function compares (case insensitive) *length* bytes of the buffer pointed to by *s1* with those of the buffer pointed to by *s2*.

Returns:

0	The object pointed to by *s1* is the same as the object pointed to by *s2*.
Less than 0	The object pointed to by *s1* is less than the object pointed to by *s2*.
Greater than 0	The object pointed to by *s1* is greater than the object pointed to by *s2*.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
```

```
    char buffer[80];
    int retval;

    strcpy( buffer, "World" );

    retval = memicmp( buffer, "hello", 5 );
    if( retval < 0 ) {
        printf( "Less than\n" );
    } else if( retval == 0 ) {
        printf( "Equal\n" );
    } else {
        printf( "Greater than\n");
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
Less than
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), memchr(), memcmp(), memcpy(), memmove(), memset()

memmove()

Copy bytes from one buffer to another, handling overlapping memory correctly

Synopsis:

```
#include <string.h>

void* memmove( void* dst,
               const void* src,
               size_t length );
```

Arguments:

dest	A pointer to where you want the function to copy the data.
src	A pointer to the buffer that you want to copy data from.
length	The number of bytes to copy.

Library:

libc

Description:

The *memmove()* function copies *length* bytes from the buffer pointed to by *src* to the buffer pointed to by *dst*. Copying of overlapping regions is handled safely. Use *memcpy()* for greater speed when copying buffers that don't overlap.

Returns:

A pointer to the destination buffer (that is, the value of *dst*).

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    char buffer[80];

    strcpy( buffer, "World");
    memmove( buffer+1, buffer, 79 );
```

```
    printf ("%s\n", buffer);

    return EXIT_SUCCESS;
}
```

produces the output:

```
WWorld
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), *memchr()*, *memcmp()*, *memcpy()*, *memicmp()*, *memset()*, *wmemmove()*

memset()

Set memory to a given value

Synopsis:

```
#include <string.h>

void* memset( void* dst,
              int c,
              size_t length );
```

Arguments:

dst	A pointer to the memory that you want to set.
c	The value that you want to store in each byte.
length	The number of bytes to set.

Library:

libc

Description:

The *memset()* function fills *length* bytes starting at *dst* with the value *c*.

Returns:

A pointer to the destination buffer (that is, the value of *dst*).

Examples:

```
#include <string.h>
#include <stdlib.h>
#include <stdio.h>

int main( void )
{
    char buffer[80];

    memset( buffer, '=', 80 );
    buffer[79] = '\0';

    puts( buffer );
```

```
    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), *memchr()*, *memcmp()*, *memcpy()*, *memicmp()*, *memmove()*

message_attach()

Attach a message range

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int message_attach( dispatch_t * dpp,
                    message_attr_t * attr,
                    int low,
                    int high,
                    int (* func) (
                           message_context_t * ctp,
                           int code,
                           unsigned flags,
                           void * handle ),
                    void * handle );
```

Arguments:

dpp	The dispatch handle, as returned by *dispatch_create()*.
attr	A pointer to a **message_attr_t** structure that lets you specify additional requirements for the message; see "**message_attr_t** structure," below.
low, *high*	The range of messages that you're interested in.
func	The function that you want to call when a message in the given range is received; see "Handler function," below.
handle	An arbitrary handle that you want to associate with data for the defined message range. This handle is passed to *func*.

Library:

libc

Description:

The *message_attach()* function attaches a handler to the message range defined by the message type [*low*, *high*] (i.e. an inclusive message range) for dispatch handle *dpp*.

It's considered a programming error to attach overlapping message or pulse ranges. Message types should be greater than _IO_MAX (defined in **<sys/iomsg.h>**.

When a message with a type in that range is received, *dispatch_handler()* calls the user-supplied function *func*. You can also use the same function with *pulse_attach()*. By examining *ctp->rcvid*, *func* can determine whether a pulse or message was received.

This function is responsible for doing any specific work needed to handle the message pointed to by *ctp->msg*. The *handle* passed to the function is the *handle* initially passed to *message_attach()*.

`message_attr_t` structure

The *attr* argument is a pointer to a **`message_attr_t`** structure:

```
typedef struct _message_attr {
   unsigned                flags;
   unsigned                nparts_max;
   unsigned                msg_max_size;
} message_attr_t;
```

You can use this structure to specify:

- the maximum message size to be received (the context allocated must be at least big enough to contain a message of that size)
- the maximum number of iovs to reserve in the **`message_context_t`** structure (*attr->nparts_max*)
- various *flags*:

  Currently, the following *attr->flags* are defined:

MSG_FLAG_CROSS_ENDIAN

Allow the server to receive messages from clients on machines with different native endian formats.

MSG_FLAG_DEFAULT_FUNC

Call this function if no other match is found, in this case, *low* and *high* are ignored. This overrides the default behavior of *dispatch_handler()* which is to return *MsgError()* (ENOSYS) to the sender when an unknown message is received.

Handler function

The user-supplied function *func* is called when a message in the defined range is received. This function is passed the message context *ctp*, in which the message was received, the message type, and the *handle* (the one passed to *message_attach()*). Currently, the argument *flags* is reserved. Your function should return `0`; other return values are reserved.

Here's a brief description of the context pointer fields:

ctp->rcvid	The receive ID of the message.
ctp->msg	A pointer to the message.
ctp->info	Data from a **`_msg_info`** structure.

Returns:

Zero on success, or -1 on failure (*errno* is set).

Errors:

EINVAL	The message *code* is out of range.
ENOMEM	Insufficient memory to attach message type.

Examples:

In this example, we create a resource manager where we attach to a private message range and attach a pulse, which is then used as a timer event:

```
#include <stdio.h>
#include <stddef.h>
#include <stdlib.h>

#define THREAD_POOL_PARAM_T     dispatch_context_t
#include <sys/iofunc.h>
#include <sys/dispatch.h>

static resmgr_connect_funcs_t   connect_func;
static resmgr_io_funcs_t        io_func;
static iofunc_attr_t            attr;

int
timer_tick(message_context_t *ctp, int code,
           unsigned flags, void *handle) {

    union sigval       value = ctp->msg->pulse.value;
    /* Do some useful work on every timer firing... */
    printf("received timer event, value %d\n", value.sival_int);
    return 0;
}

int
message_handler(message_context_t *ctp, int code,
                unsigned flags, void *handle ) {
    printf("received private message, type %d\n", code);
    return 0;
}

int
main(int argc, char **argv) {
    thread_pool_attr_t    pool_attr;
    thread_pool_t         *tpp;
    dispatch_t            *dpp;
    resmgr_attr_t         resmgr_attr;
    int                   id;
    int                   timer_id;
    struct sigevent       event;
    struct _itimer        itime;


    if((dpp = dispatch_create()) == NULL) {
        fprintf(stderr,
                "%s: Unable to allocate dispatch handle.\n",
```

```
            argv[0]);
    return EXIT_FAILURE;
}

memset(&pool_attr, 0, sizeof pool_attr);
pool_attr.handle = dpp;
/* We are doing resmgr and pulse-type attaches */
pool_attr.context_alloc = dispatch_context_alloc;
pool_attr.block_func = dispatch_block;
pool_attr.unblock_func = dispatch_unblock;
pool_attr.handler_func = dispatch_handler;
pool_attr.context_free = dispatch_context_free;
pool_attr.lo_water = 2;
pool_attr.hi_water = 4;
pool_attr.increment = 1;
pool_attr.maximum = 50;

if((tpp = thread_pool_create(&pool_attr,
                             POOL_FLAG_EXIT_SELF)) == NULL) {
    fprintf(stderr,
            "%s: Unable to initialize thread pool.\n",
            argv[0]);
    return EXIT_FAILURE;
}

iofunc_func_init(_RESMGR_CONNECT_NFUNCS, &connect_func,
                 _RESMGR_IO_NFUNCS, &io_func);
iofunc_attr_init(&attr, S_IFNAM | 0666, 0, 0);

memset(&resmgr_attr, 0, sizeof resmgr_attr);
resmgr_attr.nparts_max = 1;
resmgr_attr.msg_max_size = 2048;

if((id = resmgr_attach(dpp, &resmgr_attr, "/dev/mynull",
             _FTYPE_ANY, 0,
             &connect_func, &io_func, &attr)) == -1) {
    fprintf(stderr, "%s: Unable to attach name.\n", argv[0]);
    return EXIT_FAILURE;
}

/*
 We want to handle our own private messages, of type
 0x5000 to 0x5fff
*/
if(message_attach(dpp, NULL, 0x5000, 0x5fff,
                  &message_handler, NULL) == -1) {
    fprintf(stderr,
       "Unable to attach to private message range.\n");
    return EXIT_FAILURE;
}
```

```
    /* Initialize an event structure, and attach a pulse to it */
    if((event.sigev_code = pulse_attach(dpp,
                            MSG_FLAG_ALLOC_PULSE, 0,
                            &timer_tick, NULL)) == -1) {
        fprintf(stderr, "Unable to attach timer pulse.\n");
        return EXIT_FAILURE;
    }

    /* Connect to our channel */
    if((event.sigev_coid = message_connect(dpp,
                            MSG_FLAG_SIDE_CHANNEL)) == -1) {
        fprintf(stderr, "Unable to attach to channel.\n");
        return EXIT_FAILURE;
    }

    event.sigev_notify = SIGEV_PULSE;
    event.sigev_priority = -1;
    /*
     We could create several timers and use different
     sigev values for each
    */
    event.sigev_value.sival_int = 0;

    if((timer_id = TimerCreate(CLOCK_REALTIME, &event)) == -1) {;
        fprintf(stderr,
                "Unable to attach channel and connection.\n");
        return EXIT_FAILURE;
    }

    /* And now setup our timer to fire every second */
    itime.nsec = 1000000000;
    itime.interval_nsec = 1000000000;
    TimerSettime(timer_id, 0, &itime, NULL);

    /* Never returns */
    thread_pool_start(tpp);
    return EXIT_SUCCESS;
}
```

For more examples using the dispatch interface, see *dispatch_create()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

dispatch_block(), *dispatch_create()*, *dispatch_handler()*, *dispatch_unblock()*, *message_connect()*, *message_detach()*, **_msg_info**, *pulse_attach()*

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

message_connect()

Create a connection to a channel

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int message_connect( dispatch_t * dpp,
                     int flags );
```

Arguments:

dpp The dispatch handle, as returned by *dispatch_create()*.

flags Currently, the following flag is defined in **<sys/dispatch.h>**:

- MSG_FLAG_SIDE_CHANNEL — request the connection ID be returned from a different space. This ID will be greater than any valid file descriptor. Once created there's no difference in the use of the messaging primitives on these IDs.

Library:

libc

Description:

The *message_connect()* function creates a connection to the channel used by dispatch handle *dpp*. This function calls the *ConnectAttach()* kernel call. To detach the connection ID, you can call *ConnectDetach()*.

The *message_connect()* function works only when the dispatch blocking type is receive, i.e. attaches were done for resmgr, message, or select "type" events. If no attaches were done yet, the *message_connect()* call fails, since dispatch can't determine if receive or sigwait blocking will be used.

Returns:

A connection ID used by the message primitives, or -1 if an error occurs (*errno* is set).

Errors:

EAGAIN	All kernel connection objects are in use.
EINVAL	Dispatch *dpp* doesn't have a channel.

Examples:

```
#include <sys/dispatch.h>
#include <time.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   dispatch_t    *dpp;
   int           flags, coid, id;

   if( ( dpp = dispatch_create() ) == NULL ) {
     fprintf( stderr,
        "%s: Unable to allocate dispatch context.\n",
        argv[0] );
     return EXIT_FAILURE;
   }

   id = resmgr_attach ( ... );

   .
   .
   .

   if ( (coid = message_connect ( dpp, flags )) == -1 ) {
      fprintf ( stderr, "Failed to create connection \
                to channel used by dispatch.\n");
      return 1;
```

```
    }
    /* else connection to channel used by dispatch is created */

    .
    .
    .
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

Dispatch *dpp* must block on messages.

See also:

ConnectAttach(), *message_attach()*

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

message_detach()

Detach a message range

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int message_detach( dispatch_t * dpp,
                    int low,
                    int high,
                    int flags );
```

Arguments:

dpp	The dispatch handle, as returned by *dispatch_create()*.
low, *high*	The range of messages that you want to detach the handler from. This range must be the same one that you passed to *message_attach()*.
flags	Reserved.

Library:

libc

Description:

The *message_detach()* function detaches the message type [*low*, *high*], for dispatch handle *dpp*, that was attached with *message_attach()*.

Returns:

Zero on success. If an error occurs, -1 or the following error constant:

EINVAL	The range [*low*, *high*] doesn't match the range that you attached with *message_attach()*.

Examples:

```
#include <sys/dispatch.h>
#include <time.h>
#include <stdio.h>
#include <stdlib.h>

int my_func( ... ) {

   ...

}

int main( int argc, char **argv ) {
   dispatch_t    *dpp;
   int           lo=0x2000, hi=0x2fff, flags=0;

   if( ( dpp = dispatch_create() ) == NULL ) {
     fprintf( stderr,
       "%s: Unable to allocate dispatch handle.\n",
       argv[0] );
     return EXIT_FAILURE;
   }

   ...

   if( message_attach( dpp, NULL, lo, hi,
                       &my_func, NULL) == -1 ) {
     fprintf( stderr,
       "%s: Failed to attach message range.\n",
        argv[0] );
     return 1;
   }

   ...

   if ( message_detach ( dpp, lo, hi, flags ) == -1 ) {
      fprintf ( stderr,
        "Failed to detach message range from %d to %d.\n",
        lo, hi );
      return 1;
   }
   /* else message was detached */

   ...
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

message_attach()

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

min()

Return the lesser of two numbers

Synopsis:

```
#include <stdlib.h>

#define min(a,b) ...
```

Arguments:

a,b The numbers that you want to get the lesser of.

Library:

libc

Description:

The *min()* function returns the lesser of two values.

☞ The *min()* function is for C programs only. For C+ and C++ programs, use the *__max()* or *__min()* macros.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    int a;

    a = min( 1, 10 );
    printf( "The value is: %d\n", a );
    return EXIT_SUCCESS;
}
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

max()

Synopsis:

```
#include <sys/types.h>
#include <sys/stat.h>

int mkdir( const char *path,
           mode_t mode );
```

Arguments:

path The name of the directory that you want to create.

mode The permissions for the directory, modified by the process's file-creation mask (see *umask()*).

The access permissions for the file or directory are specified as a combination of bits defined in the **<sys/stat.h>** header file. For more information, see "Access permissions" in the documentation for *stat()*.

Library:

libc

Description:

The *mkdir()* function creates a new subdirectory named *path*. The *path* can be relative to the current working directory or it can be an absolute path name.

The directory's owner ID is set to the process's effective user ID. The directory's group ID is set to the group ID of the parent directory (if the parent set-group ID bit is set) or to the process's effective group ID.

The newly created directory is empty.

The *mkdir()* function marks the *st_atime*, *st_ctime*, and *st_mtime* fields of the directory for update. Also, the *st_ctime* and *st_mtime* fields of the parent directory are also updated.

Returns:

`0`, or `-1` if an error occurs (*errno* is set).

Errors:

EACCES — Search permission is denied for a component of *path*, or write permission is denied on the parent directory of *path*.

EEXIST — The directory named by *path* already exists.

ELOOP — Too many levels of symbolic links.

EMLINK — The link count of the parent directory would exceed LINK_MAX.

ENAMETOOLONG — The length of *path* exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT — A pathname component in the specified *path* does not exist, or *path* is an empty string.

ENOSPC — The filesystem does not contain enough space to hold the contents of the new directory or to extend the parent directory.

ENOSYS — This function is not supported for this path.

ENOTDIR — A component of *path* is not a directory.

EROFS — The parent directory resides on a read-only filesystem.

Examples:

To make a new directory called **`/src`** in **`/hd`**:

```
#include <sys/types.h>
#include <sys/stat.h>
#include <stdlib.h>

int main( void )
```

```
{
    (void)mkdir( "/hd/src",
                 S_IRWXU |
                 S_IRGRP | S_IXGRP |
                 S_IROTH | S_IXOTH );

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chdir(), chmod(), errno, getcwd(), mknod(), rmdir(), stat(), umask()

mkfifo()

Create a FIFO special file

Synopsis:

```
#include <sys/types.h>
#include <sys/stat.h>

int mkfifo( const char* path,
            mode_t mode );
```

Arguments:

path The pathname that you want to use for the FIFO special file.

mode The file permission bits for the new FIFO. For more information, see "Access permissions" in the documentation for *stat()*.

Library:

libc

Description:

The *mkfifo()* function creates a new FIFO special file named by the pathname pointed to by *path*. The file permission bits of the new FIFO are initialized from *mode*, modified by the process's creation mask (see *umask()*). Bits that are set in *mode* other than the file permission bits are ignored.

The FIFO owner ID is set to the process's effective user ID and the FIFO's group ID is set to the process's effective group ID.

If *mkfifo()* succeeds, the *st_ftime*, *st_ctime*, *st_atime* and *st_mtime* fields of the file are marked for update. Also, the *st_ctime* and *st_mtime* fields of the directory that contains the new entry are marked for update.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES A component of the path prefix denies search permission.

EEXIST The named file already exists.

ENAMETOOLONG
The length of the *path* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT A component of the path prefix doesn't exist, or the *path* arguments points to an empty string.

ENOSPC The directory that would contain the new file cannot be extended, or the filesystem is out of file allocation resources (that is, the disk is full).

ENOSYS This function isn't supported for this path.

ENOTDIR A component of the path prefix isn't a directory.

EROFS The named file resides on a read-only filesystem.

Examples:

```
#include <sys/types.h>
#include <sys/stat.h>
#include <stdlib.h>

int main( void )
{
    (void)mkfifo( "hd/qnx", S_IRUSR | S_IWUSR );

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chmod(), errno, mknod(), pipe(), stat(), umask()

mknod()

Make a new filesystem entry point

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>
#include <sys/stat.h>

int mknod( const char * path,
           mode_t mode,
           dev_t dev );
```

Arguments:

path The pathname that you want to use for the file.

mode A set of bits that define the file type and access permissions that you want to use. The valid file types are:

- S_IFDIR — create a directory.
- S_IFIFO — create a FIFO.

For more information, see "Access permissions" in the documentation for *stat()*.

dev Ignored.

Library:

libc

Description:

The *mknod()* makes a file, named *path*, using the file type encoded in the *mode* argument. Supported file types are directories and FIFOs.

☞ This function is included to enhance portability with software written for Unix-compatible operating systems. For POSIX portability, use *mkdir()* or *mkfifo()* instead.

To make a directory with read-write-execute permissions for everyone, you could use the following:

```
mknod (name, S_IFDIR | 0777, 0);
```

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES A component of the *path* prefix denies search permission, or write permission is denied for the parent directory.

EEXIST The named file already exists.

ELOOP Too many levels of symbolic links or prefixes.

EMLINK The link count of the parent directory would exceed LINK_MAX.

ENAMETOOLONG
The length of the *path* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT A component of the *path* prefix doesn't exist, or the *path* arguments points to an empty string.

ENOSPC The directory that would contain the new file cannot be extended or the filesystem is out of file allocation resources (that is, the disk is full).

ENOSYS The *mknod()* function isn't implemented for the filesystem specified in *path*.

ENOTDIR A component of the *path* prefix isn't a directory.

EROFS The named file resides on a read-only filesystem.

Examples:

```
/*
 * Create special files as a directory or FIFO
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/stat.h>
#include <unistd.h>

int main( int argc, char** argv )
  {
    int c;
    mode_t mode = 0666;
    int ecode = 0;

    if( argc == 1 ) {
      printf( "Use: %s [-d directory] ... [-f fifo] ... \n",
          argv[0] );
      return( 0 );
    }

    while(( c = getopt( argc, argv, "d:f:" )) != -1 ) {
      switch( c ) {
        case 'd': mode = S_IFDIR | 0666; break;
        case 'f': mode = S_IFIFO | 0666; break;
      }

      if( mknod( optarg, mode, 0 ) != 0 ) {
        perror( optarg );
        ++ecode;
      }
    }

    return( ecode );
  }
```

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

errno, *mkdir()*, *mkfifo()*

mkstemp()

Make a unique temporary filename, and open the file

Synopsis:

```
#include <stdlib.h>

int mkstemp( char* template );
```

Arguments:

template A template for the filename that you want to use. This template can be any file name with some number of Xs appended to it, for example **/tmp/temp.XXXX**.

Library:

libc

Description:

The *mkstemp()* function takes the given file name template and overwrites a portion of it to create a filename. This file name is unique and suitable for use by the application. The trailing Xs are replaced with the current process number and/or a unique letter combination. The number of unique file names *mkstemp()* can return depends on the number of Xs provided; if you specify six Xs, *mkstemp()* tests roughly 26^6 combinations.

The *mkstemp()* function (unlike *mktemp()*) creates the template file, mode 0600 (i.e. read-write for the owner), returning a file descriptor opened for reading and writing. This avoids the race between testing for a file's existence and opening it for use.

Returns:

The file descriptor of the temporary file, or -1 if no suitable file could be created; *errno* is set.

Errors:

ENOTDIR — The pathname portion of the template isn't an existing directory.

This function may also set *errno* to any value specified by *open()* and *stat()*.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

It's possible to run out of letters. The *mkstemp()* function doesn't check to determine whether the file name part of template exceeds the maximum allowable filename length.

For portability with X/Open standards prior to XPG4v2, use *tmpfile()* instead.

See also:

chmod(). getpid(). mktemp(), open() stat(). tmpfile(), tmpnam()

mktemp()

Make a unique temporary filename

Synopsis:

```
#include <stdlib.h>

char* mktemp( char* template );
```

Arguments:

template A template for the filename that you want to use. This template can be any file name with some number of Xs appended to it, for example **/tmp/temp.XXXX**.

Library:

libc

Description:

The *mktemp()* function takes the given file name template and overwrites a portion of it to create a filename. This file name is unique and suitable for use by the application. The trailing Xs are replaced with the current process number and/or a unique letter combination. The number of unique file names *mktemp()* can return depends on the number of Xs provided; if you specify six Xs, *mktemp()* tests roughly 26^6 combinations.

The *mkstemp()* function (unlike this function) creates the template file, mode 0600 (i.e. read-write for the owner), returning a file descriptor opened for reading and writing. This avoids the race between testing for a file's existence and opening it for use.

Returns:

A pointer to the template, or NULL on failure; *errno* is set.

Errors:

ENOTDIR The pathname portion of the template isn't an existing directory.

This function may also set *errno* to any value specified by *stat()*.

Classification:

Legacy Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

In general, avoid using *mktemp()*, because a hostile process can exploit a race condition in the time between the generation of a temporary filename by *mktemp()* and the invoker's use of the temporary name. Use *mkstemp()* instead.

This function can create only 26 unique file names per thread for each unique template.

See also:

chmod(). getpid(). mkstemp(), open() stat(). tmpfile(), tmpnam()

Synopsis:

```
#include <time.h>

time_t mktime( struct tm* timeptr );
```

Arguments:

timeptr	A pointer to a **tm** structure that contains the local time that you want to convert.

Library:

libc

Description:

The *mktime()* function converts the local time information in the **struct tm** specified by *timeptr* into a calendar time (Coordinated Universal Time) with the same encoding used by the *time()* function.

The original values of the *tm_sec*, *tm_min*, *tm_hour*, *tm_mday* and *tm_mon* fields aren't restricted to the ranges described for **struct tm**. If these fields aren't in their proper ranges, they're adjusted so that they are. Values for the fields *tm_wday* and *tm_yday* are computed after all the other fields have been adjusted.

The original value of *tm_isdst* is interpreted as follows:

< 0	This field is computed as well.
0	Daylight savings time isn't in effect.
> 0	Daylight savings time is in effect.

Whenever *mktime()* is called, the *tzset()* function is also called.

Returns:

The converted calendar time, or -1 if *mktime()* can't convert it.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

static const char *week_day[] = {
    "Sunday", "Monday", "Tuesday", "Wednesday",
    "Thursday", "Friday", "Saturday"
};

int main( void )
{
    struct tm new_year;
    time_t t;

    new_year.tm_year  = 2001 - 1900;
    new_year.tm_mon   = 0;
    new_year.tm_mday  = 1;
    new_year.tm_hour  = 0;
    new_year.tm_min   = 0;
    new_year.tm_sec   = 0;
    new_year.tm_isdst = 0;

    t = mktime( &new_year );
    if ( t == (time_t)-1)
        printf("No conversion possible.\n");
    else
        printf( "The 21st century begins on a %s.\n",
            week_day[ new_year.tm_wday ] );

    return EXIT_SUCCESS;
}
```

produces the output:

```
The 21st century begins on a Monday.
```

Classification:

ANSI, POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

asctime(), asctime_r(), clock(), ctime(), ctime_r(), difftime(), gmtime(), gmtime_r(), localtime(), localtime_r(), strftime(), time(), `tm`*, tzset()*

mlock()

Lock a buffer in physical memory

Synopsis:

```
#include <sys/mman.h>

int mlock( const void * addr,
           size_t len );
```

Library:

libc

Description:

The *mlock()* function isn't currently supported.

Returns:

-1 to indicate an error (*errno* is set).

Errors:

ENOSYS The *mlock()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mlockall(), munlock(), munlockall()

mlockall()

Lock a process's address space

Synopsis:

```
#include <sys/mman.h>

int mlockall( int flags );
```

Library:

libc

Description:

The *mlockall()* function isn't currently supported.

Returns:

-1 to indicate an error (*errno* is set.)

Errors:

ENOSYS The *mlockall()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mlock(), munlock(), munlockall()

mmap(), *mmap64()*

Map a memory region into a process's address space

Synopsis:

```
#include <sys/mman.h>

void * mmap( void * addr,
             size_t len,
             int prot,
             int flags,
             int fildes,
             off_t off );

void * mmap64( void * addr,
               size_t len,
               int prot,
               int flags,
               int fildes,
               off64_t off );
```

Arguments:

addr NULL, or a pointer to where you want the object to be mapped in the calling process's address space.

len The number of bytes to map into the caller's address space. It can't be 0.

prot The access capabilities that you want to use for the memory region being mapped. You can combine at least the following protection bits, as defined in **<sys/mman.h>**:

- PROT_EXEC — the region can be executed.
- PROT_NOCACHE — disable caching of the region (e.g. so it can be used to access dual-ported memory).
- PROT_NONE — the region can't be accessed.
- PROT_READ — the region can be read.
- PROT_WRITE — the region can be written.

flags Flags that specify further information about handling the mapped region; see below.

fildes The file descriptor for a shared memory object, or NOFD if you're mapping physical memory.

off The offset into shared memory of the location that you want to start mapping.

Library:

libc

Description:

The *mmap()* function maps a region within the object beginning at *off* and continuing for *len* into the caller's address space and returns the location.

Typically, you don't need to use *addr*; you can just pass NULL instead. If you set *addr* to a non-NULL value, whether the object is mapped depends on whether or not you set MAP_FIXED in *flags*:

MAP_FIXED is set

The object is mapped to the address in *addr*, or the function fails.

MAP_FIXED isn't set

The value of *addr* is taken as a hint as to where to map the object in the calling process's address space. The mapped area won't overlay any current mapped areas.

There are two parts to the *flags* parameter. The first part is a type (masked by the MAP_TYPE bits), which you must specify as one of the following:

MAP_PRIVATE The mapping is private to the calling process. It allocates system RAM and copies the current object.

MAP_SHARED The mapping may be shared by many processes.

You can OR the following flags into the above type to further specify the mapping:

MAP_ANON
: This is most commonly used with MAP_PRIVATE. The *fildes* parameter must be NOFD. The allocated memory is zero-filled. This is equivalent to opening **/dev/zero**.

MAP_BELOW16M
: Used with MAP_PHYS | MAP_ANON. The allocated memory area resides in physical memory below 16M. This is important for using DMA with ISA bus devices.

MAP_FIXED
: Map the object to the address specified by *addr*. If this area is already mapped, the call changes the existing mapping of the area.

☞ Use MAP_FIXED with caution. Not all memory models support it. In general, you should assume that you can MAP_FIXED only at an address (and size) that a call to *mmap()* without MAP_FIXED returned.

A memory area being mapped with MAP_FIXED is first unmapped by the system using the same memory area. See *munmap()* for details.

MAP_LAZY
: Delay acquiring system memory, and copying or zero-filling the MAP_PRIVATE or MAP_ANON pages, until an access to the area has occurred. If you set this flag, and there's no system memory at the time of the access, the thread gets a SIGBUS with a code of BUS_ADRERR. This flag is a hint to the memory manager.

MAP_PHYS
: Physical memory is required. The *fildes* parameter must be NOFD. When used with MAP_PRIVATE or MAP_SHARED, the offset specifies the exact

physical address to map (e.g. for video frame buffers), and is equivalent to opening **/dev/mem**. If used with MAP_ANON, then physically contiguous memory is allocated.

MAP_NOX64K and MAP_BELOW16M are used to further define the MAP_ANON allocated memory (useful on x86 only).

You should use *mmap_device_memory()* instead of MAP_PHYS.

MAP_NOX64K (Useful on x86 only). Used with MAP_PHYS | MAP_ANON. Prevent the allocated memory area from crossing a 64K boundary. This may be important to some DMA devices. If more than 64K is requested, the area begins on a 64K boundary.

MAP_STACK This flag tells the memory allocator what the MAP_ANON memory will be used for. It's only a hint.

Using the mapping flags described above, a process can easily share memory between processes:

```
/* Map in a shared memory region */
fd = shm_open( "/datapoints", O_RDWR, 0777 );
addr = mmap( 0, len, PROT_READ|PROT_WRITE, MAP_SHARED, fd, 0 );
```

To share memory with hardware such as video memory on an x86 platform:

```
/* Map in VGA display memory */
addr = mmap( 0,
             65536,
             PROT_READ|PROT_WRITE,
             MAP_PHYS|MAP_SHARED,
             NOFD,
             0xa0000 );
```

To allocate a DMA buffer for a bus-mastering PCI network card:

```
/* Allocate a physically contiguous buffer */
addr = mmap( 0,
             262144,
             PROT_READ|PROT_WRITE|PROT_NOCACHE,
             MAP_PHYS|MAP_ANON,
             NOFD,
             0 );
```

Returns:

The address of the mapped-in object, or MAP_FAILED if an error occurred (*errno* is set).

Errors:

EACCES	The file descriptor in *fildes* isn't open for reading, or you specified PROT_WRITE and MAP_SHARED, and *fildes* isn't open for writing.
EBADF	Invalid file descriptor, *fildes*.
EINVAL	Invalid *flags* type, or *len* is 0.
ENODEV	The *fildes* argument refers to an object for which *mmap()* is meaningless (e.g. a terminal).
ENOMEM	You specified MAP_FIXED, and the address range requested is outside of the allowed process address range, or there wasn't enough memory to satisfy the request.
ENXIO	The address from *off* for *len* bytes is invalid for the requested object, or you specified MAP_FIXED, and *addr*, *len*, and *off* are invalid for the requested object.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <fcntl.h>
#include <errno.h>
#include <stdlib.h>
```

```
#include <sys/mman.h>

int main(int argc, char *argv[])
{
  int          i;
  unsigned char         *addr, c;

  /* Map BIOS ROM */
  addr = mmap(0, 0x10000, PROT_READ | PROT_WRITE,
              MAP_SHARED | MAP_PHYS, NOFD, 0xf0000);
  if (addr == MAP_FAILED) {
    fprintf(stderr, "mmap failed : %s\n",
     strerror(errno));
     return EXIT_FAILURE;
  }
  printf("Map addr is %p\n",(void*) addr);

  for (i = 0; i < 3 * 80; ++i) {
     c = *addr++;
     if (c >= ' ' && c <= 0x7f)
       putchar(c);
     else
       putchar('.');
  }

  return EXIT_SUCCESS;
}
```

Classification:

mmap() is POSIX 1003.1; *mmap64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mmap_device_memory(), munmap()

mmap_device_io()

Gain access to a device's registers

Synopsis:

```
#include <stdint.h>
#include <sys/mman.h>

uintptr_t mmap_device_io( size_t len,
                          uint64_t io );
```

Arguments:

len The number of bytes of device I/O memory that you want to access. It can't be 0.

io The address of the area that you want to access.

Library:

libc

Description:

The *mmap_device_io()* function maps *len* bytes of device I/O memory at *io* and makes it accessible via the *in*()* and *out*()* functions in **<hw/inout.h>**.

Returns:

A handle to the device's I/O memory, or MAP_DEVICE_FAILED if an error occurs (*errno* is set).

Errors:

EINVAL Invalid *flags* type, or *len* is 0.

ENOMEM The address range requested is outside of the allowed process address range, or there wasn't enough memory to satisfy the request.

ENXIO The address from *io* for *len* bytes is invalid.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

You need I/O privileges to use the result of the *mmap_device_io()* function. The calling thread may call *ThreadCtl()* with the _NTO_TCTL_IO command to establish these privileges.

See also:

mmap(), *mmap_device_memory()*, *munmap_device_io()*

mmap_device_memory()

Map a device's physical memory into a process's address space

Synopsis:

```
#include <sys/mman.h>

void * mmap_device_memory( void * addr,
                           size_t len,
                           int prot,
                           int flags,
                           uint64_t physical );
```

Arguments:

addr — NULL, or a pointer to where you want to map the object in the calling process's address space.

len — The number of bytes you want to map into the caller's address space. It can't be 0.

prot — The access capabilities that you want to use for the memory region being mapped. You can use a combination of at least the following protection bits, as defined in **<sys/mman.h>**:

- PROT_EXEC — the region can be executed.
- PROT_NOCACHE — disable the caching of the region (e.g. to access dual-ported memory).

Read the architecture guide for your processor; you may need to add special instructions. For example, if you specify PROT_NOCACHE on a PPC device, you may need to issue special *eieio()* instructions to ensure that writes occur in a desired order.

- PROT_NONE — the region can't be accessed.
- PROT_READ — the region can be read.
- PROT_WRITE — the region can be written.

flags — Specifies further information about handling the mapped region. You can use the following flag:

- MAP_FIXED — map the object to the address specified by *addr*. If this area is already mapped, the call changes the existing mapping of the area.

Use MAP_FIXED with caution. Not all memory models support it. In general, you should assume that you can MAP_FIXED only at an address (and size) that a call to *mmap()* without MAP_FIXED returned. These restrictions will be removed from the user-to-user protection model with the full VM (available with a later version of the QNX Neutrino OS).

A memory area being mapped with MAP_FIXED is first unmapped by the system using the same memory area. See *munmap()* for details.

This function already uses MAP_SHARED ORed with MAP_PHYS (see *mmap()* for a description of these flags).

physical The physical address of the memory to map into the caller's address space.

Library:

libc

Description:

The *mmap_device_memory()* function maps *len* bytes of a device's *physical* memory address into the caller's address space at the location returned by *mmap_device_memory()*.

You should use this function instead of using *mmap()* with the MAP_PHYS flag.

Typically, you don't need to use *addr*; you can just pass NULL instead. If you set *addr* to a non-NULL value, whether the object is mapped depends on whether or not you set MAP_FIXED in *flags*:

MAP_FIXED is set

The object is mapped to the address in *addr*, or the function fails.

MAP_FIXED isn't set

The value of *addr* is taken as a hint as to where to map the object in the calling process's address space. The mapped area won't overlay any current mapped areas.

Returns:

The address of the mapped-in object, or MAP_FAILED if an error occurs (*errno* is set).

Errors:

EINVAL	Invalid *flags* type, or *len* is 0.
ENOMEM	The address range requested is outside of the allowed process address range, or there wasn't enough memory to satisfy the request.
ENXIO	The address from *physical* for *len* bytes is invalid for the requested object, or MAP_FIXED was specified and *addr*, *len*, and *physical* are invalid for the requested object.

Examples:

```
/* map in the physical memory, 0xb8000 is text mode VGA video memory */

ptr = mmap_device_memory( 0, len, PROT_READ|PROT_WRITE|PROT_NOCACHE, 0, 0xb8000 );
if ( ptr == MAP_FAILED ) {
    perror( "mmap_device_memory for physical address 0xb8000 failed" );
    exit( EXIT_FAILURE );
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

You need I/O privileges to use the result of the *mmap_device_memory()* function. The calling thread may call *ThreadCtl()* with the _NTO_TCTL_IO command to establish these privileges.

See also:

mmap(), *mmap_device_io()*, *munmap_device_memory()*

modem_open()

Open a serial port

Synopsis:

```
#include <sys/modem.h>

int modem_open( char* device,
                speed_t baud );
```

Arguments:

device The path name of the serial port that you want to open.

baud Zero, or the baud rate that you want to use.

Library:

libc

Description:

The *modem_open()* function opens a serial port identified by *device*. The device is set to raw mode by changing the control flags using *tcgetattr()* and *tcsetattr()* as follows:

```
termio.c_cflag = CS8|IHFLOW|OHFLOW|CREAD|HUPCL;
termio.c_iflag = BRKINT;
termio.c_lflag = IEXTEN;
termio.c_oflag = 0;
```

Any pending input or output characters are discarded.

If *baud* is nonzero, then the baud rate is changed to that value.

Returns:

An open file descriptor, or -1 on failure (*errno* is set).

Errors:

EACCES Search permission is denied on a component of the path prefix, or the file doesn't exist.

EBADFSYS	While attempting to open the named file, either the file itself or a component of the path prefix was found to be corrupted. A system failure — from which no automatic recovery is possible — occurred while the file was being written to, or while the directory was being updated. You'll need to invoke appropriate systems-administration procedures to correct this situation before proceeding.
EBUSY	The file named by *device* is a block special device that's already open for writing, or *device* names a file that's on a filesystem mounted on a block special device that's already open for writing, or *device* is in use.
EINTR	The open operation was interrupted by a signal.
EISDIR	The named *device* is a directory.
ELOOP	Too many levels of symbolic links or prefixes.
EMFILE	Too many file descriptors are currently in use by this process.
ENAMETOOLONG	The length of the *device* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.
ENFILE	Too many files are currently open in the system.
ENOENT	The named *device* doesn't exist, or the *path* argument points to an empty string.
ENOSYS	The *modem_open()* function isn't implemented for the filesystem specified in *device*.
ENOTDIR	A component of the path prefix isn't a directory.
ENXIO	No process has the file open for reading.

Examples:

```
#include <stdlib.h>
#include <unistd.h>
#include <string.h>
#include <fcntl.h>
#include <sys/modem.h>
#include <stdio.h>
#include <errno.h>

/*
 curstate curflags newstate newflags newtimeout
 newquiet retvalue pattern response
*/

struct modem_script table[] ={
  {1, 0,            1, 0,              2,  5, 0,
   NULL,              "ATZ\\r\\P0a"},
  {1, 0,            2, 0,              30, 5, 0,
   "*ok*",            "ATDT5910934"},
  {2, MODEM_BAUD,   3, MODEM_LASTLINE, 10, 5, 0,
   "*connect*",       NULL},
  {3, 0,            4, 0,              8,  5, 0,
   "*login:*",        "guest"},
  {4, MODEM_NOECHO, 5, 0,              15, 5, 0,
   "*password:*",     "xxxx"},
  {5, 0,            0, 0,              0,  0, 0,
   "*$ *",            NULL},
  {0, 0,            0, 0,              0,  0, 1,
   "*no carrier*",    NULL},
  {0, 0,            0, 0,              0,  0, 2,
   "*no answer*",     NULL},
  {0, 0,            0, 0,              0,  0, 3,
   "*no dialtone*",   NULL},
  {0, 0,            0, 0,              0,  0, 4,
   "*busy*",          NULL},
  { NULL }
};

void io(char* progress, char* in, char* out) {

    if(progress)
        printf("progress: %s\n", progress);

    if(in)
        printf("input: %s\n", in);

    if(out)
        printf("output: %s\n", out);
}
```

```
int main(int argc, char* argv[]) {
    int        fd, status;
    speed_t    baud = -1;

    if((fd = modem_open(argv[1], 0)) == -1) {
        fprintf(stderr, "Unable to open %s: %s\n",
                argv[1], strerror(errno));
        exit(1);
    }

    status = modem_script( fd, table, &baud,
                           &io, NULL );
    printf("status=%d  baud=%d\n", status, baud);
    exit(status);
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

modem_read(), *modem_script()*, *modem_write()*

modem_read()

Read bytes from a file descriptor

Synopsis:

```
#include <sys/modem.h>

int modem_read( int fd,
                char* buf,
                int bufsize,
                int quiet,
                int timeout,
                int flags,
                int (*cancel)(void) );
```

Arguments:

fd The file descriptor for the device that you want to read from; see *modem_open()*.

buf A pointer to a buffer where the function can store the data.

bufsize The size of the buffer, in bytes.

quiet The maximum time to wait for more input after receiving at least one characters, in tenths of a second.

timeout The maximum time to wait for any input, in tenths of a second.

flags Flags that you can use to filter and map received characters; any combination of:

- MODEM_ALLOWCASE — preserve the case of incoming characters. Without this flag, all letters are mapped to lower case.
- MODEM_ALLOWCTRL — allow control characters. Without this flag, control characters are discarded.
- MODEM_ALLOW8BIT — preserve the top bit of incoming characters. Without this flag, the top bit is set to zero for all characters.

- MODEM_LASTLINE — discard all previously received characters when a newline is received followed by more characters. Without this flag, *buf* may contain multiple lines. If an automatic login script may be presented with an arbitrary text screen before the login prompt, you can use this flag to discard all but the login line, reducing the possibility of false matches.

cancel NULL, or a callback that's called whenever the *quiet* time period expires while waiting for more input.

Library:

libc

Description:

The *modem_read()* function reads up to *bufsize* bytes from the device specified by the file descriptor, *fd*, and places them into the buffer pointed to by *buf*.

If no characters are received within the given *timeout*, *modem_read()* returns with -1.

When at least one character has been received, *modem_read()* returns if the flow of incoming characters stops for at least the *quiet* time period. The number of characters saved in *buf* is returned.

If you provide a *cancel* function, it's called once each *quiet* time period while waiting for input. If this function returns a nonzero value, *modem_read()* returns -1 immediately and sets *errno* to ETIMEDOUT. You can use the *cancel* function as a callback in a graphical dialer that needs to support a cancel button to stop a script (see *modem_script()*).

Returns:

Zero for success, or -1 on failure (*errno* is set).

Errors:

EAGAIN	The O_NONBLOCK flag is set on this *fd*, and the process would have been blocked in trying to perform this operation.
EBADF	The argument *fd* is invalid, or the file isn't opened for reading.
EINTR	The *readcond()* call was interrupted by the process being signalled.
EIO	This process isn't currently able to read data from this *fd*.
ENOSYS	This function isn't supported for this *fd*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Read the *Caveats*
Thread	Read the *Caveats*

Caveats:

Depending on what you do in your *cancel* function, *modem_read()* may or not be signal handler or thread-safe.

See also:

modem_open(), *modem_script()*, *modem_write()*

modem_script()

Run a script on a device

Synopsis:

```
#include <sys/modem.h>

int modem_script( int fd,
                  struct modem_script* table,
                  speed_t* baud,
                  void (*io)(
                         char* progress,
                         char* in,
                         char* out ),
                  int (*cancel)(void) );
```

Arguments:

fd	The file descriptor for the device that you want to read from; see *modem_open()*.
table	An array of **modem_script** structures that comprise a script of commands that you want to run on the device; see below.
baud	A pointer to a **speed_t** where the function can store the baud rate (if you script says to do so).
io	A function that's called to process each string that's emitted or received.
cancel	NULL, or a callback function that's called whenever the *newquiet* time period (specified in the script) expires while waiting for input.

Library:

libc

Description:

The *modem_script()* function runs the script *table* on the device associated with the file descriptor *fd*. The script implements a simple state machine that emits strings and waits for responses.

Each string that's emitted or received is passed to the function *io()* as follows:

Call	Description
*(*io)(str, 0, 0)*	Emitted *progress* string
*(*io)(0, str, 0)*	Received string
*(*io)(0, 0, str)*	Emitted *response* string

This lets an application set up a callback that can display the script's interaction in a status window.

If you provide a *cancel* function, it's called once each *newquiet* 1/10 of a second while waiting for input. If this function returns a nonzero value, the read returns immediately with -1 and *errno* is set to ETIMEDOUT. You can use the *cancel* function as a callback in a graphical dialer that needs to support a cancel button to stop a script.

The *table* is an array of **modem_script** structures that contain the following members:

char *curstate*
: The current state. Execution always begins at state 1, which must be the first array element of *table*. Multiple elements may have the same current state, in which case any received input is matched against each *pattern* member for that state.

int *curflags*
: The flags to use on a pattern match of a response:

- MODEM_NOECHO — don't echo the response through the *io()* callback.
- MODEM_BAUD — extract any number in the response and assign it to *baud*.

char *newstate*	When a pattern match occurs with *pattern*, this is the next state. A state transition causes *response* to be output and *newflags*, *newtimeout*, and *newquiet* to be saved and associated with the new state. Changing to a new state of 0 causes *modem_script()* to return with the value in *retvalue*.
int *newflags*	Saved on a state transition and passed to *modem_read()* when waiting for a response in the new state. For information about these flags, see *modem_read()*.
int *newtimeout*	Saved on a state transition and passed to *modem_read()* when waiting for a response in the new state. This timeout is described in *modem_read()*.
int *newquiet*	Saved on a state transition and passed to *modem_read()* when waiting for a response in the new state. This quiet timeout is described in *modem_read()*.
short *retvalue*	The return value when the script terminates with a pattern match, and the new state is 0.
char* *pattern*	A pattern to match against received characters. The pattern is matched using *fnmatch()*. Only patterns in the current state or the wildcard state of 0 are matched. On a match, the current state changes to *newstate*.
char* *response*	On a *pattern* match, this response is output to the device. If the *curflags* don't have MODEM_NOECHO set, the response is given to the callback function passed as the *io* parameter.
char* *progress*	On a *pattern* match, this progress string is passed to the callback function passed as the *io* parameter.

Here's an example that demonstrates the operation of the script:

```
/*
 curstate curflags newstate newflags newtimeout
 newquiet retvalue pattern response
*/

struct modem_script table[] ={
  {1, 0,            1, 0,              2,  5, 0,
   NULL,              "ATZ\\r\\P0a"},
  {1, 0,            2, 0,              30, 5, 0,
   "*ok*",            "ATDT5910934"},
  {2, MODEM_BAUD,   3, MODEM_LASTLINE, 10, 5, 0,
   "*connect*",       NULL},
  {3, 0,            4, 0,              8,  5, 0,
   "*login:*",        "guest"},
  {4, MODEM_NOECHO, 5, 0,              15, 5, 0,
   "*password:*",     "xxxx"},
  {5, 0,            0, 0,              0,  0, 0,
   "*$ *",            NULL},
  {0, 0,            0, 0,              0,  0, 1,
   "*no carrier*",    NULL},
  {0, 0,            0, 0,              0,  0, 2,
   "*no answer*",     NULL},
  {0, 0,            0, 0,              0,  0, 3,
   "*no dialtone*",   NULL},
  {0, 0,            0, 0,              0,  0, 4,
   "*busy*",          NULL},
  { NULL }
};
```

When this script is passed to *modem_script()*, the current state is set to 1, and the output is **ATZ** (the *response* in the first array element).

While in any state, *modem_script()* waits for input, matching it against the current state or the wildcard state of 0.

State 1

Input	Action
ok	Go to state 2 and emit **ATDT1-591-0934**. The flags to be used in the new state are set to 0, the quiet time in the new state is set to 5/10 of a second, and the timeout time in the new state is set to 30 seconds.
no carrier	Go to state 0 (the termination newstate), return with the contents of *retvalue* (1).
no answer	Go to state 0 (the termination newstate), return with the contents of *retvalue* (2).
no dialtone	Go to state 0 (the termination newstate), return with the contents of *retvalue* (3).
busy	Go to state 0 (the termination newstate), return with the contents of *retvalue* (4).

State 2

Input	Action
connect	Go to state 3 and don't emit anything to the device. The flags to be used in the new state are set to MODEM_LASTLINE, the quiet time in the new state is set to 5/10 of a second, and the timeout time in the new state is set to 10 seconds. Since the current flags are MODEM_BAUD, the baud rate is extracted from the connect message.
no carrier	Same as previous table
no answer	Same as previous table
no dialtone	Same as previous table
busy	Same as previous table

State 3

Input	Action
login	Go to state 4 and emit **guest**. The flags to be used in the new state are set to 0, the quiet time in the new state is set to 5/10 of a second, and the timeout time in the new state is set to 8 seconds.
no carrier	Same as previous table
no answer	Same as previous table
no dialtone	Same as previous table
busy	Same as previous table

State 4

Input	Action
password	Go to state 5 and emit **xxxx**. The flags to be used in the new state are set to 0, the quiet time in the new state is set to 5/10 of a second, and the timeout time in the new state is set to 15 seconds. Since the current flags are MODEM_NOECHO, the password response **xxxx** isn't sent to the *io()* callback.
no carrier	Same as previous table
no answer	Same as previous table
no dialtone	Same as previous table
busy	Same as previous table

State 5

Input	Action
`*$ *`	Go to state 0 (the termination newstate), return with the contents of *retvalue* (0).
`*no carrier*`	Same as previous table
`*no answer*`	Same as previous table
`*no dialtone*`	Same as previous table
`*busy*`	Same as previous table

If you set the flag MODEM_BAUD for a state, then any number embedded in a matching response is extracted and assigned as a number to the *baud* parameter.

If you don't set the flag MODEM_NOECHO for a state, then all emitted strings are also given to the passed *io* function as `(*io)(0, 0,` *response*`)`.

Returns:

The *retvalue* member of a script entry that terminates the script. This will always be a positive number. If *modem_script* fails, it returns -1 and sets *errno*.

Errors:

EAGAIN	The O_NONBLOCK flag is set for the file descriptor, and the process would be delayed in the write operation.
EBADF	The file descriptor, *fildes*, isn't a valid file descriptor open for writing.
EINTR	The write operation was interrupted by a signal, and either no data was transferred, or the resource manager responsible for that file doesn't report partial transfers.
EIO	A physical I/O error occurred. The precise meaning depends on the device.

EPIPE — An attempt was made to write to a pipe (or FIFO) that isn't open for reading by any process. A SIGPIPE signal is also sent to the process.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Read the *Caveats*
Thread	Read the *Caveats*

Caveats:

Depending on what you do in your *cancel* function, it might or might not be safe to call *modem_script()* from a signal handler or a multithreaded program.

See also:

modem_open(), *modem_read()*, *modem_write()*

modem_write()

Write a string to a device

Synopsis:

```
#include <sys/modem.h>

int modem_write( int fd,
                 char* str );
```

Arguments:

fd The file descriptor for the device that you want to write to; see *modem_open()*.

str The string that you want to write.

Library:

libc

Description:

The *modem_write()* function writes the string *str* to the device specified by the file descriptor *fd*. Just before writing each character, all buffered input from the same device is flushed. After writing each character, an attempt to read an echo is made. The intent is to write a string without its appearing back in the input stream even if the device is echoing each character written.

If the **** character appears in *str*, then the character following it is interpreted by *modem_write()*, and instead of both being written, they're treated as a special escape sequence that causes the following actions to be taken:

Escape	Description
\r	Output a carriage return.
\n	Output a newline.

continued...

Escape	Description
\x*hh*	Output the single character whose hex representation follows as *hh*.
\B	Send a 500 msec break on the line using *tcsendbreak()*.
\D	Drop the line for 1 second using *tcdropline()*.
\P*hh*	Pause for *hh* 1/10 of a second where *hh* is two hex characters.

Returns:

Zero on success, -1 on failure (*errno* is set).

Errors:

EAGAIN	The O_NONBLOCK flag is set for the file descriptor, and the process would be delayed in the write operation.
EBADF	The file descriptor, *fildes*, isn't a valid file descriptor open for writing.
EINTR	The write operation was interrupted by a signal, and either no data was transferred, or the resource manager responsible for that file doesn't report partial transfers.
EIO	A physical I/O error occurred. The precise meaning depends on the device.
EPIPE	An attempt was made to write to a pipe (or FIFO) that isn't open for reading by any process. A SIGPIPE signal is also sent to the process.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

modem_open(), *modem_read()*, *modem_script()*

modf(), modff()

Break a number into integral and fractional parts

Synopsis:

```
#include <math.h>

double modf( double value,
             double* iptr );

float modff( float value,
             float* iptr );
```

Arguments:

value The value that you want to break into parts.

iptr A pointer to a location where the function can store the integral part of the number.

Library:

libm

Description:

The *modf()* and *modff()* functions break the given *value* into integral and fractional parts, each of which has the same sign as the argument. They store the integral part as a **double** in the object pointed to by *iptr*.

Returns:

The signed fractional part of *value*.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

int main( void )
{
    double integral_value, fractional_part;

    fractional_part = modf( 4.5, &integral_value );
    printf( "%f %f\n", fractional_part, integral_value );

    fractional_part = modf( -4.5, &integral_value );
    printf( "%f %f\n", fractional_part, integral_value );

    return EXIT_SUCCESS;
}
```

produces the output:

```
0.500000 4.000000
-0.500000 -4.000000
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

frexp(), *ldexp()*

mount()

Mount a filesystem

Synopsis:

```
#include <sys/mount.h>

int mount( const char* spec,
           const char* dir,
           int flags,
           const char* type,
           const void* data,
     int datalen );
```

Arguments:

spec A null-terminated string describing a special device (e.g. **/dev/hd0t77**), or NULL if there's no special device.

dir A null-terminated string that names the directory that you want to mount (e.g. **/mnt/home**).

flags Flags that are passed to the driver:

- _MFLAG_OCB — ignore the special device string, and contact all servers.
- _MOUNT_READONLY — mark the filesystem mountpoint as read-only.
- _MOUNT_NOEXEC — don't allow executables to load.
- _MOUNT_NOSUID — don't honor setuid bits on the filesystem.
- _MOUNT_NOCREAT — don't allow file creation on the filesystem.
- _MOUNT_OFF32 — limit **off_t** to 32 bits.
- _MOUNT_NOATIME — disable logging of file access times.
- _MOUNT_BEFORE — call *resmgr_attach()* with RESMGR_FLAG_BEFORE.

- _MOUNT_AFTER — call *resmgr_attach()* with RESMGR_FLAG_AFTER.
- _MOUNT_OPAQUE — call *resmgr_attach()* with RESMGR_FLAG_OPAQUE.
- _MOUNT_UNMOUNT — unmount this path.
- _MOUNT_REMOUNT — this path is already mounted; perform an update.
- _MOUNT_FORCE — force an unmount or a remount change.
- _MOUNT_ENUMERATE — autodetect on this device.

type A null-terminated string with the filesystem type (e.g. **nfs**, **cifs**, **qnx4**, **ext2**, **network**).

data A pointer to additional data to be sent to the manager. If *datalen* is <0, the data points to a null-terminated string.

datalen The length of the data, in bytes, that's being sent to the server, or <0 if the data is a null-terminated string.

Library:

libc

Description:

The *mount()* function sends a request to servers to mount the services provided by *spec* and *type* at *dir*.

If you set _MFLAG_OCB in the flags, then the special device string is ignored, and all servers are contacted. If you don't set this bit, and the special device *spec* exists, then only the server that created that device is contacted, and the full path to *spec* is provided.

If *datalen* is any value <0, and there's a data pointer, the function assumes that the data pointer is a pointer to a string.

Returns:

-1 on failure; no server supports the request (*errno* is set).

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

resmgr_attach(), *umount()*

Writing a Resource Manager in *Programmer's Guide*

mount_parse_generic_args()

Strip off common mount arguments

Synopsis:

```
#include <sys/mount.h>

char * mount_parse_generic_args( char * options,
                                 int * flags );
```

Arguments:

options The string of options that you want to parse; see below.

flags A pointer to a location where the function can store a set of bits corresponding to the options that it finds; see below.

Library:

libc

Description:

The *mount_parse_generic_args()* function allows you to strip out common flags to help you parse mount arguments. This is useful when you want to create a custom mount utility.

Here's a list of the supported options that may be stripped:

Option:	Set/Clear this bit:	Description:
after	Set _MOUNT_AFTER	Call *resmgr_attach()* with RESMGR_FLAG_AFTER.
atime	Clear _MOUNT_ATIME	Log file access times (default).
before	Set _MOUNT_BEFORE	Call *resmgr_attach()* with RESMGR_FLAG_BEFORE.
creat	Clear _MOUNT_CREAT	Allow file creation on the filesystem (default).

continued...

Option:	Set/Clear this bit:	Description:
enumerate	Set _MOUNT_ENUMERATE	Auto-detect on this device.
exec	Clear _MOUNT_NOEXEC	Load executables (default).
force	Set _MOUNT_FORCE	Force an unmount or a remount change.
noatime	Set _MOUNT_NOATIME	Disable logging of file access times.
nocreat	Set _MOUNT_NOCREAT	Don't allow file creation on the filesystem.
noexec	Set _MOUNT_NOEXEC	Don't allow executables to load.
nostat	Set _MFLAG_OCB	Don't attempt to *stat()* the special device before mounting (i.e. **-t**).
nosuid	Set _MOUNT_NOSUID	Don't honor setuid bits on the filesystem.
opaque	Set _MOUNT_OPAQUE	Call *resmgr_attach()* with RESMGR_FLAG_OPAQUE.
remount	Set _MOUNT_REMOUNT	This path is already mounted; perform an update.
ro	Set _MOUNT_READONLY	Mark the filesystem mountpoint as read-only.
rw	Clear _MOUNT_READONLY	Mark the filesystem mountpoint as read/write (default).
suid	Clear _MOUNT_SUID	Honor setuid bits on the filesystem (default).
update	Set _MOUNT_REMOUNT	This path is already mounted, perform an update.

Returns:

A string pointing to unprocessed options.

Examples:

```
while ((c = getopt(argv, argc, "o:"))) {
  switch (c) {
  case 'o':
    if ((mysteryop = mount_parse_generic_args(optarg, &flags))) {
           /*
            You can do your own getsubopt type processing here
            mysteryop is stripped of the common options.
           */
    }
    break;
  }
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mount(), *resmgr_attach()*, *umount()*

mount in the *Utilities Reference*

Writing a Resource Manager in *Programmer's Guide*

mprobe()

Perform consistency check on memory

Synopsis:

```
#include <malloc.h>

enum mcheck_status mprobe(void * ptr);
```

Arguments:

ptr A pointer to the start of the heap block.

Library:

libc

Description:

The *mprobe()* function attempts to perform consistency checks on an allocated heap block.

Consistency checks look for inconsistencies within the block header or in the block trailer byte. They may also detect block overruns.

The level of checking provided depends on which version of the allocator you've linked the application with:

- C library — minimal consistency checking.
- Nondebug version of the **malloc** library — a slightly greater level of consistency checking.
- Debug version of the **malloc** library — extensive consistency checking, with tuning available through the use of the *mallopt()* function.

Returns:

One of the values of the **mcheck_status** enumeration:

MCHECK_DISABLED

Consistency checking isn't currently enabled, or consistency information isn't available for this block.

MCHECK_OK	There are no inconsistencies in this block.
MCHECK_HEAD	The block header is corrupted.
MCHECK_TAIL	The block trailer byte is corrupted or there has been a block overrun.
MCHECK_FREE	The *ptr* argument doesn't point to an allocated heap block.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mallopt(), mcheck()

The Heap Analysis chapter in the *Programmer's Guide*.

mprotect()

Change memory protection

Synopsis:

```
#include <sys/mman.h>

int mprotect( const void * addr,
              size_t len,
              int prot );
```

Arguments:

addr The beginning of the range of addresses whose protection you want to change.

len The length of the range of addresses, in bytes.

prot The new access capabilities for the mapped memory region(s). You can combine the following bits, which are defined in **<sys/mman.h>**:

- PROT_EXEC — the region can be executed.
- PROT_NOCACHE — disable caching of the region (for example, to access dual ported memory).
- PROT_NONE — the region can't be accessed.
- PROT_READ — the region can be read.
- PROT_WRITE — the region can be written.

Library:

libc

Description:

The *mprotect()* function changes the access protections on any mappings residing in the range starting at *addr*, and continuing for *len* bytes.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

☞ If *mprotect()* fails, the protections on some of the pages in the address range starting at *addr* and continuing for *len* bytes may have been changed.

Errors:

EACCES The memory object wasn't opened for read, regardless of the protection specified.

The memory object wasn't opened for write, and PROT_WRITE was specified for a MAP_SHARED type mapping.

EAGAIN The *prot* argument specifies PROT_WRITE on a MAP_PRIVATE mapping, and there's insufficient memory resources to reserve for locking the private pages (if required).

ENOMEM The addresses in the range starting at *addr* and continuing for *len* bytes are outside the range allowed for the address space of a process, or specify one or more pages that are not mapped.

The *prot* argument specifies PROT_WRITE on a MAP_PRIVATE mapping, and locking the private pages (if required) would need more space than the system can supply to reserve for doing so.

ENOSYS The function *mprotect()* isn't supported by this implementation.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mmap(), munmap(), shm_open(), shm_unlink()

mq_close()

Close a message queue

Synopsis:

```
#include <mqueue.h>

int mq_close( mqd_t mqdes );
```

Arguments:

mqdes The message-queue descriptor, returned by *mq_open()*, of the message queue that you want to close.

Library:

libc

Description:

The *mq_close()* function removes the association between *mqdes* and a message queue. If the current process attaches a notify to this queue for notification, the attachment is eliminated. If this queue is unlinked before the call to *mq_close()*, and this process is the last process to call *mq_close()* on the queue, then the queue is destroyed, along with its contents.

Calling *close()* with *mqdes* has the same effect as calling *mq_close()*.

Returns:

-1 if an error occurred (*errno* is set). Any other value indicates success.

Errors:

EBADF Invalid queue *mqdes*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mq_open(), mq_unlink()

mq_getattr()

Get a message queue's attributes

Synopsis:

```
#include <mqueue.h>

int mq_getattr( mqd_t mqdes,
                struct mq_attr* mqstat );
```

Arguments:

mqdes The message-queue descriptor, returned by *mq_open()*, of the message queue that you want to get the attributes of.

mqstat A pointer to a **mq_attr** structure where the function can store the attributes of the message queue. For more information, see below.

Library:

libc

Description:

The *mq_getattr()* function determines the current attributes of the queue referenced by *mqdes*. These attributes are stored in the location pointed to by *mqstat*. The fields of the **mq_attr** structure are as follows:

long *mq_flags* The options set for this open message-queue description (i.e. these options are for the given *mqdes*, not the queue as a whole). This field may have been changed by call to *mq_setattr()* since you opened the queue.

- O_NONBLOCK — no call to *mq_receive()* or *mq_send()* will ever block on this queue. If the queue is in such a condition that the given operation can't be performed without blocking, then an error is returned, and *errno* is set to EAGAIN.

This constant is specified by POSIX 1003.1b.

long *mq_maxmsg*

The maximum number of messages that can be stored on the queue. This value was set when the queue was created.

long *mq_msgsize*

The maximum size of each message on the given message queue. This value was also set when the queue was created.

long *mq_curmsgs*

The number of messages currently on the given queue.

long *mq_sendwait*

The number of threads currently waiting to send a message. This field was eliminated from the POSIX standard after draft 9, but has been resurrected for the QNX implementation. A nonzero value in this field implies that the queue is full.

long *mq_recvwait*

The number of threads currently waiting to receive a message. Like *mq_sendwait*, this field was resurrected for the QNX implementation. A nonzero value in this field implies that the queue is empty.

Returns:

-1 if an error occurred (*errno* is set). Any other value indicates success.

Errors:

EBADF Invalid message queue *mqdes*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mq_close(), *mq_open()*, *mq_receive()*, *mq_send()*, *mq_setattr()*

Ask to be notified when there is a message in the queue

Synopsis:

```
#include <mqueue.h>

int mq_notify(
        mqd_t mqdes,
        const struct sigevent* notification );
```

Arguments:

mqdes	The message-queue descriptor, returned by *mq_open()*, of the message queue that you want to get notification for.
notification	NULL, or a pointer to a **sigevent** structure that describes how you want to be notified.

Library:

libc

Description:

If *notification* isn't NULL, the *mq_notify()* function asks the server to notify the calling process when the queue makes the transition from empty to nonempty. The means by which the server is to notify the process is passed in the **sigevent** structure pointed to by *notification*. Once the message queue server has notified the process of the transition, the notification is removed.

We recommend that you use the following event types in this case:

- SIGEV_SIGNAL
- SIGEV_SIGNAL_CODE
- SIGEV_SIGNAL_THREAD
- SIGEV_PULSE
- SIGEV_INTR

Under normal operation, only one process may register for notification at a time. If a process attempts to attach a notification, and another process is already attached, an error is returned and *errno* is set to EBUSY.

If a process has registered for notification, and another process is blocked on *mq_receive()*, then the *mq_receive()* call is satisfied by any arriving message. The resulting behavior is as if the message queue remained empty.

If *notification* is NULL and the current process is currently registered for notification, then the existing registration is removed.

Returns:

-1 if an error occurred (*errno* is set). Any other value indicates success.

Errors:

EBADF	Invalid message queue *mqdes*.
EBUSY	A process has already registered for notification for the given queue.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mq_open(), *mq_receive()*, *mq_send()*, **sigevent**

mq_open()

Open a message queue

Synopsis:

```
#include <mqueue.h>

mqd_t mq_open( const char * name,
               int oflag,
               ... )
```

Arguments:

name The name of the message queue that you want to open; see below.

oflag You must specify one of O_RDONLY (receive-only), O_WRONLY (send-only) or O_RDWR (send-receive). In addition, you can OR in the following constants to produce the following effects:

- O_CREAT — if *name* doesn't exist, instruct the server to create a new message queue with the given name. If you specify this flag, *mq_open()* uses its *mode* and *mq_attr* arguments; see below.
- O_EXCL — if you set both O_EXCL and O_CREAT, and a message queue *name* exists, the call fails and *errno* is set to EEXIST. Otherwise, the queue is created normally. If you set O_EXCL without O_CREAT, it's ignored.
- O_NONBLOCK — under normal message queue operation, a call to *mq_send()* or *mq_receive()* could block if the message queue is full or empty. If you set this flag, these calls never block. If the queue isn't in a condition to perform the given call, *errno* is set to EAGAIN and the call returns an error.

If you set O_CREAT in the *oflag* argument, you must also pass these arguments to *mq_open()*:

mode The file permissions for the new queue. For more information, see "Access permissions" in the documentation for *stat()*.

If you set any bits other than file permission bits, they're ignored. Read and write permissions are analogous to receive and send permissions; execute permissions are ignored.

mq_attr NULL, or a pointer to an **mq_attr** structure that contains the attributes that you want to use for the new queue. For more information, see *mq_getattr()*.

If *mq_attr* is NULL, the following default attributes are used (provided that no defaults were specified when starting the message queue server):

- *mq_maxmsg*: 1024
- *mq_msgsize*: 4096
- *mq_flags*: 0

If *mq_attr* isn't NULL, the new queue adopts the *mq_maxmsg* and *mq_msgsize* of **mq_attr**. The *mq_flags* flags field is ignored.

Library:

libc

Description:

The *mq_open()* function opens a message queue referred to by *name*, and returns a message queue descriptor by which the queue can be referenced in the future. The name is interpreted as follows:

name	Pathname space entry
entry	*CWD*/*entry*
/*entry*	/dev/mqueue/*entry*
entry/*newentry*	*CWD*/*entry*/*newentry*
/*entry*/*newentry*	/*entry*/*newentry*

where *CWD* is the current working directory for the program at the point that it calls *mq_open()*.

If you want to open a queue on another node, you have to specify the name as **/net/***node***/***mqueue_location*.

If *name* doesn't exist, *mq_open()* examines the third and fourth parameters: a **mode_t** and a pointer to an **mq_attr** structure.

The only time that a call to *mq_open()* with O_CREAT set fails is if you open a message queue and later unlink it, but never close it. Like their file counterparts, an unlinked queue that hasn't yet been closed must continue to exist; an attempt to recreate such a message queue fails, and *errno* is set to ENOENT.

Message queues persist — like files — even after the processes that created them end. A message queue is destroyed when the last process connected to it unlinks from the queue by calling *mq_unlink()*.

Returns:

A valid message queue descriptor if the queue is successfully created, or -1 (*errno* is set).

Errors:

EACCES	The message queue exists, and you don't have permission to open the queue under the given *oflag*, or the message queue doesn't exist, and you don't have permission to create one.
EEXIST	You specified the O_CREAT and O_EXCL flags in *oflag*, and the queue *name* exists.
EINTR	The operation was interrupted by a signal.

EINVAL	You specified the O_CREAT flag in *oflag*, and *mq_attr* wasn't NULL, but some values in the **mq_attr** structure were invalid.
ELOOP	Too many levels of symbolic links or prefixes.
EMFILE	Too many file descriptors are in use by the calling process.
ENAMETOOLONG	The length of *name* exceeds PATH_MAX.
ENOENT	You didn't set the O_CREAT flag, and the queue *name* doesn't exist.
ENOSPC	The message queue server has run out of memory.
ENOSYS	The *mq_open()* function isn't implemented for the filesystem specified in *name*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mq_close(), mq_getattr(), mq_notify(), mq_receive(), mq_send(), mq_setattr(), mq_timedreceive(), mq_timedsend(), mq_unlink()

mq_receive()

Receive a message from a queue

Synopsis:

```
#include <mqueue.h>

ssize_t mq_receive( mqd_t mqdes,
                    char* msg_ptr,
                    size_t msg_len,
                    unsigned int* msg_prio );
```

Arguments:

mqdes	The message-queue descriptor, returned by *mq_open()*, of the message queue that you want to get a message from.
msg_ptr	A pointer to a buffer where the function can store the message received.
msg_len	The message size of the given queue.
msg_prio	NULL, or a pointer to a location where the function can store the priority of the message received.

Library:

libc

Description:

The *mq_receive()* function is used to receive the oldest of the highest priority messages in the queue specified by *mqdes*. The priority of the message received is put in the location pointed to by *msg_prio*, the data itself in the location pointed to by *msg_ptr*, and the size received is be returned.

If you call *mq_receive()* with a *msg_len* of anything other than the *mq_msgsize* of the specified queue, then *mq_receive()* returns an error, and *errno* is set to EINVAL.

If there are no messages on the queue specified, and O_NONBLOCK wasn't set in *oflag* during *mq_open()*, and MQ_NONBLOCK isn't

present in the queue's *mq_flags*, then the *mq_receive()* call blocks. If multiple *mq_receive()* calls are blocked on a single queue, then they're unblocked in FIFO order as messages arrive.

Calling *read()* with *mqdes* is analogous to calling *mq_receive()* with a NULL *msg_prio*.

Returns:

The size of the message removed from the queue. If the call fails, -1 is returned as the size, no message is removed from the queue, and *errno* is set.

Errors:

EAGAIN	The O_NONBLOCK or MQ_NONBLOCK flags were set and there are no messages currently on the specified queue.
EBADF	The *mqdes* argument doesn't represent a valid queue open for reading.
EINTR	The operation was interrupted by a signal.
EINVAL	The *msg_ptr* argument isn't a valid pointer, or *msg_len* is less than 0, or *msg_len* is less than the message size specified in *mq_open()*. The default message size is 4096 bytes.
EMSGSIZE	The given *msg_len* is shorter than the *mq_msgsize* for the given queue *or* the given *msg_len* is too short for the message that would have been received.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mq_close(), *mq_open()*, *mq_send()*, *mq_timedreceive()*, *read()*

Synopsis:

```
#include <mqueue.h>

int mq_send( mqd_t mqdes,
             const char * msg_ptr,
             size_t msg_len,
             unsigned int msg_prio );
```

Arguments:

mqdes	The message-queue descriptor, returned by *mq_open()*, of the message queue that you want to send a message to.
msg_ptr	A pointer to the message that you want to send.
msg_len	The size of the message.
msg_prio	The priority of the message, in the range from 0 to (MQ_PRIO_MAX-1).

Library:

libc

Description:

The *mq_send()* function puts a message of size *msg_len* and pointed to by *msg_ptr* into the queue indicated by *mqdes*. The new message has a priority of *msg_prio*.

The queue is maintained in priority order, and in FIFO order within the same priority.

If the number of elements on the specified queue is equal to its *mq_maxmsg*, and O_NONBLOCK (in *oflag* of *mq_open()*) has been set, the call to *mq_send()* blocks. It becomes unblocked when there's room on the queue to send the given message. If more than one *mq_send()* is blocked on a given queue, and space becomes available

in that queue to send, then the *mq_send()* with the highest priority message is unblocked.

Calling *write()* with *mqdes* is analogous to calling *mq_send()* with a *msg_prio* of 0.

Returns:

-1 if an error occurred (*errno* is set). Any other value indicates success.

Errors:

EAGAIN	The O_NONBLOCK flag was set when opening the queue, and the specified queue is full.
EBADF	The *mqdes* argument doesn't represent a valid message queue descriptor, or *mqdes* wasn't opened for writing.
EINTR	The call was interrupted by a signal.
EINVAL	One of the following cases is true: • *msg_len* was negative • *msg_prio* was greater than (MQ_PRIO_MAX-1) • *msg_prio* was less than 0
EMSGSIZE	The *msg_len* argument was greater than the *msgsize* associated with the specified queue.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

mq_close(), *mq_open()*, *mq_receive()*, *mq_timedsend()*

mq_setattr()

Set a queue's attributes

Synopsis:

```
#include <mqueue.h>

int mq_setattr( mqd_t mqdes,
                const struct mq_attr* mqstat,
                struct mq_attr* omqstat );
```

Arguments:

mqdes The message-queue descriptor, returned by *mq_open()*, of the message queue that you want to set the attributes of.

mqstat A pointer to a **mq_attr** structure that specifies the attributes that you want to use for the message queue. For more information about this structure, see *mq_getattr()*; for information about which attributes you can set, see below.

omqstat NULL, or a pointer to a **mq_attr** structure where the function can store the old attributes of the message queue.

Library:

libc

Description:

The *mq_setattr()* function sets the *mq_flags* field for the specified queue (passed as the *mq_flags* field in *mqstat*). If *omqstat* isn't NULL, then the old attribute structure is stored in the location that it points to.

This function ignores the *mq_maxmsg*, *mq_msgsize*, and *mq_curmsgs* fields of *mqstat*. The *mq_flags* field is the bit-wise OR of zero or more of the following constants:

O_NONBLOCK

No *mq_receive()* or *mq_send()* will ever block on this queue. If the queue is in such a condition that the given operation can't be

performed without blocking, then an error is returned, and *errno* is set to EAGAIN.

This constant is specified by POSIX 1003.1b.

The settings that you make for *mq_flags* apply only to the given message-queue description (i.e. locally), not to the queue itself.

Returns:

-1 if the function couldn't change the attributes (*errno* is set). Any other value indicates success.

Errors:

EBADF Invalid message queue *mqdes*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mq_getattr(), *mq_open()*, *mq_receive()*, *mq_send()*

mq_timedreceive()

Receive a message from a message queue

Synopsis:

```
#include <mqueue.h>
#include <time.h>

ssize_t mq_timedreceive(
                mqd_t mqdes,
                char * msg_ptr,
                size_t msg_len,
                unsigned int * msg_prio,
                const struct timespec * abs_timeout );
```

Arguments:

mqdes	The descriptor of the message queue you want to receive a message from, returned by *mq_open()*.
msg_ptr	A pointer to a buffer where the function can store the message data.
msg_len	The size of the buffer, in bytes.
msg_prio	NULL, or a pointer to a location where the function can store the priority of the message that it removed from the queue.
abs_timeout	A pointer to a **timespec** structure that specifies the *absolute* time (not the relative time to the current time) to wait before the function stops trying to receive messages.

Library:

libc

Description:

The *mq_timedreceive()* function receives the oldest of the highest priority messages in the queue specified by *mqdes*.

If you call *mq_timedreceive()* with a *msg_len* of anything other than the *mq_msgsize* of the specified queue, then *mq_timedreceive()* returns an error, and *errno* is set to EINVAL.

If there are no messages on the queue specified, and O_NONBLOCK isn't set in *oflag* during *mq_open()*, and MQ_NONBLOCK isn't present in the queue's *mq_flags*, then the *mq_timedreceive()* call blocks. If multiple *mq_timedreceive()* calls are blocked on a single queue, then they're unblocked in FIFO order as messages arrive.

Calling *read()* with *mqdes* is analogous to calling *mq_timedreceive()* with a NULL *msg_prio*.

Returns:

The size of the message removed from the queue, or -1 if an error occurred (no message is removed from the queue, and *errno* is set).

Errors:

EAGAIN	The O_NONBLOCK or MQ_NONBLOCK flags were set and there are no messages currently on the specified queue.
EBADF	The *mqdes* argument doesn't represent a valid queue open for reading.
EINTR	The operation was interrupted by a signal.
EINVAL	The *msg_ptr* argument isn't a valid pointer, or *msg_len* is less than 0, or *msg_len* is less than the message size specified in *mq_open()*. The default message size is 4096 bytes.
EMSGSIZE	The given *msg_len* is shorter than the *mq_msgsize* for the given queue *or* the given *msg_len* is too short for the message that would have been received.
ETIMEDOUT	The timeout value was exceeded.

Examples:

Specify an absolute timeout of 1 second:

```
struct   timespec tm;

clock_gettime(CLOCK_REALTIME, &tm);
tm.tv_sec += 1;
if( 0 > mq_timedreceive( fd, buf, 4096, NULL,  t ) )  {
  ...
}
```

Classification:

POSIX 1003.1d (draft)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mq_close(), *mq_open()*, *mq_receive()*, *mq_send()*, *mq_timedsend()*, **timespec**

mq_timedsend()

Send a message to a message queue

Synopsis:

```
#include <mqueue.h>
#include <time.h>

int mq_timedsend( mqd_t mqdes,
                  const char * msg_ptr,
                  size_t msg_len,
                  unsigned int msg_prio,
                  const struct timespec * abs_timeout );
```

Arguments:

mqdes	The descriptor of the message queue you want to put the message into, returned by *mq_open()*.
msg_ptr	A pointer to the message data.
msg_len	The size of the buffer, in bytes.
msg_prio	The priority of the message, in the range from 0 to (MQ_PRIO_MAX-1).
abs_timeout	A pointer to a **timespec** structure that specifies the *absolute* time (not the relative time to the current time) to wait before the function stops trying to receive messages.

Library:

libc

Description:

The *mq_timedsend()* function puts a message of size *msg_len* and pointed to by *msg_ptr* into the queue indicated by *mqdes*. The new message has a priority of *msg_prio*.

The queue maintained is in priority order, and in FIFO order within the same priority.

If the number of elements on the specified queue is equal to its *mq_maxmsg*, and neither O_NONBLOCK (in *oflag* of *mq_open()*) nor MQ_NONBLOCK (in the queue's *mq_flags*) has been set, the call to *mq_timedsend()* blocks. It becomes unblocked when there's room on the queue to send the given message. If more than one *mq_timedsend()* is blocked on a given queue, and space becomes available in that queue to send, then the *mq_timedsend()* with the highest priority message is unblocked.

Calling *write()* with *mqdes* is analogous to calling *mq_timedsend()* with a *msg_prio* of 0.

Returns:

-1 if an error occurred (*errno* is set). Any other value indicates success.

Errors:

EAGAIN	The O_NONBLOCK flag is set when opening the queue, or the MQ_NONBLOCK flag is set in its attributes, and the specified queue is full.
EBADF	The *mqdes* argument doesn't represent a valid message queue descriptor, or *mqdes* isn't opened for writing.
EINTR	The call was interrupted by a signal.
EINVAL	One of the following is true: • The *msg_len* is negative. • The *msg_prio* is greater than (MQ_PRIO_MAX-1). • The *msg_prio* is less than 0. • The MQ_PRIO_RESTRICT flag is set in the *mq_attr* member of *mqdes*, and *msg_prio* is greater than the priority of the calling process.

EMSGSIZE	The *msg_len* argument is greater than the *msgsize* associated with the specified queue.
ETIMEDOUT	The timeout value was exceeded.

Examples:

See the example for *mq_timedreceive()*.

Classification:

POSIX 1003.1d (draft)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mq_close(), *mq_open()*, *mq_receive()*, *mq_send()*, *mq_timedreceive()*, **`timespec`**

mq_unlink()

Remove a queue

Synopsis:

```
#include <mqueue.h>

int mq_unlink( const char* name );
```

Arguments:

name The name of the message queue that you want to unlink.

Library:

libc

Description:

The *mq_unlink()* function removes the queue with the given *name*.

If some process has the queue open when the call to *mq_unlink()* is made, then the actual deletion of the queue is postponed until it has been closed. If a queue exists in the netherworld between unlinking and the actual removal of the queue, then *all* calls to open a queue with the given name fail (even if O_CREAT is present in *oflag*). Once the queue is deleted, all elements currently on it are freed. Due to the lazy deletion of queues, it's impossible for any process to be blocked on the message queue when it's deleted.

Calling *unlink()* with a name that resolves to the message queue server's namespace (e.g. **/dev/mqueue/my_queue**) is analogous to calling *mq_unlink()* with *name* set to the last elements of the pathname (e.g. **my_queue**).

Returns:

-1 if the queue wasn't successfully unlinked (*errno* is set). Any other value indicates that the queue was successfully unlinked.

Errors:

EACCES — You don't have permission to unlink the specified queue.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *name* exceeds PATH_MAX.

ENOENT — The queue *name* doesn't exist.

ENOSYS — The *mq_unlink()* function isn't implemented for the filesystem specified in *path*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mq_close(), *mq_open()*, *unlink()*

mrand48()

Generate a pseudo-random signed **long** *integer*

Synopsis:

```
#include <stdlib.h>

long mrand48( void );
```

Library:

libc

Description:

The *mrand48()* function uses a linear congruential algorithm and 48-bit integer arithmetic to generate a signed **long** integer uniformly distributed over the interval $[-2^{31}, 2^{31})$.

Call one of *lcong48()*, *seed48()*, or *srand48()* to initialize the random-number generator before calling *drand48()*, *lrand48()*, or *mrand48()*.

The *jrand48()* function is a thread-safe version of *mrand48()*.

Returns:

A pseudo-random **long** integer.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

drand48(), *erand48()*, *jrand48()*, *lcong48()*, *lrand48()*, *nrand48()*, *seed48()*, *srand48()*

_msg_info

Information about a message

Synopsis:

```
struct _msg_info { /* _msg_info _server_info */
uint32_t nd; /*  client      server */
uint32_t srcnd; /*  server      n/a */
pid_t pid; /* client server */
int32_t tid; /* thread n/a */
int32_t chid; /* server server */
int32_t scoid; /* server server */
int32_t coid; /* client client */
int32_t msglen; /* msg n/a */
int32_t srcmsglen; /* thread n/a */
int32_t dstmsglen; /* thread n/a */
int16_t priority; /* thread n/a */
int16_t flags; /* n/a client */
uint32_t reserved;
};
```

Description:

The **_msg_info** structure contains information about a message. The members include:

nd	The node descriptor of the client machine as viewed by the server. See “Node descriptors,” below.
srcnd	The node descriptor of the server, as viewed by the client.
pid	The process ID of the sending thread.
tid	The thread ID of the sending thread.
chid	The channel ID that the message was received on.
scoid	The server connection ID.
coid	The client connection ID.
msglen	The number of bytes received.

srcmsglen The length of the source message, in bytes, as sent by *MsgSend*()*. This may be greater than the value in *msglen*. This member is valid only if you set _NTO_CHF_SENDER_LEN in the *flags* argument to *ChannelCreate()* for the channel that received the message.

dstmsglen The length of the client's reply buffer, in bytes, as passed to *MsgSend*()*. This member is valid only if you set _NTO_CHF_REPLY_LEN in the *flags* argument to *ChannelCreate()* for the channel that received the message.

priority The priority of the sending thread.

flags The client has an unblock pending _NTO_MI_UNBLOCK_REQ (i.e. a timeout on the send occurred or a signal was delivered and _NTO_CHF_UNBLOCK is set on the channel).

The *msglen* and *srcmsglen* members are valid only until the next call to *MsgRead*()* or *MsgWrite*()*.

If *msglen* is less than *srcmsglen* and is also less than the receive buffer size, the message is a network transaction that requires more reading of data with *MsgRead*()*.

Node descriptors

The *nd* (node descriptor) is a temporary numeric description of a remote node. For more information, see the Qnet Networking chapter of the *System Architecture* guide.

To:	Use this function:
Compare two *nd* objects	*ND_NODE_CMP()*

continued...

To:	Use this function:
Convert a *nd* to text	*netmgr_ndtostr()*
Convert text to a *nd*	*netmgr_strtond()*

Classification:

QNX Neutrino

See also:

MsgInfo(), *MsgReceive()*, *MsgReceivev()*, *ND_NODE_CMP()*, *netmgr_ndtostr()*, *netmgr_remote_nd()*, *netmgr_strtond()*

MsgDeliverEvent(), MsgDeliverEvent_r()

Deliver an event through a channel

Synopsis:

```
#include <sys/neutrino.h>

int MsgDeliverEvent( int rcvid,
                     const struct sigevent* event );

int MsgDeliverEvent_r(
                   int rcvid,
                   const struct sigevent* event );
```

Arguments:

rcvid The value returned to the server when it receives a message from a client using *MsgReceive*()*.

event A pointer to a **sigevent** structure that contains the event you want to send. These events are defined in **<sys/siginfo.h>**. The type of event is placed in *event.sigev_notify*.

Library:

libc

Description:

The *MsgDeliverEvent()* and *MsgDeliverEvent_r()* kernel calls deliver an *event* from a server to a client through a channel connection. They're typically used to perform async IO and async event notification to clients that don't want to block on a server.

These functions are identical except in the way they indicate errors. See the Returns section for details.

Although the server can explicitly send any event it desires, it's more typical for the server to receive a **struct sigevent** in a message from the client that already contains this data. The message also contains information for the server indicating the conditions on when to notify the client with the event. The server then saves the *rcvid*

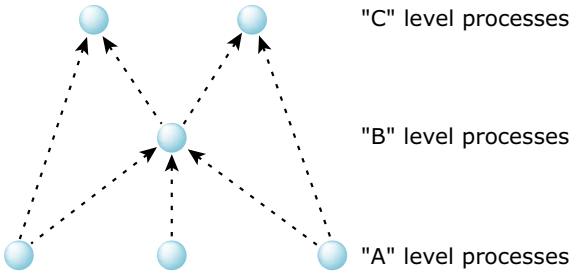
from *MsgReceive*()* and the event from the message without needing to examine the event in any way. When the trigger conditions are met in the server, such as data becoming available, the server calls *MsgDeliverEvent()* with the saved *rcvid* and *event*.

You can use the SIGEV_SIGNAL set of notifications to create an asynchronous design in which the client is interrupted when the event occurs. The client can make this synchronous by using the *SignalWaitinfo()* kernel call to wait for the signal. Where possible, you should use an event-driven synchronous design that's based on SIGEV_PULSE. In this case, the client sends messages to servers, and requests event notification via a pulse.

You're not likely to use the event types SIGEV_UNBLOCK and SIGEV_INTR with this call.

You should use *MsgDeliverEvent()* when two processes need to communicate with each other without the possibility of deadlock. The blocking nature of *MsgSend*()* introduces a hierarchy of processes in which "sends" flow one way and "replies" the other way.

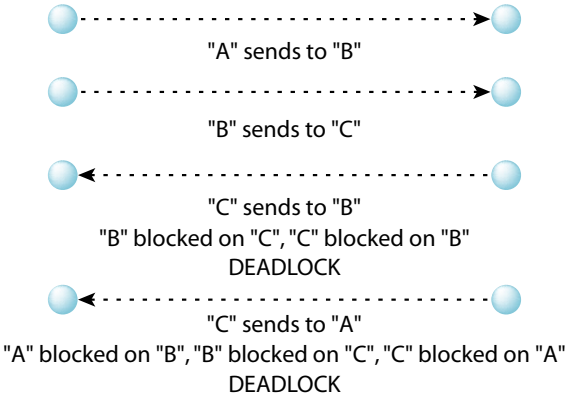
In the following diagram, processes at the A level can send to processes at the B or C level. Processes at the B level can send to the C level but they should never send to the A level. Likewise, processes at the C level can never send to those at the A or B level. To A, B and C are servers. To B, A is a client and C is a server.



A hierarchy of processes.

These hierarchies are simple to establish and ensure a clean

deadlock-free design. If these rules are broken then deadlock can occur as shown below:



A deadlock when sending messages improperly among processes.

There are common situations which require communication to flow backwards through the hierarchy. For example, A sends to B requesting notification when data is available. B immediately replies to A. At some point in the future, B will have the data A requested and will inform A. B can't send a message to A because this might result in deadlock if A decided to send to B at the same time.

The solution is to have B use a nonblocking *MsgDeliverEvent()* to inform A. A receives this pulse and sends a message to B requesting the data. B then replies with the data. This is the basis for asynchronous IO. Clients send to servers and where necessary, servers use pulses to request clients to resend to them as needed. This is illustrated below:

Message	Use
A sends to → B	Async IO request
B replies to → A	Request acknowledged

continued...

Message	Use
B sends pulse to → A	Requested data available
A sends to → B	Request for the data
B replies to → A	Reply with data

☞ In client/server designs, you typically use *MsgDeliverEvent()* in the server, and *MsgSendPulse()* in the client.

Blocking states

None. In the network case, lower priority threads may run.

Native networking

When you use *MsgDeliverEvent()* to communicate across a network, the return code isn't "reliable". In the local case, *MsgDeliverEvent()* always returns a correct success or failure value. But since *MsgDeliverEvent() must be nonblocking*, in the networked case, the return value isn't guaranteed to reflect the actual result on the client's node. This is because *MsgDeliverEvent()* would have to block waiting for the communications between the two **npm-qnet**s.

Generally, this isn't a problem, because *MsgDeliverEvent()* is for the benefit of the client anyway — if the client no longer exists, then the client obviously doesn't care that it didn't get the event. The server usually delivers the event and then goes about its business, regardless of the success or failure of the event delivery.

Returns:

The only difference between these functions is the way they indicate errors:

MsgDeliverEvent()

If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

MsgDeliverEvent_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EAGAIN	The kernel has insufficient resources to enqueue the event.
EBADF	The thread indicated by *rcvid* had its connection detached.
EFAULT	A fault occurred when the kernel tried to access the buffers provided.
ESRCH	The thread indicated by *rcvid* doesn't exist.
ESRVRFAULT	A fault occurred in the server's address space when it tried to write the pulse message to the server's receive message buffer (SIGEV_PULSE only).

Examples:

The following example demonstrates how a client can request a server to notify it with a pulse at a later time (in this case, after the server has slept for two seconds). The server side notifies the client using *MsgDeliverEvent()*.

Here's the header file that's used by **`client.c`** and **`server.c`**:

```
struct my_msg
{
   short type;
   struct sigevent event;
};

#define MY_PULSE_CODE _PULSE_CODE_MINAVAIL+5
#define MSG_GIVE_PULSE _IO_MAX+4
#define MY_SERV "my_server_name"
```

Here's the client side that fills in a **struct sigevent** and then receives a pulse:

```
/* client.c */

#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>
#include <sys/neutrino.h>
#include <sys/iomsg.h>

#include "my_hdr.h"

int main( int argc, char **argv)
{
  int chid, coid, srv_coid, rcvid;
  struct my_msg msg;
  struct _pulse pulse;

  /* we need a channel to receive the pulse notification on */
  chid = ChannelCreate( 0 );

  /* and we need a connection to that channel for the pulse to be
     delivered on */
  coid = ConnectAttach( 0, 0, chid, _NTO_SIDE_CHANNEL, 0 );

  /* fill in the event structure for a pulse */
  SIGEV_PULSE_INIT( &msg.event, coid, SIGEV_PULSE_PRIO_INHERIT,
                    MY_PULSE_CODE, 0 );
  msg.type = MSG_GIVE_PULSE;

  /* find the server */
  if ( (srv_coid = name_open( MY_SERV, 0 )) == -1)
  {
     printf("failed to find server, errno %d\n", errno );
     exit(1);
  }

  /* give the pulse event we initialized above to the server for
     later delivery */
  MsgSend( srv_coid, &msg, sizeof(msg), NULL, 0 );

  /* wait for the pulse from the server */
  rcvid = MsgReceivePulse( chid, &pulse, sizeof( pulse ), NULL );
  printf("got pulse with code %d, waiting for %d\n", pulse.code,
         MY_PULSE_CODE );

  return 0;
```

```
}
```

Here's the server side that delivers the pulse defined by the **struct sigevent**:

```
/* server.c */

#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <errno.h>
#include <sys/neutrino.h>
#include <sys/iomsg.h>
#include <sys/iofunc.h>
#include <sys/dispatch.h>

#include "my_hdr.h"

int main( int argc, char **argv)
{
  int rcvid;
  struct my_msg msg;
  name_attach_t *attach;

  /* attach the name the client will use to find us */
  /* our channel will be in the attach structure */
  if ( (attach = name_attach( NULL, MY_SERV, 0 )) == NULL)
  {
     printf("server:failed to attach name, errno %d\n", errno );
     exit(1);
  }

  /* wait for the message from the client */
  rcvid = MsgReceive( attach->chid, &msg, sizeof( msg ), NULL );
  MsgReply(rcvid, 0, NULL, 0);
  if ( msg.type == MSG_GIVE_PULSE )
  {
     /* wait until it is time to notify the client */
     sleep(2);

     /* deliver notification to client that client requested */
     MsgDeliverEvent( rcvid, &msg.event );
     printf("server:delivered event\n");
  } else
  {
    printf("server: unexpected message \n");
  }

  return 0;
```

```
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

In the case of a pulse event, if the server faults on delivery, the pulse is either lost or an error is returned.

See also:

MsgReceive(), *MsgReceivev()*, *MsgSend()*, *MsgSendPulse()*, *MsgSendv()*, **`sigevent`**, *SignalWaitinfo()*

MsgError(), MsgError_r()

Unblock a client and set its errno

Synopsis:

```
#include <sys/neutrino.h>

int MsgError( int rcvid,
              int error );

int MsgError_r( int rcvid,
                int error );
```

Arguments:

rcvid The receive ID that *MsgReceive*()* returned.

error The error code that you want to set for the client.

Library:

libc

Description:

The *MsgError()* and *MsgError_r()* kernel calls unblock the client's *MsgSend*()* call and set the client's *errno* to *error*. No data is transferred.

If *error* is EOK, the *MsgSend*()* call returns EOK; if *error* is any other value, the *MsgSend*()* call returns -1.

These functions are identical except in the way they indicate errors. See the Returns section for details.

☞ An error number of ERESTART causes the sender to immediately call *MsgSend*()* again. Since send and receive buffers passed to *MsgSend()* may overlap, you shouldn't use ERESTART after a call to *MsgWrite()*.

Blocking states

None. In the network case, lower priority threads may run.

Native networking

MsgError() has increased latency when you use it to communicate across a network — the server is now writing the error code to its local **npm-qnet**, which may need to communicate with the client's **npm-qnet** to actually transfer the error code.

Returns:

The only difference between these functions is the way they indicate errors:

MsgError() — If an error occurs, the function returns -1 and and sets *errno*. Any other value returned indicates success.

MsgError_r() — Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function returns one of the values listed in the Errors section.

Errors:

ESRCH — The thread indicated by *rcvid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ChannelCreate(), *MsgRead()*, *MsgReadv()*, *MsgReceive()*, *MsgReceivev()*, *MsgSend()*, *MsgSendv()*

MsgInfo(), *MsgInfo_r()*

Get additional information about a message

Synopsis:

```
#include <sys/neutrino.h>

int MsgInfo( int rcvid,
             struct _msg_info* info );

int MsgInfo_r( int rcvid,
               struct _msg_info* info );
```

Arguments:

rcvid The return value from *MsgReceive*()*.

info A pointer to a **_msg_info** structure where the function can store information about the message.

Library:

libc

Description:

The *MsgInfo()* and *MsgInfo_r()* kernel calls get additional information about a received message and store it in the specified **_msg_info** structure.

These functions are identical, except in the way they indicate errors. See the Returns section for details.

☞ The *info->msglen* and *info->srcmsglen* members are valid only until the next call to *MsgRead*()* or *MsgWrite*()*.

Blocking states

This call doesn't block.

Returns:

The only difference between these functions is the way they indicate errors:

MsgInfo() If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

MsgInfo_r() EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EFAULT A fault occurred when the kernel tried to access the buffers provided.

ESRCH The thread indicated by *rcvid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ChannelCreate(), **_msg_info**, *MsgRead()*, *MsgReadv()*, *MsgReceive()*, *MsgReceivev()*, *MsgSend()*, *MsgSendv()*,

MsgKeyData(), MsgKeyData_r()

Pass data through a common client

Synopsis:

```
#include <sys/neutrino.h>

int MsgKeyData( int rcvid,
                int op,
                uint32_t key,
                uint32_t * key2,
                const iov_t * msg,
                int parts );

int MsgKeyData_r( int rcvid,
                  int op,
                  uint32_t key,
                  uint32_t * key2,
                  const iov_t * msg,
                  int parts );
```

Arguments:

rcvid The return value from *MsgReceive*()*.

op The operation to perform; one of:

- _NTO_KEYDATA_CALCULATE — calculate a new key.
- _NTO_KEYDATA_VERIFY — verify the key.

key A private value for key (this can be a value returned by the *rand()* function).

key2 A pointer to a key. What the function stores in this location depends on the *op* argument:

- _NTO_KEYDATA_CALCULATE — the new key.
- _NTO_KEYDATA_VERIFY — zero if no tampering has occurred.

msg A pointer to a portion of the reply data to be keyed.

parts The number of parts in *msg*.

Library:

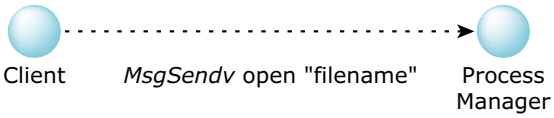
`libc`

Description:

The *MsgKeyData()* and *MsgKeyData_r()* kernel calls allow two privileged processes to pass data through a common client while verifying that the client hasn't modified the data. This is best explained by an example.

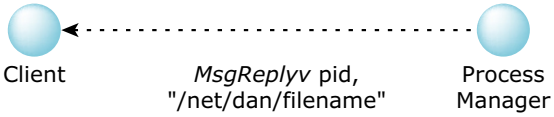
These functions are identical except in the way they indicate errors. See the Returns section for details.

A program calls *open()* with a filename. The *open()* function sends a message to the Process Manager, which is responsible for pathname management.



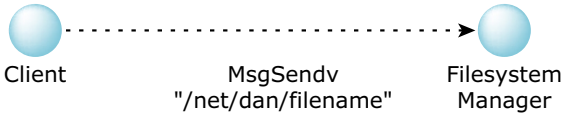
MsgSendv(), client to process manager.

The Process Manager resolves the pathname, resulting in a fully qualified network path and the process ID to send the *open()* request to. This information is replied to the client.



MsgReplyv(), process manager to client.

The client now sends this message to *pid* with the fully qualified pathname.



MsgSendv(), client to filesystem manager

Note that the client can change the pathname before it sends it to the Filesystem Manager. In fact, it could skip the call to the Process Manager and manufacture any pathname it desired. The Filesystem Manager always performs permission checking. Therefore, changing or manufacturing pathnames isn't normally something to be concerned about, except in one case: *chroot()* lets you specify a prefix that must be applied to all pathnames.

In the above example, the client may have had a *chroot()* of **`/net/node2/home/dan`**. This should limit the process from accessing files outside of **`/net/node2/home/dan`**. For example:

User path	Mapped to *chroot()* path
`/bin/ls`	`/net/node2/home/dan/bin/ls`
`/`	`/net/node2/home/dan`

The process has had its root set to a subdirectory, limiting the files it can access. For this to work, it's necessary to prevent the client from changing or manufacturing its own pathnames.

☞ In QNX Neutrino, only the Process Manager handles a user *chroot()*. Unlike a monolithic kernel where the filesystem shares the same address space as the kernel and the *chroot()* information, QNX I/O managers reside in separate address spaces and might not even reside on the same machine.

The solution to this problem is the *MsgKeyData()* call. When the Process Manager receives the *open()* message, it generates the reply data. Before replying, it calls *MsgKeyData()*, with these arguments:

rcvid The return value from *MsgReceive*()*.

op _NTO_KEYDATA_CALCULATE

key A private value for key (this can be a value returned by the *rand()* function).

key2 A pointer to a new key that should be returned to the client in a unkeyed area of the message.

msg A pointer to a portion of the reply data to be keyed.

parts The number of parts in *msg*.

The client now sends the message to the File Manager. On receipt of the message, the File Manager calls *MsgKeyData()* with the same arguments as above, except for:

op _NTO_KEYDATA_VERIFY

key The key that's provided in the message.

MsgKeyData() sets the key pointed to by *key2* to zero if no tampering has occurred.

Note that there are actually two keys involved. A public key that's returned to the client and a private key that the Process Manager generated. The algorithm uses both keys and the data for verification.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

MsgKeyData() If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

MsgKeyData_r() EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

ESRCH The thread indicated by *rcvid* doesn't exist.

EFAULT A fault occurred when the kernel tried to access the buffers provided.

Examples:

```
/*
 * This program demonstrates the use of MsgKeyData() as a way
 * of a client handing off data from a source server to a
 * destination server such that if the client tampers with
 * the data, the destination server will know about it.
 */

#include <errno.h>
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <time.h>
#include <unistd.h>
#include <sys/neutrino.h>

typedef struct {
    int     public_key;
    char    text[10];
} IPC_t;

int chid_src, chid_dst;

void* server_src_thread(void* parm);
void* server_dst_thread(void* parm);

main()
{
    pthread_t   tid[2];
    IPC_t       msg;
    int         coid;
    int         status;

    pthread_create(&tid[0], NULL, server_src_thread, NULL);
```

```
    pthread_create(&tid[1], NULL, server_dst_thread, NULL);
    sleep(3);
    /* give time for channels to be created, sloppy but simple */

    /*
     * Send to server_src_thread for some data.
     * The data will include some text and a public
     * key for that text.
     */

    coid = ConnectAttach(0, 0, chid_src, 0, 0);
    MsgSend(coid, NULL, 0, &msg, sizeof(msg));
    ConnectDetach(coid);

    /*
     * Now send to server_dst_thread with the reply from
     * server_src_thread. We didn't modify the 'text' so it
     * should reply success.  Note that we're including the
     * public key.
     */

    coid = ConnectAttach(0, 0, chid_dst, 0, 0);
    status = MsgSend(coid, &msg, sizeof(msg), &msg, sizeof(msg));
    printf("Sent unmodified text to server_dst_thread.
            Replied with %s\n", status == EOK ? "EOK" : "EINVAL" );

    /*
     * Now tamper with the original 'text' (which we aren't
     * supposed to do) and send to server_dst_thread again
     * but with the modified 'text' and the public key.
     * Since we tampered with the 'text', server_dst_thread
     * should reply failure.
     */

    strcpy(msg.text, "NEWDATA");
    status = MsgSend(coid, &msg, sizeof(msg), &msg, sizeof(msg));
    printf("Sent modified text to server_dst_thread.
            Replied with %s\n", status == EOK ? "EOK" : "EINVAL" );

    return 0;
}

void* server_src_thread(void* parm)
{
    int             rcvid;
    int             private_key;  /* the kernel keeps this */
    iov_t           keyed_area_iov;
    IPC_t           msg;
    struct timespec t;
```



```
    chid_src = ChannelCreate(0);
    while (1) {
        rcvid = MsgReceive(chid_src, &msg, sizeof(msg), NULL);

        /*
         * Give MsgKeyData() the private key and it will
         * calculate a public key for the 'text' member of
         * the message.  The kernel will keep the private key
         * and we reply with the public key.
         * Note that we use the number of nanoseconds since the
         * last second as a way of getting a 32-bit pseudo
         * random number for the private key.
         */

        clock_gettime(CLOCK_REALTIME, &t);
        private_key = t.tv_nsec; /* nanoseconds since last second */
        strcpy(msg.text, "OKDATA");
        SETIOV(&keyed_area_iov, &msg.text, sizeof(msg.text));
        MsgKeyData(rcvid, _NTO_KEYDATA_CALCULATE, private_key,
                   &msg.public_key, &keyed_area_iov, 1);

        MsgReply(rcvid, 0, &msg, sizeof(msg));
    }
    return NULL;
}

void* server_dst_thread(void* parm)
{
    int     rcvid, tampered, status;
    iov_t   keyed_area_iov;
    IPC_t   msg;

    chid_dst = ChannelCreate(0);
    while (1) {
        rcvid = MsgReceive(chid_dst, &msg, sizeof(msg), NULL);

        /*
         * Use the public key to see if the data
         * has been tampered with.
         */

        SETIOV(&keyed_area_iov, &msg.text, sizeof(msg.text));
        MsgKeyData(rcvid, _NTO_KEYDATA_VERIFY, msg.public_key,
                   &tampered, &keyed_area_iov, 1);

        if (tampered)
            status = EINVAL; /* reply: 'text' was modified */
        else
            status = EOK;    /* reply: 'text' was okay */
        MsgReply(rcvid, status, &msg, sizeof(msg));
```

```
    }
    return NULL;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chroot(), MsgReceive(), MsgReceivev(), open(), rand()

MsgRead(), *MsgRead_r()*

Read data from a message

Synopsis:

```
#include <sys/neutrino.h>

int MsgRead( int rcvid,
             void* msg,
             int bytes,
             int offset );

int MsgRead_r( int rcvid,
               void* msg,
               int bytes,
               int offset );
```

Arguments:

rcvid The value returned by *MsgReceive*()* when you received the message.

msg A pointer to a buffer where the function can store the data.

bytes The number of bytes that you want to read. These functions don't let you read past the end of the thread's message; they return the number of bytes actually read.

offset An offset into the thread's send message that indicates where you want to start reading the data.

Library:

libc

Description:

The *MsgRead()* and *MsgRead_r()* kernel calls read data from a message sent by a thread identified by *rcvid*. The thread being read from must not have been replied to and will be in the REPLY-blocked state. Any thread in the receiving process is free to read the message.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The data transfer occurs immediately and the thread doesn't block. The state of the sending thread doesn't change.

You'll use these functions in these situations:

- A message is sent consisting of a fixed header and a variable amount of data. The header contains the byte count of the data. If the data is large and has to be inserted into one or more buffers (like a filesystem cache), rather than read the data into one large buffer and then copy it into several other buffers, *MsgReceive()* reads only the header, and you can call *MsgRead()* one or more times to read data directly into the required buffer(s).
- A message is received but can't be handled at the present time. At some point in the future, an event will occur that will allow the message to be processed. Rather than saving the message until it can be processed (thus using memory resources), you can use *MsgRead()* to reread the message, during which time the sending thread is still blocked.
- Messages that are larger than available buffer space are received. Perhaps the process is an agent between two processes and simply filters the data and passes it on. You can use *MsgRead()* to read the message in small pieces, and use *MsgWrite*()* to write the messages in small pieces.

When you're finished using *MsgRead()*, you must use *MsgReply*()* to ready the REPLY-blocked process and complete the message exchange.

Blocking states

None. In the network case, lower priority threads may run.

Native networking

The *MsgRead()* function has increased latency when it's used to communicate across a network — a message pass is involved from the server to the network manager (at least). Depending on the size of the data transfer, the server's **`npm-qnet`** and the client's **`npm-qnet`** may

need to communicate over the link to read more data bytes from the client.

Returns:

The only difference between the *MsgRead()* and *MsgRead_r()* functions is the way they indicate errors:

MsgRead()	The number of bytes read. If an error occurs, -1 is returned and *errno* is set.
MsgRead_r()	The number of bytes read. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

If you try to read past the end of the thread's message, the functions return the number of bytes they were actually able to read.

Errors:

EFAULT	A fault occurred in a server's address space when it tried to access the caller's message buffers.
ESRCH	The thread indicated by *rcvid* doesn't exist or has had its connection detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

MsgReadv(), MsgReceive(), MsgReceivev(), MsgReply(), MsgReplyv(), MsgWrite(), MsgWritev()

MsgReadv(), MsgReadv_r()

Read data from a message

Synopsis:

```
#include <sys/neutrino.h>

int MsgReadv( int rcvid,
              const iov_t* riov,
              int rparts,
              int offset );

int MsgReadv_r( int rcvid,
                const iov_t* riov,
                int rparts,
                int offset );
```

Arguments:

rcvid	The value returned by *MsgReceive*()* when you received the message.
riov	An array of buffers where the functions can store the data.
rparts	The number of elements in the *riov* array.
offset	An offset into the thread's send message that indicates where you want to start reading the data.

Library:

libc

Description:

The *MsgReadv()* and *MsgReadv_r()* kernel calls read data from a message sent by a thread identified by *rcvid*. The thread being read from must not have been replied to and will be in the REPLY-blocked state. Any thread in the receiving process is free to read the message.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The data transfer occurs immediately and the thread doesn't block. The state of the sending thread doesn't change.

An attempt to read past the end of the thread's message results in fewer bytes returned than requested.

You'll use these functions in these situations:

- A message is sent consisting of a fixed header and a variable amount of data. The header contains the byte count of the data. If the data is large and has to be inserted into one or more buffers (like a filesystem cache), rather than read the data into one large buffer and then copy it into several other buffers, *MsgReceive()* reads only the header, and you can build a custom **`iov_t`** list to let *MsgReadv()* read data directly into the required buffers.
- A message is received but can't be handled at the present time. At some point in the future, an event will occur that will allow the message to be processed. Rather than saving the message until it can be processed (thus using memory resources), you can use *MsgReadv()* to reread the message, during which time the sending thread is still blocked.
- Messages that are larger than available buffer space are received. Perhaps the process is an agent between two processes and simply filters the data and passes it on. You can use *MsgReadv()* to read the message in small pieces, and use *MsgWrite*()* to write the messages in small pieces.

When you're finished using *MsgReadv()*, you must use *MsgReply*()* to ready the REPLY-blocked process and complete the message exchange.

Blocking states

None. In the network case, lower priority threads may run.

Returns:

The only difference between the *MsgReadv()* and *MsgReadv_r()* functions is the way they indicate errors:

MsgReadv()	The number of bytes read. If an error occurs, -1 is returned and *errno* is set.

MsgReadv_r()	The number of bytes read. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EFAULT	A fault occurred in a server's address space when it tried to access the caller's message buffers.
ESRCH	The thread indicated by *rcvid* doesn't exist or has had its connection detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgRead(), *MsgReceive()*, *MsgReceivev()*, *MsgReply()*, *MsgReplyv()*, *MsgWrite()*, *MsgWritev()*

Synopsis:

```
#include <sys/neutrino.h>

int MsgReceive( int chid,
                void * msg,
                int bytes,
                struct _msg_info * info );

int MsgReceive_r( int chid,
                  void * msg,
                  int bytes,
                  struct _msg_info * info );
```

Arguments:

chid The ID of a channel that you established by calling *ChannelCreate()*.

msg A pointer to a buffer where the function can store the received data.

bytes The size of the buffer.

info NULL, or a pointer to a **_msg_info** structure where the function can store additional information about the message.

Library:

libc

Description:

The *MsgReceive()* and *MsgReceive_r()* kernel calls wait for a message or pulse to arrive on the channel identified by *chid*, and store the received data in the buffer pointed to by *msg*.

These functions are identical, except in the way they indicate errors; see the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The received data isn't allowed to overflow the receive buffer area provided.

The *msg* buffer *must* be big enough to contain a pulse. If it isn't, the functions indicate an error of EFAULT.

If a message is waiting on the channel when you call *MsgReceive()*, the calling thread doesn't block, and the message is immediately copied. If a message isn't waiting, the calling thread enters the RECEIVE-blocked state until a message arrives.

If multiple messages are sent to a channel without a thread waiting to receive them, the messages are queued in priority order.

If you pass a non-NULL pointer for *info*, the functions store additional information about the message and the thread that sent it in the **_msg_info** structure that *info* points to. You can get this information later by calling *MsgInfo()*.

On sucess, *MsgReceive()* and *MsgReceive_r()* return:

>0	A message was received; the returned value is a a *rcvid* (receive identifier). You'll use the *rcvid* with other *Msg*()* kernel calls to interact with and reply to the sending thread. *MsgReceive()* changes the state of the sending thread to REPLY-blocked when the message is received. When you use *MsgReply*()* to reply to the received message, the sending thread is made ready again. The *rcvid* encodes the sending thread's ID and a local connection ID.
0	A pulse was received; *msg* contains a pulse message of type **_pulse**. When a pulse is received, the kernel space allocated to hold it is immediately released. The **_msg_info** structure isn't updated.

☞ Don't reply to a pulse.

Blocking states

State	Meaning
STATE_RECEIVE	There's no message waiting

Native networking

In networked message-passing transactions, the most noticeable impact is on the server. The server receives the client's message from the server's local **npm-qnet**. Note that the receive ID that comes back from *MsgReceive()* will have some differences, but you don't need to worry about the format of the receive ID — just treat it as a "magic cookie."

When the server unblocks from its *MsgReceive()*, it may or may not have received as much of the message as it would in the local case. This is because of the way that message passing is defined — the client and the server agree on the size of the message transfer area (the transmit parameters passed to *MsgSend()* on the client end) and the size of the message receive area on the server's *MsgReceive()*.

In a local message pass, the kernel would ordinarily limit the size of the transfer to the minimum of both sizes. But in the networked case, the message is received by the client's **npm-qnet** into its own private buffers and then sent via transport to the remote **npm-qnet**. Since the size of the server's receive data area can't be known in advance by the client's **npm-qnet** when the message is sent, only a fixed maximum size (currently 8K) message is transferred between the client and the server.

This means, for example, that if the client sends 1 Mbyte of data and the server issues a *MsgReceive()* with a 1-Mbyte data area, then only the number of bytes determined by a network manager would in fact be transferred. The number of bytes transferred to the server is returned via the last parameter to *MsgReceive()* or a call to *MsgInfo()*,

specifically the *msglen* member of struct **_msg_info**. The client doesn't notice this, because it's still blocked.

You can use the following code to ensure that the desired number of bytes are received. Note that this is handled for you automatically when you're using the resource manager library:

```
chid = ChannelCreate(_NTO_CHF_SENDER_LEN);
...
rcvid = MsgReceive(chid, msg, nbytes, &info);

/*
 Doing a network transaction and not all
 the message was send, so get the rest...
*/
if (rcvid > 0 && info.srcmsglen > info.msglen && info.msglen < nbytes) {
    int n;

    if((n = MsgRead_r(rcvid, (char *) msg + info.msglen,
            nbytes - info.msglen, info.msglen)) < 0) {
        MsgError(rcvid, -n);
        continue;
    }
    info.msglen += n;
}
```

Returns:

The only difference between *MsgReceive()* and *MsgReceive_r()* is the way they indicate errors. On success, both functions return a positive *rcvid* if they received a message, or 0 if they received a pulse.

If an error occurs:

- *MsgReceive()* returns -1 and sets *errno*.
- *MsgReceive_r()* returns the negative of a value from the Errors section is returned. This function **doesn't** set *errno*.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers provided. Because the OS accesses the sender's buffers only when *MsgReceive()* is called, a fault could occur *in the sender* if the sender's buffers are invalid. If a fault occurs when accessing the sender buffers (only) they'll receive an EFAULT and *MsgReceive()* won't unblock.
EINTR	The call was interrupted by a signal.
ESRCH	The channel indicated by *chid* doesn't exist.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ChannelCreate(), **_msg_info**, *MsgInfo()*, *MsgRead()*, *MsgReadv()*, *MsgReceivePulse()*, *MsgReceivePulsev()*, *MsgReceivev()*, *MsgReply()*, *MsgReplyv()*, *MsgSend()*, *MsgWrite()*, *MsgWritev()*, **_pulse**, *TimerTimeout()*

MsgReceivePulse(), *MsgReceivePulse_r()*

Receive a pulse on a channel

Synopsis:

```
#include <sys/neutrino.h>

int MsgReceivePulse( int chid,
                     void * pulse,
                     int bytes,
                     struct _msg_info * info );

int MsgReceivePulse_r( int chid,
                       void * pulse,
                       int bytes,
                       struct _msg_info * info );
```

Arguments:

chid The ID of a channel that you established by calling *ChannelCreate()*.

pulse A pointer to a buffer where the function can store the received data.

bytes The size of the buffer.

info The function doesn't update this structure, so you typically pass NULL for this argument.

Library:

libc

Description:

The *MsgReceivePulse()* and *MsgReceivePulse_r()* kernel calls wait for a pulse to arrive on the channel identified by *chid* and place the received data in the buffer pointed to by *pulse*.

These functions are identical, except in the way they indicate errors; see the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The received data isn't allowed to overflow the receive buffer area provided.

☞ The *pulse* buffer *must* be big enough to contain a pulse. If it isn't, the functions indicate an error of EFAULT.

If a pulse is waiting on the channel when you call *MsgReceivePulse()*, the calling thread doesn't block, and the pulse is immediately copied. If a pulse isn't waiting, the calling thread enters the RECEIVE-blocked state until a pulse arrives.

If multiple pulses are sent to a channel without a thread waiting to receive them, the pulses are queued in priority order.

On success, *MsgReceivePulse()* and *MsgReceivePulse_r()* return 0 to indicate that they received a pulse. When a pulse is received:

- the kernel space allocated to hold it is immediately released
- *pulse* contains a pulse message of type **_pulse**.

☞ Don't reply to a pulse.

Blocking states

State	Meaning
STATE_RECEIVE	There's no pulse waiting.

Returns:

The only difference between *MsgReceivePulse()* and *MsgReceivePulse_r()* is the way they indicate errors. On success, they both return 0.

If an error occurred:

- *MsgReceivePulse()* returns -1 and sets *errno*.

- *MsgReceivePulse_r()* returns the negative of a value from the Errors section. This function **doesn't** set *errno*.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers provided. Because the OS accesses the sender's buffers only when *MsgReceivePulse()* is called, a fault could occur *in the sender* if the sender's buffers are invalid. If a fault occurs when accessing the sender buffers (only) they'll receive an EFAULT and *MsgReceivePulse()* won't unblock.
EINTR	The call was interrupted by a signal.
ESRCH	The channel indicated by *chid* doesn't exist.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgDeliverEvent(), *MsgReceive()*, *MsgReceivePulsev()*, *MsgReceivev()*, *MsgSendPulse()*, `_pulse`, *TimerTimeout()*

MsgReceivePulsev(), MsgReceivePulsev_r()

Receive a pulse on a channel

Synopsis:

```
#include <sys/neutrino.h>

int MsgReceivePulsev( int chid,
                      const iov_t * piov,
                      int parts,
                      struct _msg_info * info );

int MsgReceivePulsev_r( int chid,
                        const iov_t * piov,
                        int parts,
                        struct _msg_info * info );
```

Arguments:

chid The ID of a channel that you established by calling *ChannelCreate()*.

piov An array of buffers where the function can store the received data.

parts The number of elements in the array.

info The function doesn't update this structure, so you typically pass NULL for this argument.

Library:

libc

Description:

The *MsgReceivePulsev()* and *MsgReceivePulsev_r()* kernel calls wait for a pulse to arrive on the channel identified by *chid* and places the received data in the array of buffers pointed to by *piov*.

These functions are identical, except in the way they indicate errors; see the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The received data isn't allowed to overflow the receive buffer area provided.

The first buffer of the IOV (input/output vector) *must* be big enough to contain a pulse. If it isn't, the functions indicate an error of EFAULT.

If a pulse is waiting on the channel when you call *MsgReceivePulsev()*, the calling thread doesn't block, and the pulse is immediately copied. If a pulse isn't waiting, the calling thread enters the RECEIVE-blocked state until a pulse arrives.

If multiple pulses are sent to a channel without a thread waiting to receive them, the pulses are queued in priority order.

On success, *MsgReceivePulsev()* and *MsgReceivePulsev_r()* return 0 to indicate that they received a pulse. When a pulse is received:

- the kernel space allocated to hold it is immediately released
- the IOV's first buffer contains a pulse message of type **`_pulse`**.

Blocking states

State	Meaning
STATE_RECEIVE	There's no pulse waiting.

Returns:

The only difference between *MsgReceivePulsev()* and *MsgReceivePulsev_r()* is the way they indicate errors. On success, they both return 0.

If an error occurs:

- *MsgReceivePulsev()* returns -1 and sets *errno*.
- *MsgReceivePulsev_r()* returns the negative of a value from the Errors section. This function **doesn't** set *errno*.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers provided. Because the OS accesses the sender's buffers only when *MsgReceivePulsev()* is called, a fault could occur *in the sender* if the sender's buffers are invalid. If a fault occurs when accessing the sender buffers (only) they'll receive an EFAULT and *MsgReceivePulsev()* won't unblock.
EINTR	The call was interrupted by a signal.
ESRCH	The channel indicated by *chid* doesn't exist.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgDeliverEvent(), *MsgReceive()*, *MsgReceivePulse()*, *MsgReceivev()*, *MsgSendPulse()*, `_pulse`, *TimerTimeout()*

MsgReceivev(), MsgReceivev_r()

Wait for a message or pulse on a channel

Synopsis:

```
#include <sys/neutrino.h>

int MsgReceivev( int chid,
                 const iov_t * riov,
                 int rparts,
                 struct _msg_info * info );

int MsgReceivev_r( int chid,
                   const iov_t * riov,
                   int rparts,
                   struct _msg_info * info );
```

Arguments:

chid The ID of a channel that you established by calling *ChannelCreate()*.

riov An array of buffers where the function can store the received data.

rparts The number of elements in the array.

info NULL, or a pointer to a **_msg_info** structure where the function can store additional information about the message.

Library:

libc

Description:

The *MsgReceivev()* and *MsgReceivev_r()* kernel calls wait for a message or pulse to arrive on the channel identified by *chid* and place the received data in the array of buffers pointed to by *riov*.

These functions are identical, except in the way they indicate errors; see the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The received data isn't allowed to overflow the receive buffer area provided.

The first buffer of the IOV (input/output vector) *must* be big enough to contain a pulse. If it isn't, the functions indicate an error of EFAULT.

If a message is waiting on the channel when you call *MsgReceivev()*, the calling thread won't block, and the message is immediately copied. If a message isn't waiting, the calling thread enters the RECEIVE-blocked state until a message arrives.

If multiple messages are sent to a channel without a thread waiting to receive them, the messages are queued in priority order.

If you pass a non-NULL pointer for *info*, the functions store additional information about the message and the thread that sent it in the **_msg_info** structure that *info* points to. You can get this information later by calling *MsgInfo()*.

On success, *MsgReceivev()* and *MsgReceivev_r()* return:

>0 A message was received; the value returned is a *rcvid* (receive identifier). You'll use the *rcvid* with other *Msg*()* kernel calls to interact with and reply to the sending thread. *MsgReceivev()* changes the state of the sending thread to REPLY-blocked when the message is received. When you use *MsgReply*()* to reply to the received message, the sending thread is made ready again. The *rcvid* encodes the sending thread's ID and a local connection ID.

0 A pulse was received; the IOV's first buffer contains a pulse message of type **_pulse**. When a pulse is received, the kernel space allocated to hold it is immediately released. The **_msg_info** structure isn't updated.

☞ Don't reply to a pulse.

Blocking states

State	Meaning
STATE_RECEIVE	There's no message waiting.

Returns:

The only difference between *MsgReceivev()* and *MsgReceivev_r()* is the way they indicate errors. On success, both functions return a positive *rcvid* if they received a message, or 0 if they received a pulse.

If an error occurs:

- *MsgReceivev()* returns -1 and sets *errno*.
- *MsgReceivev_r()* returns the negative of a value from the Errors section. This function **doesn't** set *errno*.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers provided. Because the OS accesses the sender's buffers only when *MsgReceivev()* is called, a fault could occur *in the sender* if the sender's buffers are invalid. If a fault occurs when accessing the sender buffers (only) they'll receive an EFAULT and *MsgReceivev()* won't unblock.
EINTR	The call was interrupted by a signal.
ESRCH	The channel indicated by *chid* doesn't exist.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ChannelCreate(), **_msg_info**, *MsgInfo()*, *MsgRead()*, *MsgReadv()*, *MsgReceive()*, *MsgReceivePulse()*, *MsgReceivePulsev()*, *MsgReply()*, *MsgReplyv()*, *MsgWrite()*, *MsgWritev()*, **_pulse**, *TimerTimeout()*

MsgReply(), *MsgReply_r()*

Reply with a message

Synopsis:

```
#include <sys/neutrino.h>

int MsgReply( int rcvid,
              int status,
              const void* msg,
              int size );

int MsgReply_r( int rcvid,
                int status,
                const void* msg,
                int size );
```

Arguments:

rcvid	The receive ID that *MsgReceive*()* returned when you received the message.
status	The status to use when unblocking the *MsgSend*()* call in the *rcvid* thread.
msg	A pointer to a buffer that contains the message that you want to reply with.
size	The size of the message, in bytes.

Library:

libc

Description:

The *MsgReply()* and *MsgReply_r()* kernel calls reply with a message to the thread identified by *rcvid*. The thread being replied to must be in the REPLY-blocked state. Any thread in the receiving process is free to reply to the message, however, it may be replied to only once for each receive.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The *MsgSend*()* in the *rcvid* thread unblocks with a return value of *status*.

The status argument for both *MsgReply()*, and *MsgReply_r()* functions should not be passed a negative value.

The number of bytes transferred is the minimum of that specified by both the replier and the sender. The reply data isn't allowed to overflow the reply buffer area provided by the sender.

The data transfer occurs immediately, and the replying task doesn't block. There's no need to reply to received messages in any particular order, but you must eventually reply to each message to allow the sending thread(s) to continue execution.

Blocking states

None. In the network case, lower priority threads may run.

Native networking

The *MsgReply()* function has increased latency when it's used to communicate across a network — the server is now writing data to its local **`npm-qnet`**, which may need to communicate with the client's **`npm-qnet`** to actually transfer the data.

Returns:

The only difference between the *MsgReply()* and *MsgReply_r()* functions is the way they indicate errors:

MsgReply()	If an error occurs, -1 is returned and *errno* is set.
MsgReply_r()	This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EFAULT	A fault occurred in the sender's address space when a server tried to access the sender's return message buffers.
ESRCH	The thread indicated by *rcvid* doesn't exist, or is no longer REPLY-blocked on the channel, or the connection is detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgReceive(), *MsgReceivev()*, *MsgReplyv()*, *MsgSend()*, *MsgSendv()*, *MsgWrite()*, *MsgWritev()*

Synopsis:

```
#include <sys/neutrino.h>

int MsgReplyv( int rcvid,
               int status,
               const iov_t* riov,
               int rparts );

int MsgReplyv_r( int rcvid,
                 int status,
                 const iov_t* riov,
                 int rparts );
```

Arguments:

rcvid The receive ID that *MsgReceive*()* returned when you received the message.

status The status to use when unblocking the *MsgSend*()* call in the *rcvid* thread.

riov An array of buffers that contains the message that you want to reply with.

size The number of elements in the array.

Library:

libc

Description:

The *MsgReplyv()* and *MsgReplyv_r()* kernel calls reply with a message to the thread identified by *rcvid*. The thread being replied to must be in the REPLY-blocked state. Any thread in the receiving process is free to reply to the message, however, it may be replied to only once for each receive.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The *MsgSend*()* in the *rcvid* thread unblocks with a return value of *status*.

The data is taken from the array of message buffers pointed to by *riov*. The number of elements in this array is given by *rparts*. The size of the message is the sum of the sizes of each buffer.

The number of bytes transferred is the minimum of that specified by both the replier and the sender. The reply data isn't allowed to overflow the reply buffer area provided by the sender.

The data transfer occurs immediately, and the replying task doesn't block. There's no need to reply to received messages in any particular order, but you must eventually reply to each message to allow the sending thread(s) to continue execution.

It's quite common to reply with two-part messages consisting of a fixed header and a buffer of data. The *MsgReplyv()* function gathers the data from the buffer list into a logical contiguous message and transfers it to the sender's reply buffer(s). The sender doesn't need to specify the same number or size of buffers. The data is laid down filling each buffer as required. The filesystem, for example, builds a reply list pointing into its cache in order to reply with what appears to be one contiguous piece of data.

Blocking states

None. In the network case, lower priority threads may run.

Returns:

The only difference between the *MsgReplyv()* and *MsgReplyv_r()* functions is the way they indicate errors:

MsgReplyv()	If an error occurs, -1 is returned and *errno* is set.
MsgReplyv_r()	This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EFAULT	A fault occurred in the sender's address space when a server tried to access the sender's return message buffers.
ESRCH	The thread indicated by *rcvid* doesn't exist, or is no longer REPLY-blocked on the channel, or the connection is detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgReceive(), MsgReceivev(), MsgReply(), MsgSend(), MsgSendv(), MsgWrite(), MsgWritev()

MsgSend(), MsgSend_r()

Send a message to a channel

Synopsis:

```
#include <sys/neutrino.h>

int MsgSend( int coid,
             const void* smsg,
             int sbytes,
             void* rmsg,
             int rbytes );

int MsgSend_r( int coid,
               const void* smsg,
               int sbytes,
               void* rmsg,
               int rbytes );
```

Arguments:

coid	The ID of the channel to send the message on, which you've established by calling *ConnectAttach()*.
smsg	A pointer to a buffer that contains the message that you want to send.
sbytes	The number of bytes to send.
rmsg	A pointer to a buffer where the reply can be stored.
rbytes	The size of the reply buffer, in bytes.

Library:

libc

Description:

The *MsgSend()* and *MsgSend_r()* kernel calls send a message to a process's channel identified by *coid*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The send data isn't allowed to overflow the receive buffer area provided by the receiver. The reply data isn't allowed to overflow the reply buffer area provided.

The sending thread becomes blocked waiting for a reply. If the receiving process has a thread that's RECEIVE-blocked on the channel, the transfer of data into its address space occurs immediately, and the receiving thread is unblocked and made ready to run. The sending thread becomes REPLY-blocked. If there are no waiting threads on the channel, the sending thread becomes SEND-blocked and is placed in a queue (perhaps with other threads). In this case, the actual transfer of data doesn't occur until a receiving thread receives on the channel. At this point, the sending thread becomes REPLY-blocked.

MsgSend() is a cancellation point for the *ThreadCancel()* kernel call; *MsgSendnc()* isn't.

Blocking states

STATE_SEND	The message has been sent but not yet received. If a thread is waiting to receive the message, this state is skipped and the calling thread goes directly to STATE_REPLY.
STATE_REPLY	The message has been received but not yet replied to. This state may be entered directly, or from STATE_SEND.

Native networking

When a client sends a message to a remote server, the client is effectively sending the message via its local microkernel; the network manager does the actual "work." The local network manager negotiates with the remote network manager and causes the message to be delivered there. However, the remote manager is the one that actually delivers the message to the server.

This message transfer from the remote manager to the server is accomplished via a special nonblocking message pass.

The only impact on the client is the latency of the message-passing operations. This is purely a function of the network link speed and the overhead associated with the protocol (i.e. **npm-qnet** for native networking) that **io-net** uses.

The client still remains blocked in its *MsgSend()*, and unblocks only on account of a signal, a kernel timeout, or the completion of its function.

Returns:

The only difference between the *MsgSend()* and *MsgSend_r()* functions is the way they indicate errors:

MsgSend()	Success	The value of *status* from *MsgReply*()*.
	-1	An error occurred (*errno* is set), or the server called *MsgError*()* (*errno* is set to the error value passed to *MsgError()*).
MsgSend_r()	Success	The value of *status* from *MsgReply*()*.
	negative value	An error occurred (*errno* is *NOT* set, the value is the negative of a value from the Errors section), or the server called *MsgError*()* (*errno* is *NOT* set, the value is the negative of the error value passed to *MsgError()*).

Errors:

EBADF	The connection indicated by *coid* is no longer connected to a channel, or the connection indicated by *coid* doesn't exist. The channel may have been terminated by the server, or the network manager if it failed to respond to multiple polls.

EFAULT	A fault occurred when the kernel tried to access the buffers provided. This may have occurred on the receive or the reply.
EINTR	The call was interrupted by a signal.
ESRCH	The server died while the calling thread was SEND-blocked or REPLY-blocked.
ESRVRFAULT	A fault occurred in a server's address space when accessing the server's message buffers.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), *MsgReceive()*, *MsgReceivev()*, *MsgSendnc()*, *MsgSendPulse()*, *MsgSendsv()*, *MsgSendsvnc()*, *MsgSendv()*, *MsgSendvnc()*, *MsgSendvs()*, *MsgSendvsnc()*, *TimerTimeout()*

MsgSendnc(), MsgSendnc_r()

Send a message to a channel (non-cancellation point)

Synopsis:

```
#include <sys/neutrino.h>

int MsgSendnc( int coid,
               const void* smsg,
               int sbytes,
               void* rmsg,
               int rbytes );

int MsgSendnc_r( int coid,
                 const void* smsg,
                 int sbytes,
                 void* rmsg,
                 int rbytes );
```

Arguments:

coid The ID of the channel to send the message on, which you've established by calling *ConnectAttach()*.

smsg A pointer to a buffer that contains the message that you want to send.

sbytes The number of bytes to send.

rmsg A pointer to a buffer where the reply can be stored.

rbytes The size of the reply buffer, in bytes.

Library:

libc

Description:

The *MsgSendnc()* and *MsgSendnc_r()* kernel calls send a message to a process's channel identified by *coid*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The send data isn't allowed to overflow the receive buffer area provided by the receiver. The reply data isn't allowed to overflow the reply buffer area provided.

The sending thread becomes blocked waiting for a reply. If the receiving process has a thread that's RECEIVE-blocked on the channel, the transfer of data into its address space occurs immediately, and the receiving thread is unblocked and made ready to run. The sending thread becomes REPLY-blocked. If there are no waiting threads on the channel, the sending thread becomes SEND-blocked and is placed in a queue (perhaps with other threads). In this case the actual transfer of data doesn't occur until a receiving thread receives on the channel. At this point, the sending thread becomes REPLY-blocked.

MsgSend() is a cancellation point for the *ThreadCancel()* kernel call; *MsgSendnc()* isn't.

Blocking states

STATE_SEND	The message has been sent but not yet received. If a thread is waiting to receive the message, this state is skipped and the calling thread goes directly to STATE_REPLY.
STATE_REPLY	The message has been received but not yet replied to. This state may be entered directly, or from STATE_SEND.

Returns:

The only difference between the *MsgSendnc()* and *MsgSendnc_r()* functions is the way they indicate errors:

MsgSendnc()	Success	The value of *status* from *MsgReply*()*.
	-1	An error occurred (*errno* is set), or the server called *MsgError*()* (*errno* is set to the error value passed to *MsgError()*).

MsgSendnc_r()	Success	The value of *status* from *MsgReply*()*.
	negative value	An error occurred (*errno* is *NOT* set, the value is the negative of a value from the Errors section), or the server called *MsgError*()* (*errno* is *NOT* set, the value is the negative of the error value passed to *MsgError()*).

Errors:

EBADF	The connection indicated by *coid* is no longer connected to a channel, or the connection indicated by *coid* doesn't exist. The channel may have been terminated by the server, or the network manager if it failed to respond to multiple polls.
EFAULT	A fault occurred when the kernel tried to access the buffers provided. This may have occurred on the receive or the reply.
EINTR	The call was interrupted by a signal.
ESRCH	The server died while the calling thread was SEND-blocked or REPLY-blocked.
ESRVRFAULT	A fault occurred in a server's address space when accessing the server's message buffers.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), MsgReceive(), MsgReceivev(), MsgSend(), MsgSendPulse(), MsgSendsv(), MsgSendsvnc(), MsgSendv(), MsgSendvnc(), MsgSendvs(), MsgSendvsnc(), TimerTimeout()

MsgSendPulse(), *MsgSendPulse_r()*

Send a pulse to a process

Synopsis:

```
#include <sys/neutrino.h>

int MsgSendPulse ( int coid,
                   int priority,
                   int code,
                   int value );

int MsgSendPulse_r ( int coid,
                     int priority,
                     int code,
                     int value );
```

Arguments:

coid — The ID of the channel to send the message on, which you've established by calling *ConnectAttach()*.

priority — The priority to use for the pulse. This must be within the range of valid priorities, which you can determine by calling *sched_get_priority_min()* and *sched_get_priority_max()*.

code — The 8-bit pulse code.

Although *code* can be any 8-bit signed value, you should avoid *code* values less than zero, in order to avoid conflict with kernel- or QNX manager-generated pulse codes. These codes all start with _PULSE_CODE_ and are defined in **<sys/neutrino.h>**; for more information, see the documentation for the **_pulse** structure. A safe range of pulse values is _PULSE_CODE_MINAVAIL through _PULSE_CODE_MAXAVAIL.

value — The 32-bit pulse value.

Library:

libc

Description:

The *MsgSendPulse()* and *MsgSendPulse_r()* kernel calls send a short, nonblocking message to a process's channel identified by *coid*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

You can send a pulse to a process if the sending process's real or effective user ID either:

- matches the real or effective user ID of the receiving process

  Or:

- equals zero.

This permission checking is identical to that used by *kill()*.

You can use *MsgSendPulse()* for many purposes; however, due to the small payload of data, you shouldn't use it for transmitting large amounts of bulk data by sending a great number of pulses.

Pulses are queued for the receiving process in the system, using a dynamic pool of memory objects. If pulses are generated faster than they can be consumed by the receiver, then over a period of time the system queue for the pulses could reach a low memory condition. If there's no memory available for the pulse to be queued in the system, the kernel fails the pulse request with an error of EAGAIN. If the priority, code and value don't change, the kernel compresses the pulses by storing an 8-bit count with an already queued pulse.

When you receive a pulse via the *MsgReceive*()* kernel call, the *rcvid* returned is zero. This indicates to the receiver that it's a pulse and, unlike a message, shouldn't be replied to using *MsgReply*()*.

☞ In a client/server design, *MsgDeliverEvent()* is typically used in the server, and *MsgSendPulse()* in the client.

Blocking states

None. In the network case, lower priority threads may run.

Native networking

You can use *MsgSendPulse()* to send pulses across the network.

Returns:

The only difference between the *MsgSendPulse()* and *MsgSendPulse_r()* functions is the way they indicate errors:

MsgSendPulse()

If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

MsgSendPulse_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EAGAIN	The kernel had insufficient resources to enqueue the pulse.
EBADF	The connection indicated by *coid* is no longer connected to a channel or the connection indicated by *coid* doesn't exist. The channel may have been terminated by the server or the network manager if it failed to respond to multiple polls.
EFAULT	A fault occurred when the kernel tried to access the buffers provided.

EPERM	This process doesn't have sufficient permission to send a pulse to the connection, *coid*.
ESRVRFAULT	A fault occurred in the server's address space when it tried to write the pulse message to the server's receive message buffer.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

If the server faults on delivery, the pulse is either lost or an error is returned.

See also:

MsgDeliverEvent(), MsgReceive(), MsgReceivev(), MsgSend(), MsgSendnc(), MsgSendsv(), MsgSendsvnc(), MsgSendv(), MsgSendvnc(), MsgSendvs(), MsgSendvsnc(), **_pulse**, *sched_get_priority_min(), sched_get_priority_max()*

MsgSendsv(), *MsgSendsv_r()*

Send a message to a channel

Synopsis:

```
#include <sys/neutrino.h>

int MsgSendsv( int coid,
               const void* smsg,
               int sbytes,
               const iov_t* riov,
               int rparts );

int MsgSendsv_r( int coid,
                 const void* smsg,
                 int sbytes,
                 const iov_t* riov,
                 int rparts );
```

Arguments:

coid	The ID of the channel to send the message on, which you've established by calling *ConnectAttach()*.
smsg	A pointer to a buffer that contains the message that you want to send.
sbytes	The number of bytes to send.
riov	An array of buffers where the reply can be stored.
rparts	The number of elements in the *riov* array.

Library:

libc

Description:

The *MsgSendsv()* and *MsgSendsv_r()* kernel calls send a message to a process's channel identified by *coid*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The send data isn't allowed to overflow the receive buffer area provided by the receiver. The reply data isn't allowed to overflow the reply buffer area provided.

The sending thread becomes blocked waiting for a reply. If the receiving process has a thread that's RECEIVE-blocked on the channel, the transfer of data into its address space occurs immediately, and the receiving thread is unblocked and made ready to run. The sending thread becomes REPLY-blocked. If there are no waiting threads on the channel, the sending thread becomes SEND-blocked and is placed in a queue (perhaps with other threads). In this case, the actual transfer of data doesn't occur until a receiving thread receives on the channel. At this point, the sending thread becomes REPLY-blocked.

MsgSendsv() is a cancellation point for the *ThreadCancel()* kernel call; *MsgSendsvnc()* isn't.

Blocking states

STATE_SEND	The message has been sent but not yet received. If a thread is waiting to receive the message, this state is skipped and the calling thread goes directly to STATE_REPLY.
STATE_REPLY	The message has been received but not yet replied to. This state may be entered directly, or from STATE_SEND.

Returns:

The only difference between the *MsgSendsv()* and *MsgSendsv_r()* functions is the way they indicate errors:

MsgSendsv()	Success	The value of *status* from *MsgReply*()*.
	-1	An error occurred (*errno* is set), or the server called *MsgError*()* (*errno* is set to the error value passed to *MsgError()*).

MsgSendsv_r()	Success	The value of *status* from *MsgReply*()*.
	negative value	An error occurred (*errno* is *NOT* set, the value is the negative of a value from the Errors section), or the server called *MsgError*()* (*errno* is *NOT* set, the value is the negative of the error value passed to *MsgError()*).

Errors:

EBADF	The connection indicated by *coid* is no longer connected to a channel, or the connection indicated by *coid* doesn't exist. The channel may have been terminated by the server, or the network manager if it failed to respond to multiple polls.
EFAULT	A fault occurred when the kernel tried to access the buffers provided. This may have occurred on the receive or the reply.
EINTR	The call was interrupted by a signal.
ESRCH	The server died while the calling thread was SEND-blocked or REPLY-blocked.
ESRVRFAULT	A fault occurred in a server's address space when accessing the server's message buffers.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), MsgReceive(), MsgReceivev(), MsgSend(), MsgSendnc(), MsgSendPulse(), MsgSendsvnc(), MsgSendv(), MsgSendvnc(), MsgSendvs(), MsgSendvsnc(), TimerTimeout()

MsgSendsvnc(), *MsgSendsvnc_r()*

Send a message to a channel (non-cancellation point)

Synopsis:

```
#include <sys/neutrino.h>

int MsgSendsvnc( int coid,
                 const void* smsg,
                 int sbytes,
                 const iov_t* riov,
                 int rparts );

int MsgSendsvnc_r( int coid,
                   const void* smsg,
                   int sbytes,
                   const iov_t* riov,
                   int rparts );
```

Arguments:

coid	The ID of the channel to send the message on, which you've established by calling *ConnectAttach()*.
smsg	A pointer to a buffer that contains the message that you want to send.
sbytes	The number of bytes to send.
riov	An array of buffers where the reply can be stored.
rparts	The number of elements in the *riov* array.

Library:

libc

Description:

The *MsgSendsvnc()* and *MsgSendsvnc_r()* kernel calls send a message to a process's channel identified by *coid*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The send data isn't allowed to overflow the receive buffer area provided by the receiver. The reply data isn't allowed to overflow the reply buffer area provided.

The sending thread becomes blocked waiting for a reply. If the receiving process has a thread that's RECEIVE-blocked on the channel, the transfer of data into its address space occurs immediately, and the receiving thread is unblocked and made ready to run. The sending thread becomes REPLY-blocked. If there are no waiting threads on the channel, the sending thread becomes SEND-blocked and is placed in a queue (perhaps with other threads). In this case, the actual transfer of data doesn't occur until a receiving thread receives on the channel. At this point, the sending thread becomes REPLY-blocked.

MsgSendsv() is a cancellation point for the *ThreadCancel()* kernel call; *MsgSendsvnc()* isn't.

Blocking states

STATE_SEND	The message has been sent but not yet received. If a thread is waiting to receive the message, this state is skipped and the calling thread goes directly to STATE_REPLY.
STATE_REPLY	The message has been received but not yet replied to. This state may be entered directly, or from STATE_SEND.

Returns:

The only difference between the *MsgSendsvnc()* and *MsgSendsvnc_r()* functions is the way they indicate errors:

MsgSendsvnc()

Success	The value of *status* from *MsgReply*()*.
-1	An error occurred (*errno* is set), or the server called *MsgError*()* (*errno* is set to the error value passed to *MsgError()*).

MsgSendsvnc_r()

Success	The value of *status* from *MsgReply*()*.
negative value	An error occurred (*errno* is *NOT* set, the value is the negative of a value from the Errors section), or the server called *MsgError*()* (*errno* is *NOT* set, the value is the negative of the error value passed to *MsgError()*).

Errors:

EBADF	The connection indicated by *coid* is no longer connected to a channel, or the connection indicated by *coid* doesn't exist. The channel may have been terminated by the server, or the network manager if it failed to respond to multiple polls.
EFAULT	A fault occurred when the kernel tried to access the buffers provided. This may have occurred on the receive or the reply.
EINTR	The call was interrupted by a signal.
ESRCH	The server died while the calling thread was SEND-blocked or REPLY-blocked.
ESRVRFAULT	A fault occurred in a server's address space when accessing the server's message buffers.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), MsgReceive(), MsgReceivev(), MsgSend(), MsgSendnc(), MsgSendPulse(), MsgSendsv(), MsgSendv(), MsgSendvnc(), MsgSendvs(), MsgSendvsnc(), TimerTimeout()

MsgSendv(), *MsgSendv_r()*

Send a message to a channel

Synopsis:

```
#include <sys/neutrino.h>

int MsgSendv( int coid,
              const iov_t* siov,
              int sparts,
              const iov_t* riov,
              int rparts );

int MsgSendv_r( int coid,
                const iov_t* siov,
                int sparts,
                const iov_t* riov,
                int rparts );
```

Arguments:

coid	The ID of the channel to send the message on, which you've established by calling *ConnectAttach()*.
siov	An array of buffers that contains the message that you want to send.
sparts	The number of elements in the *siov* array.
riov	An array of buffers where the reply can be stored.
rparts	The number of elements in the *riov* array.

Library:

libc

Description:

The *MsgSendv()* and *MsgSendv_r()* kernel calls send a message to a process's channel identified by *coid*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The send data isn't allowed to overflow the receive buffer area provided by the receiver. The reply data isn't allowed to overflow the reply buffer area provided.

The sending thread becomes blocked waiting for a reply. If the receiving process has a thread that's RECEIVE-blocked on the channel, the transfer of data into its address space occurs immediately, and the receiving thread is unblocked and made ready to run. The sending thread becomes REPLY-blocked. If there are no waiting threads on the channel, the sending thread becomes SEND-blocked and is placed in a queue (perhaps with other threads). In this case, the actual transfer of data doesn't occur until a receiving thread receives on the channel. At this point, the sending thread becomes REPLY-blocked.

It's quite common to send two-part messages consisting of a fixed header and a buffer of data. The *MsgSendv()* function gathers the data from the send list into a logically contiguous message and transfers it to the receiver. The receiver doesn't need to specify the same number or size of buffers. The data is laid down filling each entry as required. The same applies to the replied data.

MsgSendv() is a cancellation point for the *ThreadCancel()* kernel call; *MsgSendvnc()* isn't.

Blocking states

STATE_SEND	The message has been sent but not yet received. If a thread is waiting to receive the message, this state is skipped and the calling thread goes directly to STATE_REPLY.
STATE_REPLY	The message has been received but not yet replied to. This state may be entered directly, or from STATE_SEND.

Returns:

The only difference between the *MsgSendv()* and *MsgSendv_r()* functions is the way they indicate errors:

MsgSendv()	Success	The value of *status* from *MsgReply*()*.
	-1	An error occurred (*errno* is set), or the server called *MsgError*()* (*errno* is set to the error value passed to *MsgError()*).
MsgSendv_r()	Success	The value of *status* from *MsgReply*()*.
	negative value	An error occurred (*errno* is *NOT* set, the value is the negative of a value from the Errors section), or the server called *MsgError*()* (*errno* is *NOT* set, the value is the negative of the error value passed to *MsgError()*).

Errors:

EBADF	The connection indicated by *coid* is no longer connected to a channel, or the connection indicated by *coid* doesn't exist. The channel may have been terminated by the server, or the network manager if it failed to respond to multiple polls.
EFAULT	A fault occurred when the kernel tried to access the buffers provided. This may have occurred on the receive or the reply.
EINTR	The call was interrupted by a signal.
ESRCH	The server died while the calling thread was SEND-blocked or REPLY-blocked.
ESRVRFAULT	A fault occurred in a server's address space when accessing the server's message buffers.

ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), *MsgReceive()*, *MsgReceivev()*, *MsgSend()*, *MsgSendnc()*, *MsgSendPulse()*, *MsgSendsv()*, *MsgSendsvnc()*, *MsgSendvnc()*, *MsgSendvs()*, *MsgSendvsnc()*, *TimerTimeout()*

MsgSendvnc(), *MsgSendvnc_r()*

Send a message to a channel (non-cancellation point)

Synopsis:

```
#include <sys/neutrino.h>

int MsgSendvnc( int coid,
                const iov_t* siov,
                int sparts,
                const iov_t* riov,
                int rparts );

int MsgSendvnc_r( int coid,
                  const iov_t* siov,
                  int sparts,
                  const iov_t* riov,
                  int rparts );
```

Arguments:

coid	The ID of the channel to send the message on, which you've established by calling *ConnectAttach()*.
siov	An array of buffers that contains the message that you want to send.
sparts	The number of elements in the *siov* array.
riov	An array of buffers where the reply can be stored.
rparts	The number of elements in the *riov* array.

Library:

libc

Description:

The *MsgSendvnc()* and *MsgSendvnc_r()* kernel calls send a message to a process's channel identified by *coid*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The send data isn't allowed to overflow the receive buffer area provided by the receiver. The reply data isn't allowed to overflow the reply buffer area provided.

The sending thread becomes blocked waiting for a reply. If the receiving process has a thread that's RECEIVE-blocked on the channel, the transfer of data into its address space occurs immediately, and the receiving thread is unblocked and made ready to run. The sending thread becomes REPLY-blocked. If there are no waiting threads on the channel, the sending thread becomes SEND-blocked and is placed in a queue (perhaps with other threads). In this case, the actual transfer of data doesn't occur until a receiving thread receives on the channel. At this point, the sending thread becomes REPLY-blocked.

MsgSendv() is a cancellation point for the *ThreadCancel()* kernel call; *MsgSendvnc()* isn't.

Blocking states

STATE_SEND	The message has been sent but not yet received. If a thread is waiting to receive the message, this state is skipped and the calling thread goes directly to STATE_REPLY.
STATE_REPLY	The message has been received but not yet replied to. This state may be entered directly, or from STATE_SEND.

Returns:

The only difference between the *MsgSendvnc()* and *MsgSendvnc_r()* functions is the way they indicate errors:

MsgSendvnc()

Success	The value of *status* from *MsgReply*()*.
-1	An error occurred (*errno* is set), or the server called *MsgError*()* (*errno* is set to the error value passed to *MsgError()*).

MsgSendvnc_r()

Success	The value of *status* from *MsgReply*()*.
negative value	An error occurred (*errno* is *NOT* set, the value is the negative of a value from the Errors section), or the server called *MsgError*()* (*errno* is *NOT* set, the value is the negative of the error value passed to *MsgError()*).

Errors:

EBADF	The connection indicated by *coid* is no longer connected to a channel, or the connection indicated by *coid* doesn't exist. The channel may have been terminated by the server, or the network manager if it failed to respond to multiple polls.
EFAULT	A fault occurred when the kernel tried to access the buffers provided. This may have occurred on the receive or the reply.
EINTR	The call was interrupted by a signal.
ESRCH	The server died while the calling thread was SEND-blocked or REPLY-blocked.
ESRVRFAULT	A fault occurred in a server's address space when accessing the server's message buffers.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), MsgReceive(), MsgReceivev(), MsgSend(), MsgSendnc(), MsgSendPulse(), MsgSendsv(), MsgSendsvnc(), MsgSendv(), MsgSendvs(), MsgSendvsnc(), TimerTimeout()

MsgSendvs(), *MsgSendvs_r()*

Send a message to a channel

Synopsis:

```
#include <sys/neutrino.h>

int MsgSendvs( int coid,
               const iov_t* siov,
               int sparts,
               void* rmsg,
               int rbytes );

int MsgSendvs_r( int coid,
                 const iov_t* siov,
                 int sparts,
                 void* rmsg,
                 int rbytes );
```

Arguments:

coid	The ID of the channel to send the message on, which you've established by calling *ConnectAttach()*.
siov	An array of buffers that contains the message that you want to send.
sparts	The number of elements in the *siov* array.
rmsg	A pointer to a buffer where the reply can be stored.
rbytes	The size of the reply buffer.

Library:

libc

Description:

The *MsgSendvs()* and *MsgSendvs_r()* kernel calls send a message to a process's channel identified by *coid*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The send data isn't allowed to overflow the receive buffer area provided by the receiver. The reply data isn't allowed to overflow the reply buffer area provided.

The sending thread becomes blocked waiting for a reply. If the receiving process has a thread that's RECEIVE-blocked on the channel, the transfer of data into its address space occurs immediately, and the receiving thread is unblocked and made ready to run. The sending thread becomes REPLY-blocked. If there are no waiting threads on the channel, the sending thread becomes SEND-blocked and is placed in a queue (perhaps with other threads). In this case, the actual transfer of data doesn't occur until a receiving thread receives on the channel. At this point, the sending thread becomes REPLY-blocked.

MsgSendvs() is a cancellation point for the *ThreadCancel()* kernel call; *MsgSendvsnc()* isn't.

Blocking states

STATE_SEND	The message has been sent but not yet received. If a thread is waiting to receive the message, this state is skipped and the calling thread goes directly to STATE_REPLY.
STATE_REPLY	The message has been received but not yet replied to. This state may be entered directly, or from STATE_SEND.

Returns:

The only difference between the *MsgSendvs()* and *MsgSendvs_r()* functions is the way they indicate errors:

MsgSendvs()	Success	The value of *status* from *MsgReply*()*.
	-1	An error occurred (*errno* is set), or the server called *MsgError*()* (*errno* is set to the error value passed to *MsgError()*).

MsgSendvs_r()	Success	The value of *status* from *MsgReply*()*.
	negative value	An error occurred (*errno* is *NOT* set, the value is the negative of a value from the Errors section), or the server called *MsgError*()* (*errno* is *NOT* set, the value is the negative of the error value passed to *MsgError()*).

Errors:

EBADF	The connection indicated by *coid* is no longer connected to a channel, or the connection indicated by *coid* doesn't exist. The channel may have been terminated by the server, or the network manager if it failed to respond to multiple polls.
EFAULT	A fault occurred when the kernel tried to access the buffers provided. This may have occurred on the receive or the reply.
EINTR	The call was interrupted by a signal.
ESRCH	The server died while the calling thread was SEND-blocked or REPLY-blocked.
ESRVRFAULT	A fault occurred in a server's address space when accessing the server's message buffers.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), MsgReceive(), MsgReceivev(), MsgSend(), MsgSendnc(), MsgSendPulse(), MsgSendsv(), MsgSendsvnc(), MsgSendv(), MsgSendvnc(), MsgSendvsnc(), TimerTimeout()

MsgSendvsnc(), MsgSendvsnc_r()

Send a message to a channel (non-cancellation point)

Synopsis:

```
#include <sys/neutrino.h>

int MsgSendvsnc( int coid,
                 const iov_t* siov,
                 int sparts,
                 void* rmsg,
                 int rbytes );

int MsgSendvsnc_r( int coid,
                   const iov_t* siov,
                   int sparts,
                   void* rmsg,
                   int rbytes );
```

Arguments:

coid	The ID of the channel to send the message on, which you've established by calling *ConnectAttach()*.
siov	An array of buffers that contains the message that you want to send.
sparts	The number of elements in the *siov* array.
rmsg	A pointer to a buffer where the reply can be stored.
rbytes	The size of the reply buffer.

Library:

libc

Description:

The *MsgSendvsnc()* and *MsgSendvsnc_r()* kernel calls send a message to a process's channel identified by *coid*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The number of bytes transferred is the minimum of that specified by both the sender and the receiver. The send data isn't allowed to overflow the receive buffer area provided by the receiver. The reply data isn't allowed to overflow the reply buffer area provided.

The sending thread becomes blocked waiting for a reply. If the receiving process has a thread that's RECEIVE-blocked on the channel, the transfer of data into its address space occurs immediately, and the receiving thread is unblocked and made ready to run. The sending thread becomes REPLY-blocked. If there are no waiting threads on the channel, the sending thread becomes SEND-blocked and is placed in a queue (perhaps with other threads). In this case, the actual transfer of data doesn't occur until a receiving thread receives on the channel. At this point, the sending thread becomes REPLY-blocked.

MsgSendvs() is a cancellation point for the *ThreadCancel()* kernel call; *MsgSendvsnc()* isn't.

Blocking states

STATE_SEND	The message has been sent but not yet received. If a thread is waiting to receive the message, this state is skipped and the calling thread goes directly to STATE_REPLY.
STATE_REPLY	The message has been received but not yet replied to. This state may be entered directly, or from STATE_SEND.

Returns:

The only difference between the *MsgSendvsnc()* and *MsgSendvsnc_r()* functions is the way they indicate errors:

MsgSendvsnc()

Success	The value of *status* from *MsgReply*()*.
-1	An error occurred (*errno* is set), or the server called *MsgError*()* (*errno* is set to the error value passed to *MsgError()*).

MsgSendvsnc_r()

Success	The value of *status* from *MsgReply*()*.
negative value	An error occurred (*errno* is *NOT* set, the value is the negative of a value from the Errors section), or the server called *MsgError*()* (*errno* is *NOT* set, the value is the negative of the error value passed to *MsgError()*).

Errors:

EBADF	The connection indicated by *coid* is no longer connected to a channel, or the connection indicated by *coid* doesn't exist. The channel may have been terminated by the server, or the network manager if it failed to respond to multiple polls.
EFAULT	A fault occurred when the kernel tried to access the buffers provided. This may have occurred on the receive or the reply.
EINTR	The call was interrupted by a signal.
ESRCH	The server died while the calling thread was SEND-blocked or REPLY-blocked.
ESRVRFAULT	A fault occurred in a server's address space when accessing the server's message buffers.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), MsgReceive(), MsgReceivev(), MsgSend(), MsgSendnc(), MsgSendPulse(), MsgSendsv(), MsgSendsvnc(), MsgSendv(), MsgSendvnc(), MsgSendvs(), TimerTimeout()

MsgVerifyEvent(), *MsgVerifyEvent_r()*

Check the validity of a receive ID and an event configuration

Synopsis:

```
#include <sys/neutrino.h>

int MsgVerifyEvent( int rcvid,
                    const struct sigevent event );

int MsgVerifyEvent_r( int rcvid,
                      const struct sigevent event );
```

Arguments:

rcvid The receive ID that you want to check.

event A pointer to a **sigevent** structure that contains the event you want to check.

Library:

libc

Description:

The *MsgVerifyEvent()* and *MsgVerifyEvent_r()* kernel calls check the validity of the receive ID *rcvid*, and the *event* configuration. You can use these functions to verify that an event is well-formed by a client (pass a *rcvid* of 0), and by a server (pass a *rcvid* of the target thread).

These functions are identical except in the way they indicate errors. See the Returns section for details.

Blocking states

These calls don't block.

Returns:

The only difference between the *MsgVerifyEvent()* and *MsgVerifyEvent_r()* functions is the way they indicate errors:

MsgVerifyEvent()

If an error occurs, -1 is returned and *errno* is set.

MsgVerifyEvent_r()

This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EBADF	The channel for the pulse delivery doesn't exist.
EINVAL	Invalid *event* structure.
ESRCH	The connection for the pulse doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgReceive(), MsgReceivev(), MsgReply(), MsgSend(), MsgSendv(), MsgWrite(), MsgWritev(), **`sigevent`**

MsgWrite(), *MsgWrite_r()*

Write a reply

Synopsis:

```
#include <sys/neutrino.h>

int MsgWrite( int rcvid,
              const void* msg,
              int size,
              int offset );

int MsgWrite_r( int rcvid,
                const void* msg,
                int size,
                int offset );
```

Arguments:

rcvid The value returned by *MsgReceive*()* when you received the message.

msg A pointer to a buffer that contains the data you want to write.

size The number of bytes that you want to write. These functions don't let you write past the end of the sender's buffer; they return the number of bytes actually written.

offset An offset into the sender's buffer that indicates where you want to start writing the data.

Library:

libc

Description:

The *MsgWrite()* and *MsgWrite_r()* kernel calls write data to the reply buffer of a thread identified by *rcvid*. The thread being written to must be in the REPLY-blocked state. Any thread in the receiving process is free to write to the reply message.

These functions are identical except in the way they indicate errors. See the Returns section for details.

You use this function in one of these situations:

- The data arrives over time and is quite large. Rather than buffer all the data, you can use *MsgWrite()* to write it into the destination thread's reply message buffer, as it arrives.
- Messages are received that are larger than available buffer space. Perhaps the process is an agent between two processes and simply filters the data and passes it on. You can use *MsgRead*()* to read messages in small pieces, and use *MsgWrite()* to write messages in small pieces.

To complete a message exchange, you must call *MsgReply*()*. The reply doesn't need to contain any data. If it does contain data, then the data is always written at offset zero in the destination thread's reply message buffer. This is a convenient way of writing the header once all of the information has been gathered.

A single call to *MsgReply*()* is always more efficient than calls to *MsgWrite()* followed by a call to *MsgReply*()*.

Blocking states

None. In the network case, lower priority threads may run.

Native networking

The *MsgWrite()* function has increased latency when you use it to communicate across a network — the server is now writing data to its local **`npm-qnet`**, which may need to communicate with the client's **`npm-qnet`** to actually transfer the data. The server's *MsgWrite()* call effectively sends a message to the server's **`npm-qnet`** to initiate this data transfer.

But since the server's **`npm-qnet`** has no way to determine the size of the client's receive data area, the number of bytes reported as having been transferred by the server during its *MsgWrite()* call *might not be accurate* — the reported number will instead reflect the number of bytes transferred by the server to its **`npm-qnet`**.

The message is buffered in the server side's **npm-qnet** until the client replies, in order to reduce the number of network transactions.

If you want to determine the size of the sender's reply buffer, set the _NTO_CHF_REPLY_LEN when you call *ChannelCreate()*.

Returns:

The only difference between the *MsgWrite()* and *MsgWrite_r()* functions is the way they indicate errors:

MsgWrite()	The number of bytes written. If an error occurs, -1 is returned and *errno* is set.
MsgWrite_r()	The number of bytes written. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EFAULT	A fault occurred in the sender's address space when a server tried to access the sender's return message buffer.
ESRCH	The thread indicated by *rcvid* doesn't exist or its connection was detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

ChannelCreate(), MsgRead(), MsgReadv(), MsgReceive(), MsgReceivev(), MsgReply(), MsgReplyv(), MsgWritev()

MsgWritev(), MsgWritev_r()

Write a reply

Synopsis:

```
#include <sys/neutrino.h>

int MsgWritev( int rcvid,
               const iov_t* iov,
               int parts,
               int offset );

int MsgWritev_r( int rcvid,
                 const iov_t* iov,
                 int parts,
                 int offset );
```

Arguments:

rcvid The value returned by *MsgReceive*()* when you received the message.

iov An array of buffers that contains the data you want to write.

parts The number of elements in the array. These functions don't let you write past the end of the sender's buffer; they return the number of bytes actually written.

offset An offset into the sender's buffer that indicates where you want to start writing the data.

Library:

libc

Description:

The *MsgWritev()* and *MsgWritev_r()* kernel calls write data to the reply buffer of a thread identified by *rcvid*. The thread being written to must be in the REPLY-blocked state. Any thread in the receiving process is free to write to the reply message.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The data transfer occurs immediately and your thread doesn't block. The state of the sending thread doesn't change.

You'll use this function in one of these situations:

- The data arrives over time and is quite large. Rather than buffer all the data, you can use *MsgWritev()* to write it into the destination thread's reply message buffer, as it arrives.
- Messages are received that are larger than available buffer space. Perhaps the process is an agent between two processes and simply filters the data and passes it on. You can use *MsgRead*()* to read messages in small pieces, and use *MsgWritev()* to write messages in small pieces.

To complete a message exchange, you must call *MsgReply*()*. The reply doesn't need to contain any data. If it does contain data, then the data is always written at offset zero in the destination thread's reply message buffer. This is a convenient way of writing the header once all of the information has been gathered.

A single call to *MsgReply*()* is always more efficient than calls to *MsgWritev()* followed by a call to *MsgReply*()*.

Blocking states

None. In the network case, lower priority threads may run.

Returns:

The only difference between the *MsgWritev()* and *MsgWritev_r()* functions is the way they indicate errors:

MsgWritev()	The number of bytes written. If an error occurs, -1 is returned and *errno* is set.
MsgWritev_r()	The number of bytes written. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EFAULT	A fault occurred in the sender's address space when a server tried to access the sender's return message buffer.
ESRCH	The thread indicated by *rcvid* doesn't exist or its connection was detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgRead(), MsgReadv(), MsgReceive(), MsgReceivev(), MsgReply(), MsgReplyv(), MsgWrite()

Synopsis:

```
#include <sys/mman.h>

int msync( void * addr,
           size_t len,
           int flags );
```

Arguments:

addr The beginning of the range of addresses that you want to synchronize.

len The length of the range of addresses, in bytes.

flags A bitwise inclusive OR of one or more of the following flags:

- MS_ASYNC — perform asynchronous writes. The function returns immediately once all the write operations are initiated or queued for servicing.
- MS_INVALIDATE — invalidate cached data. Invalidates all cached copies of mapped data that are inconsistent with the permanent storage locations such that subsequent references obtain data that was consistent with the permanent storage locations sometime between the call to *msync()* and the first subsequent memory reference to the data.
- MS_INVALIDATE_ICACHE — (QNX Neutrino extension) if you're dynamically modifying code, use this flag to make sure that the new code is what will be executed.
- MS_SYNC — perform synchronous writes. The function doesn't return until all write operations are completed as defined for synchronized I/O data integrity completion.

☞ You can specify at most one of MS_ASYNC and MS_SYNC, not both.

Library:

libc

Description:

The *msync()* function writes all modified data to permanent storage locations, if any, in those whole pages containing any part of the address space of the process starting at address *addr* and continuing for *len* bytes. The *msync()* function is used with memory mapped files. If no such storage exists, *msync()* need not have any effect. If requested, the *msync()* function then invalidates cached copies of data.

For mappings to files, this function ensures that all write operations are completed as defined for synchronized I/O data integrity completion.

☞ Mappings to files aren't implemented on all filesystems.

When the *msync()* function is called on MAP_PRIVATE mappings, any modified data won't be written to the underlying object and won't cause such data to be made visible to other processes.

The behavior of *msync()* is unspecified if the mapping wasn't established by a call to *mmap()*.

If *msync()* causes any write to a file, the file's *st_ctime* and *st_mtime* fields are marked for update.

Returns:

0 Success

-1 An error occurred (*errno* is set).

Errors:

EBUSY	Some or all of the addresses in the range starting at *addr* and continuing for *len* bytes are locked, and MS_INVALIDATE is specified.
EINVAL	Invalid *flags* value.
ENOMEM	The addresses in the range starting at *addr* and continuing for *len* bytes are outside the range allowed for the address space of a process or specify one or more pages that aren't mapped.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

MS_INVALIDATE_ICACHE is a QNX Neutrino extension.

See also:

mmap(), *sysconf()*

munlock()

Unlock a buffer

Synopsis:

```
#include <sys/mman.h>

int munlock( const void * addr,
             size_t len );
```

Library:

libc

Description:

The *munlock()* function isn't currently supported.

Returns:

-1 to indicate an error (*errno* is set).

Errors:

ENOSYS The *munlock()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mlock(), mlockall(), munlockall()

munlockall()

Unlock a process's address space

Synopsis:

```
#include <sys/mman.h>

int munlockall( void );
```

Library:

libc

Description:

The current implementation of the *munlockall()* function doesn't do anything.

Returns:

-1 to indicate an error (*errno* is set).

Errors:

ENOSYS The *munlockall()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mlock(), munlock(), mlockall()

munmap()

Unmap previously mapped addresses

Synopsis:

```
#include <sys/mman.h>

int munmap( void * addr,
            size_t len );
```

Arguments:

addr The beginning of the range of addresses that you want to unmap.

len The length of the range of addresses, in bytes.

Library:

libc

Description:

The *munmap()* function removes any mappings for pages in the address range starting at *addr* and continuing for *len* bytes, rounded up to the next multiple of the page size. Subsequent references to these pages cause a SIGSEGV signal to be set on the process.

If there are no mappings in the specified address range, then *munmap()* has no effect.

Returns:

0 Success.

-1 Failure; *errno* is set.

Errors:

EINVAL The addresses in the specified range are outside the range allowed for the address space of a process.

ENOSYS The function *munmap()* isn't supported by this implementation.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Currently, you can't *munmap()* just a part of an area mapped with *mmap()*.

See also:

mmap(), *mprotect()*, *shm_open()*, *shm_unlink()*

munmap_device_io()

Free access to a device's registers

Synopsis:

```
#include <sys/mman.h>

int munmap_device_io( uintptr_t io,
                      size_t len );
```

Arguments:

io The address of the area that you want to unmap.

len The number of bytes of device I/O memory that you want to unmap.

Library:

libc

Description:

The function *munmap_device_io()* unmaps *len* bytes of device I/O memory at *io* (that was previously mapped with *mmap_device_io()*).

Returns:

-1 An error occurred (*errno* is set).

Any other value

Successful unmapping.

Errors:

EINVAL The addresses in the specified range are outside the range allowed for the address space of a process.

ENOSYS The function *munmap()* isn't supported by this implementation.

ENXIO The address from *io* for *len* bytes is invalid.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mmap_device_io(), *munmap()*

munmap_device_memory()

Unmap previously mapped addresses

Synopsis:

```
#include <sys/mman.h>

int munmap_device_memory( void * addr,
                          size_t len );
```

Arguments:

addr The beginning of the range of addresses that you want to unmap.

len The length of the range of addresses, in bytes.

Library:

libc

Description:

The *munmap_device_memory()* function is essentially the same as *munmap()*. It removes any mappings for pages in the address range starting at *addr* and continuing for *len* bytes, rounded up to the next multiple of the page size. Subsequent references to these pages cause a SIGSEGV signal to be set on the process.

If there are no mappings in the specified address range, then *munmap()* has no effect.

This function is the complement of *mmap_device_memory()*.

Returns:

-1 An error occurred (*errno* is set).

Any other value

Success.

Errors:

EINVAL	The addresses in the specified range are outside the range allowed for the address space of a process.
ENOSYS	The *munmap()* function isn't supported by this implementation.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mmap_device_memory(), *munmap()*, *munmap_device_io()*

name_attach()

Register a name in the namespace and create a channel

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

name_attach_t * name_attach( dispatch_t * dpp,
                             const char * path,
                             unsigned flags );
```

Arguments:

dpp NULL, or a dispatch handle returned by *dispatch_create()*.

path The path that you want to register under **/dev/name/[local|global]/**. This name shouldn't contain any **..** characters or start with a leading slash **/**.

flags Flags that affect the function's behavior:

- NAME_FLAG_ATTACH_GLOBAL — attach the name globally instead of locally.

Library:

libc

Description:

The *name_attach()*, *name_close()*, *name_detach()*, and *name_open()* functions provide the basic pathname-to-server-connection mapping, without having to become a *full* resource manager.

A dispatch structure is created for you automatically if you pass NULL as the *dpp*. If you've already created a dispatch structure, pass it in as the *dpp*. If you provide your own *dpp*, set *flags* to NAME_FLAG_DETACH_SAVEDPP when calling *name_detach()*; otherwise, your *dpp* is detached and destroyed automatically.

The *name_attach()* function puts the name *path* into the path namespace under **/dev/name/[local|global]/***path*. The name is attached locally by default, or globally when you set

NAME_FLAG_ATTACH_GLOBAL in the *flags*. You can see attached names in **/dev/name/local** and **/dev/name/global** directories.

ChannelCreate() is called with the _NTO_CHF_UNBLOCK, _NTO_CHF_DISCONNECT, and _NTO_CHF_COID_DISCONNECT flags set. The _NTO_CHF_THREAD_DEATH flag isn't passed to *ChannelCreate()*, but is implied by the setting of _NTO_CHF_COID_DISCONNECT. Therefore, your server that's using *name_attach()* may receive pulses as described in ChannelCreate. For instance, since _NTO_CHF_DISCONNECT is set, when a client calls *name_close()*, you'll receive the _PULSE_CODE_DISCONNECT pulse message.

The *name_attach()* also receives _IO_CONNECT message when *name_open()* is called.

For more information on the pulses (a *rcvid* of 0) related to the _NTO_CHF_COID_DISCONNECT, _NTO_CHF_DISCONNECT, _NTO_CHF_THREAD_DEATH and the _NTO_CHF_UNBLOCK flags, see *ChannelCreate()*.

If the receive buffer that the server provides isn't large enough to hold a pulse, then *MsgReceive()* returns -1 with *errno* set to EFAULT.

name_attach_t

The *name_attach()* function returns a pointer to a **name_attach_t** structure that looks like this:

```
typedef struct _name_attach {
    dispatch_t* dpp;
    int         chid;
    int         mntid;
    int         zero[2];
} name_attach_t;
```

The members include:

dpp The dispatch handle used in the creation of this connection.

chid The channel ID used for *MsgReceive()* directly.

mntid the mount ID for this name.

The information that's generally required by a server using these services is the *chid*.

Returns:

A pointer to a filled-in **name_attach_t** structure, or NULL if the call fails (*errno* is set).

Errors:

EINVAL	Invalid arguments (i.e. a NULL or empty path, a path starts with a leading slash **/** or contains **..** characters).
ENOMEM	Not enough free memory to complete the operation.
ENOTDIR	A component of the pathname wasn't a directory entry.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <stdlib.h>
#include <sys/dispatch.h>

#define ATTACH_POINT "myname"

/* We specify the header as being at least a pulse */
typedef struct _pulse msg_header_t;

/* Our real data comes after the header */
typedef struct _my_data {
    msg_header_t hdr;
    int data;
} my_data_t;

/*** Server Side of the code ***/
int server() {
    name_attach_t *attach;
    my_data_t msg;
    int rcvid;

    /* Create a local name (/dev/name/local/...) */
    if ((attach = name_attach(NULL, ATTACH_POINT, 0)) == NULL) {
        return EXIT_FAILURE;
    }

    /* Do your MsgReceive's here now with the chid */
```

```
while (1) {
    rcvid = MsgReceive(attach->chid, &msg, sizeof(msg), NULL);

    if (rcvid == -1) {/* Error condition, exit */
        break;
    }

    if (rcvid == 0) {/* Pulse received */
        switch (msg.hdr.code) {
        case _PULSE_CODE_DISCONNECT:
            /*
             * A client disconnected all its connections (called
             * name_close() for each name_open() of our name) or
             * terminated
             */
            ConnectDetach(msg.hdr.scoid);
            break;
        case _PULSE_CODE_UNBLOCK:
            /*
             * REPLY blocked client wants to unblock (was hit by
             * a signal or timed out).  It's up to you if you
             * reply now or later.
             */
            break;
        default:
            /*
             * A pulse sent by one of your processes or a
             * _PULSE_CODE_COIDDEATH or _PULSE_CODE_THREADDEATH
             * from the kernel?
             */
        }
        continue;
    }

    /* A QNX IO message received, reject */
    if (msg.hdr.type >= _IO_BASE && msg.hdr.type <= _IO_MAX) {
        MsgError(rcvid, ENOSYS);
        continue;
    }

    /* A message (presumable ours) received, handle */
    printf("Server receive %d \n", msg.data);
    MsgReply(rcvid, EOK, 0, 0);

}

/* Remove the name from the space */
name_detach(attach, 0);

return EXIT_SUCCESS;
```

```
}

/*** Client Side of the code ***/
int client() {
    my_data_t msg;
    int fd;

    if ((fd = name_open(ATTACH_POINT, 0)) == -1) {
        return EXIT_FAILURE;
    }

    /* We would have pre-defined data to stuff here */
    msg.hdr.type = 0x00;
    msg.hdr.subtype = 0x00;

    /* Do whatever work you wanted with server connection */
    for (msg.data=0; msg.data < 5; msg.data++) {
        printf("Client sending %d \n", msg.data);
        if (MsgSend(fd, &msg, sizeof(msg), NULL, 0) == -1) {
            break;
        }
    }

    /* Close the connection */
    name_close(fd);
    return EXIT_SUCCESS;
}

int main(int argc, char **argv) {
    int ret;

    if (argc < 2) {
        printf("Usage %s -s | -c \n", argv[0]);
        ret = EXIT_FAILURE;
    }
    else if (strcmp(argv[1], "-c") == 0) {
        printf("Running Client ... \n");
        ret = client();   /* see name_open() for this code */
    }
    else if (strcmp(argv[1], "-s") == 0) {
        printf("Running Server ... \n");
        ret = server();   /* see name_attach() for this code */
    }
    else {
        printf("Usage %s -s | -c \n", argv[0]);
        ret = EXIT_FAILURE;
    }
    return ret;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

As a server, you shouldn't assume that you're doing a *MsgReceive()* on a clean channel. In QNX Neutrino (and QNX 4), anyone can create a random message and send it to a process or a channel.

We recommend that you do the following to assure that you're playing safely with others in the system:

```
#include <sys/neutrino.h>

/* All of your messages should start with this header */
typedef struct _pulse msg_header_t;

/* Now your real data comes after this */
typedef struct _my_data {
        msg_header_t  hdr;
        int           data;
} my_data_t;
```

where:

hdr Contains a *type*/*subtype* field as the first 4 bytes. This allows you to identify data which isn't destined for your server.

data Specifies the receive data structure. The structure must be large enough to contain at least a pulse (which conveniently starts with the *type*/*subtype* field of most normal messages), because you'll receive a disconnect pulse when clients are detached.

See also:

ChannelCreate(), *dispatch*()* functions, *MsgReceive()*, *name_detach()*, *name_open()*, *name_close()*, **_pulse**, *resmgr_attach()*

name_close()

Close the file descriptor returned by name_open()

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int name_close( int filedes );
```

Arguments:

filedes The file descriptor returned by *name_open()*.

Library:

libc

Description:

The *name_close()* function closes the *filedes* obtained with the *name_open()* call.

Returns:

Zero for success, or -1 if an error occurs (*errno* is set).

Errors:

EBADF Invalid file descriptor *filedes*.

EINTR The *name_close()* call was interrupted by a signal.

ENOSYS The *name_close()* function isn't implemented for the filesystem specified by *filedes*.

Examples:

See the "Client side of the code" section in *name_attach()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

close(), ConnectDetach(), name_attach(), name_detach(), name_open()

name_detach()

Remove a name from the namespace and destroy the channel

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int name_detach( name_attach_t * attach,
                 unsigned flags );
```

Arguments:

attach A pointer to the **name_attach_t** structure returned by *name_attach()*.

flags Flags that affect the function's behavior:

- NAME_FLAG_DETACH_SAVEDPP — don't destroy the dispatch handle.

Library:

libc

Description:

The *name_detach()* function removes the name from the namespace and destroys the channel created by *name_attach()*. If you set NAME_FLAG_DETACH_SAVEDPP in *flags*, the dispatch pointer contained in the **name_attach_t** structure isn't destroyed; it's up to you to destroy it by calling *dispatch_destroy()*. The default is to destroy the dispatch pointer.

Returns:

Zero on success, or -1 if an error occurs (*errno* is set).

Errors:

EINVAL The mount ID (*mntid*) was never attached with *name_attach()*.

Examples:

See *name_attach()* and *resmgr_detach()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ChannelDestroy(), *dispatch*()* functions, *name_attach()*, *name_close()*, *name_open()*, *resmgr_detach()*

name_open()

Open a name for a server connection

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int name_open( const char * name,
               int flags );
```

Arguments:

name The name that you want to open for a server connection.

flags Flags that affect the function's behavior:

- NAME_FLAG_ATTACH_GLOBAL — attach the name globally instead of locally.

Library:

libc

Description:

The *name_open()* function opens *name* for a server connection. No ordering is guaranteed when accessing resources on other nodes.

Before, when an application used to call *name_open()* to connect to a service, the server was not aware of that. This has been changed now — a _IO_CONNECT/_IO_OPEN message is actually sent to the server.

The server application has to be modified to handle a possible _IO_CONNECT message coming in.

For more information, see the technote *Configuring the Global Name Service Manager*.

Returns:

A nonnegative integer representing a side-channel connection ID (see *ConnectAttach()*) or -1 if an error occurred (*errno* is set).

Errors:

EACCES — Search permission is denied on a component of the *name*.

EBADFSYS — While attempting to open the named file, either the file itself or a component of the path prefix was found to be corrupted. A system failure — from which no automatic recovery is possible — occurred while the file was being written to, or while the directory was being updated. You'll need to invoke appropriate systems-administration procedures to correct this situation before proceeding.

EBUSY — The connection specified by *name* has already been opened and additional connections aren't permitted.

EINTR — The *name_open()* operation was interrupted by a signal.

EISDIR — The named path is a directory.

ELOOP — Too many levels of symbolic links or prefixes.

EMFILE — Too many file descriptors are currently in use by this process.

ENAMETOOLONG — The length of the *name* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENFILE — Too many files are currently open in the system.

ENOENT — The connection specified by *name* doesn't exist.

ENOTDIR — A component of the *name* prefix isn't a directory.

Examples:

See *name_attach()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ConnectAttach(), *name_attach()*, *name_detach()*, *name_close()*, *open()*

nanosleep()

Suspend a thread until a timeout or signal occurs

Synopsis:

```
#include <time.h>

int nanosleep( const struct timespec* rqtp,
               struct timespec* rmtp );
```

Arguments:

rqtp A pointer to a **timespec** structure that specifies the time interval for which you want to suspend the thread.

rmtp NULL, or a pointer to a **timespec** structure where the function can store the amount of time remaining in the interval (the requested time minus the time actually slept).

Library:

libc

Description:

The *nanosleep()* function causes the calling thread to be suspended from execution until either:

- The time interval specified by the *rqtp* argument has elapsed

  Or

- A signal is delivered to the thread, and the signal's action is to invoke a signal-catching function or terminate the process.

The suspension time may be longer than requested because the argument value is rounded up to be a multiple of the system timer resolution or because of scheduling and other system activity.

Returns:

0 The requested time has elapsed.

-1 The *nanosleep()* function was interrupted by a signal (*errno* is set).

Errors:

EAGAIN	All timers are in use. You'll have to wait for a process to release one.
EFAULT	A fault occurred trying to access the buffers provided.
EINTR	The *nanosleep()* function was interrupted by a signal.
EINVAL	The number of nanoseconds specified by the *tv_nsec* member of the **timespec** structure pointed to by *rqtp* is less than zero or greater than or equal to 1000 million.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *clock_getres()*, *clock_gettime()*, *clock_settime()*, *sleep()*, *timer_create()*, *timer_delete()*, *timer_gettime()*, *timer_settime()*, **timespec**

nanospin()

Busy-wait without thread blocking for a period of time

Synopsis:

```
#include <time.h>

int nanospin( const struct timespec *when );
```

Arguments:

when A pointer to a **timespec** structure that specifies the amount of time to busy-wait for. This is a duration, not an absolute time.

Library:

libc

Description:

The *nanospin()* function occupies the CPU for the amount of time specified by the argument *when* without blocking the calling thread. (The thread isn't taken off the ready list.) The function is essentially a **do...while** loop.

The *nanospin*()* functions are designed for use with hardware that requires short time delays between accesses. You should use them only to delay for times less than a few milliseconds.

The first time *nanospin()* is called, the C library invokes *nanospin_calibrate()*, if you haven't already called it.

Returns:

EOK	Success.
E2BIG	The delay specified by *when* is greater than 500 milliseconds.
ENOSYS	This system's **startup-*** program didn't initialize the timing information necessary to use *nanospin()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Read the *Caveats*
Signal handler	Yes
Thread	Yes

Caveats:

Busy-waiting should be used only when absolutely necessary for accessing hardware.

It isn't safe to call this function in an interrupt handler if *nanospin_calibrate()* hasn't been called yet.

See also:

nanosleep(), *nanospin_calibrate()*, *nanospin_count()*, *nanospin_ns()*, *nanospin_ns_to_count()*, *sched_yield()*, *sleep()*, `timespec`

nanospin_calibrate()

Calibrate before calling nanospin()*

Synopsis:

```
#include <time.h>

int nanospin_calibrate( int disable );
```

Arguments:

disable 1 to disable interrupts during the call to *nanospin_calibrate()*, or 0 to enable them; see below.

Library:

libc

Description:

The *nanospin_calibrate()* function performs the calibration for the *nanospin()** family of delay functions. The first time that you call *nanospin()*, *nanospin_ns()*, or *nanospin_ns_to_count()*, the C library invokes *nanospin_calibrate()*, unless you call it directly first.

If you don't directly invoke *nanospin_calibrate()*, the first *nanospin*()* call in a process will have an overly long delay.

Interrupts occurring during *nanospin_calibrate()* can throw off its timings. If *disable* is 0 (zero), you can prevent this situation by:

1. Letting the thread acquire I/O privilege.
2. Disabling the interrupts around the *nanospin_calibrate()* call.

If *disable* is 1 (one), the code disables interrupts around the calibration loop(s). The calling thread is still responsible for obtaining I/O privilege before calling *nanospin_calibrate()*.

Returns:

EOK	Success.
EINTR	A too-high rate of interrupts occurred during the calibration routine.
EPERM	The process doesn't have superuser capabilities.

Examples:

Busy-wait for 100 nanoseconds:

```
#include <time.h>
#include <sys/syspage.h>

int disable = 0;
unsigned long time = 100;

...
/* Wake up the hardware, then wait for it to be ready. */

if ( (nanospin_calibrate( disable )) == EOK )
   nanospin_count( nanospin_ns_to_count( time ) );
else
   printf ("Didn't calibrate successfully.\n");

/* Use the hardware. */
...
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

nanospin(), *nanospin_count()*, *nanospin_ns()*, *nanospin_ns_to_count()*

nanospin_count()

Busy-wait without blocking for a number of iterations

Synopsis:

```
#include <time.h>

void nanospin_count( unsigned long count );
```

Arguments:

count The number of iterations that you want to busy-wait for.

Library:

libc

Description:

The *nanospin_count()* function busy-waits for the number of iterations specified in *count*. Use *nanospin_ns_to_count()* to turn a number of nanoseconds into an iteration count suitable for *nanospin_count()*.

The *nanospin*()* functions are designed for use with hardware that requires short time delays between accesses. You should use them only to delay for times less than a few milliseconds.

Examples:

Busy-wait for at least 100 nanoseconds:

```
#include <time.h>
#include <sys/syspage.h>

unsigned long time = 100;

...
/* Wake up the hardware, then wait for it to be ready. */

nanospin_count( nanospin_ns_to_count( time ) );

/* Use the hardware. */
...
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

You should use busy-waiting only when absolutely necessary for accessing hardware.

See also:

nanosleep(), *nanospin()*, *nanospin_calibrate()*, *nanospin_ns()*, *nanospin_ns_to_count()*, *sched_yield()*, *sleep()*

nanospin_ns()

Busy-wait without blocking for a period of time

Synopsis:

```
#include <time.h>

int nanospin_ns( unsigned long nsec );
```

Arguments:

nsec The number of nanoseconds that you want to busy-wait for.

Library:

libc

Description:

The *nanospin_ns()* function busy-waits for the number of nanoseconds specified in *nsec*, without blocking the calling thread.

The *nanospin*()* functions are designed for use with hardware that requires short time delays between accesses. You should use them only to delay for times less than a few milliseconds.

The first time you call *nanospin_ns()*, the C library invokes *nanospin_calibrate()*, if you haven't invoked it directly first.

Returns:

EOK	Success.
E2BIG	The delay specified by *nsec* is greater than 500 milliseconds.
ENOSYS	This system's **startup-*** program didn't initialize the timing information necessary to use *nanospin_ns()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Read the *Caveats*
Signal handler	Yes
Thread	Yes

Caveats:

You should use busy-waiting only when absolutely necessary for accessing hardware.

It isn't safe to call this function in an interrupt handler if *nanospin_calibrate()* hasn't been called yet.

See also:

nanosleep(), nanospin(), nanospin_calibrate(), nanospin_count(), nanospin_ns_to_count(), sched_yield(), sleep()

nanospin_ns_to_count()

Convert a time in nanoseconds into a number of iterations

Synopsis:

```
#include <time.h>

unsigned long nanospin_ns_to_count(
                  unsigned long nsec );
```

Arguments:

nsec The number of nanoseconds that you want to convert.

Library:

libc

Description:

The *nanospin_ns_to_count()* function converts the number of nanoseconds specified in *nsec* into an iteration count suitable for *nanospin_count()*.

The *nanospin*()* functions are designed for use with hardware that requires short time delays between accesses. You should them only to delay for times less than a few milliseconds.

The first time that you call *nanospin_ns_to_count()*, the C library invokes *nanospin_calibrate()* if you haven't invoked it directly first.

Returns:

The amount of time to busy-wait, or -1 if an error occurred (*errno* is set).

Errors:

ENOSYS This system's **startup-*** program didn't initialize the timing information necessary to use *nanospin_ns_to_count()*.

Examples:

Busy-wait for at least one nanosecond:

```
#include <time.h>
#include <sys/syspage.h>

unsigned long time = 1;

...
/* Wake up the hardware, then wait for it to be ready. */

/*
 The C library invokes nanospin_calibrate
 if it hasn't already been called.
*/

nanospin_count( nanospin_ns_to_count( time ) );

/* Use the hardware. */
...
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Read the *Caveats*
Signal handler	Yes
Thread	Yes

Caveats:

You should use busy-waiting only when absolutely necessary for accessing hardware.

It isn't safe to call this function in an interrupt handler if *nanospin_calibrate()* hasn't been called yet.

See also:

nanospin(), nanospin_calibrate(), nanospin_count(), nanospin_ns()

nap()

Sleep for a given number of milliseconds

Synopsis:

```
#include <unix.h>

unsigned int nap( unsigned int ms);
```

Arguments:

ms The number of milliseconds that you want the process to sleep.

Library:

libc

Description:

The *nap()* routine delays the calling process for *ms* milliseconds. This function is the same as *delay()* and is similar to *napms()*.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

delay(), napms()

napms()

Sleep for a given number of milliseconds

Synopsis:

```
#include <curses.h>

int napms( int ms);
```

Arguments:

ms The number of milliseconds that you want the process to sleep.

Library:

libc

Description:

The *napms()* routine delays the calling process for *ms* milliseconds. This function is similar to *delay()* and *nap()*.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

delay(), nap()

nbaconnect()

Initiate a connection on a socket (nonblocking)

Synopsis:

```
#include <sys/socket.h>

int nbaconnect( int s,
                const struct sockaddr * name,
                size_t namelen );
```

Arguments:

s	The descriptor of the socket on which to initiate the connection.
name	The name of the socket to connect to for a SOCK_STREAM connection.
namelen	The length of the *name*, in bytes.

Library:

libsocket

Description:

The *nbaconnect()* function is called in place of *connect()*, to prevent a nonblocking *connect()* from blocking during an autoconnect (see **/etc/autoconnect**).

When the autoconnect behavior is used, *connect()* may block your application while waiting for the autoconnect to complete; *nbaconnect()* allows your application to continue executing during the autoconnect.

The *nbaconnect()* function takes the same arguments as *connect()*, but it differs in the return value when an autoconnect is required. If an autoconnect is required, a file descriptor (*fd*) is returned. The *fd* is used in the call to *nbaconnect_result()* to get the *errno* related to the autoconnect and the connect attempt.

☞ Since *nbaconnect_result()* is a blocking call, it's recommended that you call *select()* first to determine if there's data available on the pipe.

When the data's available, call *nbaconnect_result()* to get the status of the *nbaconnect()* attempt.

If an autoconnect isn't required, *nbaconnect()* returns -1 and exhibits the same behavior as *connect()* on nonblocking sockets (e.g. if -1 is returned and *errno* is set to EINPROGRESS, it's possible to do a *select()* for completion by selecting the socket for writing).

Returns:

A file descriptor that you can pass to *nbaconnect_result()* to get the result of the *nbaconnect()* attempt, or -1 if an error occurred (*errno* is set).

Errors:

Any value from the Errors section in *connect()*, as well as:

EINVAL	The socket file descriptor being passed isn't nonblocking.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The **pipe** manager must be available.

See also:

accept(), bind(), connect(), errno, fcntl(), getsockname(), nbaconnect_result(), open(), pipe(), read(), select(), socket(), write()

/etc/autoconnect, **pipe** in the *Utilities Reference*.

nbaconnect_result()

Get the status of the previous call to nbaconnect()

Synopsis:

```
#include <sys/socket.h>

int nbaconnect_result( int fd,
                       int * error );
```

Arguments:

fd	The file descriptor returned by *nbaconnect()*.
error	A pointer to a location where the function can store the status.

Library:

libsocket

Description:

The *nbaconnect_result()* function gets the status of the previous *nbaconnect()* call when an *fd* was returned. Since *nbaconnect_result()* is a blocking call, it's best to test the status of the *fd* with a call to *select()* to verify that the file descriptor is ready to be read.

When there's data available, the status is put in *error*, which may be any of the *errno* values set by *connect()* during an attempt to make a non-blocking connection.

The *fd* is always closed by this function whether or not there's a status to report.

Returns:

0	The call was successful; *error* contains the status.
-1	An error occurred while obtaining the status.

Errors:

Any value from the Errors section in *connect()*, as well as:

EBADF	Invalid *fd*.
ENOMSG	There's no data, or not enough data, from the *fd*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

connect(), *nbaconnect()*, *select()*

autoconnect in the *Utilities Reference*.

ND_NODE_CMP()

Compare two node descriptors

Synopsis:

```
#include <sys/netmgr.h>

#define ND_NODE_CMP(a,b) ...
```

Arguments:

a, *b* The node descriptors that you want to compare. You can use either the value 0 or ND_LOCAL_NODE to refer to the local node.

Library:

libc

Description:

The *ND_NODE_CMP()* macro compares two node descriptors.

Returns:

< 0 The node descriptor *a* is less than *b*.

0 The descriptors refer to the same machine.

> 0 The node descriptor *a* is greater than *b*.

Examples:

```
#include <sys/neutrino.h>

uint32_t nd1, nd2;

if ( ND_NODE_CMP(nd1, nd2) == 0 ) {
  /* Same node */
  ...
} else {
  /* Different nodes */
  ...
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

netmgr_ndtostr(), *netmgr_remote_nd()*, *netmgr_strtond()*

Qnet Networking chapter of the *Programmer's Guide*

Qnet Networking chapter of the *System Architecture* guide

Synopsis:

```
#include <netdb.h>

struct netent {
     char *   n_name;
     char **  n_aliases;
     int      n_addrtype;
     uint32_t n_net;
};
```

Description:

This structure holds information from the network database, **/etc/networks**.

The members of this structure are:

n_name	The name of the network.
n_aliases	A zero-terminated list of alternate names for the network.
n_addrtype	The type of the network number returned; currently only AF_INET.
n_net	The network number. Network numbers are returned in machine-byte order.

Classification:

Unix, POSIX 1003.1-2001

See also:

endnetent(), *getnetbyaddr()*, *getnetbyname()*, *getnetent()*, *setnetent()*

/etc/networks in the *Utilities Reference*

netmgr_ndtostr()

Convert a node descriptor into a string

Synopsis:

```
#include <sys/netmgr.h>

int netmgr_ndtostr( unsigned flags,
                    int nd,
                    char * buf,
                    size_t maxbuf );
```

Arguments:

flags	Which part(s) of the Fully Qualified Path Name (FQPN) to adjust; see below.
nd	The node descriptor that you want to convert.
buf	A pointer to a buffer where the function can store the converted identifier.
maxbuf	The size of the buffer.

Library:

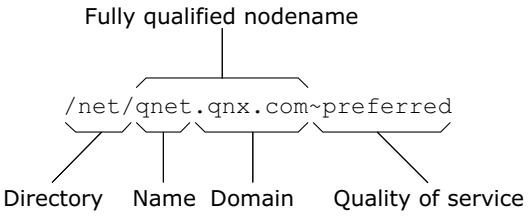
libc

Description:

The *netmgr_ndtostr()* function converts a node descriptor, *nd*, to a string and stores the string in the buffer pointed to by *buf*. The size of the buffer is given by *maxbuf*.

A node descriptor is a temporary numeric description of a remote node. For more information, see the Qnet Networking chapter of the *System Architecture* guide.

The *flags* argument indicates which part(s) of the Fully Qualified Path Name (FQPN) to adjust. The following diagram shows the components for the FQPN, **/net/qnet.qnx.com~preferred**:



Components of a fully qualified pathname.

The Fully Qualified Node Name (FQNN) is **qnet.qnx.com**.

The default string that *netmgr_ndtostr()* builds is the FQNN, plus the Quality of Service (QoS) if it isn't the default (**~loadbalance**). You can pass this string to any other node that can call *netmgr_strtond()* and has a *nd* that refers to the same node with the same QoS.

A bitwise OR of *flags* modify the default string in the following way:

ND2S_DIR_HIDE

Never include the directory.

ND2S_DIR_SHOW

Always build a pathname to the root directory (i.e. **/**) of the node indicated by *nd*. For example, calling:

```
netmgr_ndtostr(ND2S_DIR_SHOW, nd, buf, sizeofbuf)
```

on a node with a default domain of **qnx.com** using a *nd* that refers to a FQNN of **peterv.qnx.com** results in the string:

```
/net/peterv.qnx.com/
```

If Qnet isn't active on the node, and *netmgr_ndtostr(ND2S_DIR_SHOW, nd, buf, sizeofbuf)* has a *nd* of ND_LOCAL_NODE, then the string is **/**.

ND2S_DOMAIN_HIDE

Never include the domain.

ND2S_DOMAIN_SHOW

Always include the domain.

ND2S_LOCAL_STR

Display shorter node names on your local node. For example, calling:

```
netmgr_ndtostr(ND2S_LOCAL_STR, nd, buf, sizeofbuf)
```

on a node with a default domain of **qnx.com** using a *nd* that refers to an FQPN of **/net/peterv.qnx.com** results in a string of:

```
peterv
```

Whereas, a *nd* that refers to **/net/peterv.anotherhost.com** results in:

```
peterv.anotherhost.com
```

ND2S_NAME_HIDE

Never include the name.

ND2S_NAME_SHOW

Always include the name.

ND2S_QOS_HIDE

Never include the quality of service (QoS).

ND2S_QOS_SHOW

Always include the QoS.

ND2S_SEP_FORCE

Always include a leading separator. For example, calling:

```
netmgr_ndtostr(ND2S_SEP_FORCE|ND2S_DIR_HIDE|ND2S_NAME_HIDE|ND2S_DOMAIN_HIDE|ND2S_QOS_SHOW, nd, buf, sizeofbuf)
```

with a *nd* of ND_LOCAL_NODE results in a string of:

```
~loadbalance
```

This is useful if you want to concatenate each component of the FQPN individually.

☞ Don't use a ND2S_*_HIDE and a corresponding ND2S_*_SHOW together.

Returns:

The length of the string, or -1 if an error occurs (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <sys/netmgr.h>

int main ()
{
   int nd1, nd2, nd3, len;
   char path1[50] = "/net/dave",
        path2[50] = "/net/karen",
        buff[100];

   nd1 = netmgr_strtond( path1, NULL);
   if (nd1 == -1) {
      perror ("netmgr_strtond" );
      return EXIT_FAILURE;
   }
   else {
      printf ("Node id for %s is %d.\n", path1, nd1);
   }
```

```
    nd2 = netmgr_strtond( path2, NULL);
    if (nd2 == -1) {
       perror ("netmgr_strtond" );
       return EXIT_FAILURE;
    }
    else {
       printf ("Node id for %s is %d.\n", path2, nd2);
    }

    nd3 = netmgr_remote_nd ( nd2, nd1 );
    if (nd3 == -1) {
       perror ("netmgr_strtond" );
       return EXIT_FAILURE;
    }
    else {
       printf ("Node id for %s, relative to %s, is %d.\n",
               path1, path2, nd3);
    }

    len = netmgr_ndtostr ( ND2S_DIR_HIDE | ND2S_DOMAIN_SHOW |
              ND2S_NAME_SHOW | ND2S_QOS_SHOW, nd1, buff, 100 );
    if (len == -1) {
       perror ("netmgr_ndtostr" );
    }
    else {
       printf ("Node name for %d is %s.\n", nd1, buff);
       return EXIT_FAILURE;
    }

    return EXIT_SUCCESS;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ND_NODE_CMP(), *netmgr_remote_nd()*, *netmgr_strtond()*

Qnet Networking chapter of the *Programmer's Guide*

Qnet Networking chapter of the *System Architecture* guide

netmgr_remote_nd()

Get a node descriptor that's relative to a remote node

Synopsis:

```
#include <sys/netmgr.h>

int netmgr_remote_nd( int remote_nd,
                      int local_nd );
```

Arguments:

remote_nd	The node descriptor of a remote node.
local_nd	A node descriptor, relative to the local node, that you want to convert to be relative to the remote node.

Library:

libc

Description:

The *netmgr_remote_nd()* function converts a node descriptor that's relative to the local node into a node descriptor that's relative to the specified remote node.

Returns:

The node descriptor, relative to the remote node, or -1 if an error occurred (*errno* is set).

Examples:

See *netmgr_ndtostr()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ND_NODE_CMP(), netmgr_ndtostr(), netmgr_strtond()

Qnet Networking chapter of the *Programmer's Guide*

Qnet Networking chapter of the *System Architecture* guide

netmgr_strtond()

Convert a string into a node descriptor

Synopsis:

```
#include <sys/netmgr.h>

int netmgr_strtond( const char * nodename,
                    char ** endstr );
```

Arguments:

nodename	The string that you want to convert into a node descriptor.
endstr	NULL, or the address of a location where the function can store a pointer to the character after the node name in the string.

Library:

libc

Description:

The *netmgr_strtond()* function converts a string to a node descriptor. If *endstr* isn't NULL, it's set to point to the character after the node name in the given string.

Returns:

The node descriptor, or -1 if an error occurred (*errno* is set).

Errors:

ENOTSUP	Qnet isn't running.

Examples:

See *netmgr_ndtostr()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ND_NODE_CMP(), netmgr_ndtostr(), netmgr_remote_nd()

Qnet Networking chapter of the *Programmer's Guide*

Qnet Networking chapter of the *System Architecture* guide

nextafter(), *nextafterf()*

Compute the next representable double-precision floating-point number

Synopsis:

```
#include <math.h>

double nextafter ( double x,
                   double y);

float nextafterf ( float x,
                   float y );
```

Arguments:

x The number that you want the next number after.

y A number that specifies the direction you want to go; see below.

Library:

libm

Description:

The *nextafter()* and *nextafterf()* functions compute the next representable double-precision floating-point value following *x* in the direction of *y*.

Returns:

The next machine floating-point number of *x* in the direction towards *y*.

If:	*nextafter()* returns:
y < *x*	The next possible floating-point value less than *y*
y > *x*	The next possible floating-point value greater than *x*
x is NAN	NAN

continued...

If:	*nextafter()* returns:
y is NAN	NAN
x is finite	±HUGE_VAL, according to the sign of *x* (*errno* is set)

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

void dump_to_hex(double d) {
        printf("0x%08x %08x \n",
           (uint32_t)(*((uint64_t*)&d) >> 32),
           (uint32_t)(*((uint64_t*)&d)));
}

int main(int argc, char** argv)
{
    double a, b, c;

    a = 0 ;
    b = nextafter(a, -1);
    c = nextafter(a, 1);
    printf("Next possible value before %f is %f \n", a, b);
    printf("-->"); dump_to_hex(a);
    printf("-->"); dump_to_hex(b);
    printf("Next possible value after %f is %f \n", a, c);
    printf("-->"); dump_to_hex(a);
    printf("-->"); dump_to_hex(c);

    return(0);
}
```

produces the output:

```
Next possible value before 0.000000 is 0.000000
```

```
-->0x00000000 00000000
-->0x80000000 00000001
Next possible value after 0.000000 is 0.000000
-->0x00000000 00000000
```

Classification:

nextafter() is standard Unix; *nextafterf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Synopsis:

```
#include <ftw.h>

int nftw( const char *path,
          int (*fn)( const char *fname,
                     const struct stat *sbuf,
                     int flags,
                     struct FTW *ftw),
          int depth,
          int flags);
```

Arguments:

path The path of the directory whose file tree you want to walk.

fn A pointer to a function that you want to call for each file; see below.

depth The maximum number of file descriptors that *nftw()* can use. The *nftw()* function uses one file descriptor for each level in the tree.

If *depth* is zero or negative, the effect is the same as if it were 1. The *depth* must not be greater than the number of file descriptors currently available for use. The *nftw()* function is faster if *depth* is at least as large as the number of levels in the tree.

flags The value of *flags* is constructed by the bitwise ORing of values from the following list, defined in the **<ftw.h>** header file.

FTW_CHDIR If set, *nftw()* changes the current working directory to each directory as it reports files in that directory.

FTW_DEPTH If set, *nftw()* reports all files in a directory before reporting the directory itself (otherwise the directory is reported before any file it contains).

FTW_MOUNT	If set, *nftw()* only reports files on the same filesystem as *path*.
FTW_PHYS	If set, *nftw()* performs a physical walk and doesn't follow any symbolic link.

Library:

libc

Description:

The *nftw()* function recursively descends the directory hierarchy identified by *path*. For each object in the hierarchy, *nftw()* calls the user-defined function *fn()*, passing to it:

- a pointer to a NULL-terminated character string containing the name of the object
- a pointer to a **stat** structure (see *stat()*) containing information about the object
- an integer. Possible values of the integer, defined in the **<nftw.h>** header, are:

FTW_F	The object is a file.
FTW_D	The object is a directory.
FTW_DNR	The object is a directory that can't be read. Descendents of the directory aren't processed.
FTW_DP	The object is a directory, and its contents have been reported. See the FTW_DEPTH flag above.
FTW_NS	The *stat()* failed on the object because the permissions weren't appropriate. The **stat** buffer passed to *fn()* is undefined.
FTW_SL	The object is a symbolic link. See the FTW_PHYS flag above.
FTW_SLN	The object is a symbolic link that does not name an existing file.

- a pointer to a FTW structure, which contains the following fields:

  base The offset of the objects filename in the pathname passed as the first argument to *fn()*.

  level The depth relative to the root of the walk (where the root is level 0).

  quit A flag that can be set to control the behaviour of *nftw()* within the current directory. If assigned, it may be given the following values:

  FTW_SKR Skip the remainder of this directory

  FTW_SKD If the object is FTW_D, then do not enter into this directory.

The tree traversal continues until the tree is exhausted, an invocation of *fn()* returns a nonzero value, or some error is detected within *nftw()* (such as an I/O error). If the tree is exhausted, *nftw()* returns zero. If *fn()* returns a nonzero value, *nftw()* stops its tree traversal and returns whatever value was returned by *fn()*.

When *nftw()* returns, it closes any file descriptors it opened; it doesn't close any file descriptors that may have been opened by *fn()*.

Returns:

0 Success.

-1 An error (other than EACCESS) occurred (*errno* is set).

Classification:

Standard Unix, *nftw64()* is for large-file support

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

Because *nftw()* is recursive, it might terminate with a memory fault when applied to very deep file structures.

This function uses *malloc()* to allocate dynamic storage during its operation. If *nftw()* is forcibly terminated, for example if *longjmp()* is executed by *fn()* or an interrupt routine, *nftw()* doesn't have a chance to free that storage, so it remains permanently allocated. A safe way to handle interrupts is to store the fact that an interrupt has occurred, and arrange to have *fn()* return a nonzero value at its next invocation.

See also:

ftw(), longjmp(), malloc(), stat()

nice()

Change the priority of a process

Synopsis:

```
#include <unistd.h>

int  nice( int incr );
```

Arguments:

incr The amount that you want to add to the process's priority.

Library:

libc

Description:

The *nice()* function allows a process to change its priority. The invoking process must be in a scheduling class that supports the operation.

The *nice()* function adds the value of *incr* to the nice value of the calling process. A process's nice value is a nonnegative number; a greater positive value results in a lower CPU priority.

A maximum nice value of 2 * NZERO - 1 and a minimum nice value of 0 are imposed by the system. NZERO is defined in **<limits.h>** with a default value of 20. If you request a value above or below these limits, the nice value is set to the corresponding limit. A nice value of 40 is treated as 39. Only a process with superuser privileges can lower the nice value.

Returns:

The new nice value minus NZERO. If an error occurred, -1 is returned, the process's nice value isn't changed, and *errno* is set.

Errors:

EINVAL — The *nice()* function was called by a process in a scheduling class other than time-sharing.

EPERM — The *incr* argument was negative or greater than 40, and the effective user ID of the calling process isn't the superuser.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

As -1 is a permissible return value in a successful situation, an application wishing to check for error situations should set *errno* to 0, then call *nice()*, and if it returns -1, check to see if *errno* is nonzero.

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*

`nice` in the *Utilities Reference*

nrand48()

Generate a pseudo-random nonnegative **long** *integer in a thread-safe manner*

Synopsis:

```
#include <stdlib.h>

long nrand48( unsigned short xsubi[3] );
```

Arguments:

xsubi An array that comprises the 48 bits of the initial value that you want to use.

Library:

libc

Description:

The *nrand48()* function uses a linear congruential algorithm and 48-bit integer arithmetic to generate a nonnegative **long** integer uniformly distributed over the interval $[0, 2^{31}]$.

The *xsubi* array should contain the desired initial value; this makes *nrand48()* thread-safe, and lets you start a sequence of random numbers at any known value.

Returns:

A pseudo-random **long** integer.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No

continued...

Safety	
Thread	Yes

See also:

drand48(), erand48(), jrand48(), lcong48(), lrand48(), mrand48(), seed48(), srand48()

nsec2timespec()

Convert nanoseconds to a **timespec** *structure*

Synopsis:

```
#include <time.h>

void nsec2timespec( struct timespec *timespec_p,
                    _uint64 nsec );
```

Arguments:

timespec_p	A pointer to a **timespec** structure where the function can store the converted time.
nsec	The number of nanoseconds that you want to convert.

Library:

libc

Description:

This function converts the given number of nanoseconds, *nsec*, into seconds and nanoseconds, and stores them in the **timespec** structure pointed to by *timespec_p*.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

timespec, *timespec2nsec()*

Convert a 32-bit value from network-byte order to host-byte order

Synopsis:

```
#include <arpa/inet.h>

uint32_t ntohl( uint32_t netlong );
```

Arguments:

netlong The value that you want to convert.

Library:

libc

Description:

The *ntohl()* function converts a 32-bit value from network-byte order to host-byte order. If a machine's byte order is the same as the network order, this routine is defined as a null macro.

You most often use this routine in conjunction with internet addresses and ports returned by *gethostbyname()* and *getservent()*.

Returns:

The value in host-byte order.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

gethostbyname(), *getservent()*, *htonl()*, *htons()*, *ntohs()*

Convert a 16-bit value from network-byte order to host-byte order

Synopsis:

```
#include <arpa/inet.h>

uint16_t ntohs( uint16_t netshort );
```

Arguments:

netshort The value that you want to convert.

Library:

libc

Description:

The *ntohs()* function converts a 16-bit value from network-byte order to host-byte order. If a machine's byte order is the same as the network order, this routine is defined as a null macro.

You most often use this routine in conjunction with internet addresses and ports returned by *gethostbyname()* and *getservent()*.

Returns:

The value in host-byte order.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

gethostbyname(), *getservent()*, *htonl()*, *htons()*, *ntohl()*

offsetof()

Return the offset of an element within a structure

Synopsis:

```
#include <stddef.h>

#define offsetof( composite, name ) ...
```

Arguments:

composite	A **struct** or **union**.
name	The name of an element in *composite*.

Library:

libc

Description:

The *offsetof()* macro returns the offset of the element *name* within the **struct** or **union** *composite*.

This provides a portable method to determine the offset.

Returns:

The offset of *name*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <stddef.h>

struct new_def
{
    char *first;
    char second[10];
    int third;
};

int main( void )
{
    printf( "first:%d second:%d third:%d\n",
            offsetof( struct new_def, first ),
```

```
            offsetof( struct new_def, second ),
            offsetof( struct new_def, third ) );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

This is a macro.

Synopsis:

```
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>

int open( const char * path,
          int oflag,
          ... );

int open64( const char * path,
            int oflag,
            ... );
```

Arguments:

path The path name of the file that you want to open.

oflag Flags that specify the status and access modes of the file; see below.

If you set O_CREAT in *oflag*, you must also specify the following argument:

mode An object of type **mode_t** that specifies the access mode that you want to use for a newly created file. For more information, see "Access permissions" in the documentation for *stat()*, and the description of O_CREAT, below.

Library:

libc

Description:

The *open()* and *open64()* functions open the file named by *path*, creating an open file description that refers to the file, and a file descriptor that refers to the file description. The file status flags and

the file access modes of the open file description are set according to the value of *oflag*.

These functions ignore any advisory locks that you set with *fcntl()*.

The open file descriptor created is new, and therefore isn't shared with any other process in the system.

Construct the value of *oflag* by bitwise ORing values from the following list, defined in the **<fcntl.h>** header file. You must specify exactly one of the first three values (file access modes) below in the value of *oflag*:

O_RDONLY	Open for reading only.
O_RDWR	Open for reading and writing. Opening a FIFO for read-write is unsupported.
O_WRONLY	Open for writing only.

You can also specify any combination of the remaining flags in the value of *oflag*:

O_APPEND	If set, the file offset is set to the end of the file prior to each write.
O_CLOEXEC	Close the file descriptor on execution.
O_CREAT	This option requires a third argument, *mode*, which is of type **mode_t**. If the file exists, this flag has no effect, except in combination with O_EXCL as noted below. Otherwise, the file is created; the file's user ID is set to the effective user ID of the process; the group ID is set to the effective group ID of the process or the group ID of the file's parent directory (see *chmod()*).

The permission bits, as defined in **<sys/stat.h>**, are set to the value of *mode*, except those bits set in the process's file mode creation mask (see *umask()* for details). Bits set in *mode* other than the file permission bits (i.e. the file type bits) are ignored. The *mode* argument doesn't affect whether the file is opened for reading, for writing, or for both.

O_DSYNC — If set, this flag affects subsequent I/O calls; each call to *write()* waits until all data is successfully transferred to the storage device such that it's readable on any subsequent open of the file (even one that follows a system failure) in the absence of a failure of the physical storage medium. If the physical storage medium implements a non-write-through cache, then a system failure may be interpreted as a failure of the physical storage medium, and data may not be readable even if this flag is set and the *write()* indicates that it succeeded.

O_EXCL — If you set both O_EXCL and O_CREAT, *open()* fails if the file exists. The check for the existence of the file and the creation of the file if it doesn't exist are atomic; no other process that's attempting the same operation with the same filename at the same time will succeed. Specifying O_EXCL without O_CREAT has no effect.

O_LARGEFILE — Allow the file offset to be 64 bits long.

O_NOCTTY — If set, and *path* identifies a terminal device, the *open()* function doesn't cause the terminal device to become the controlling terminal for the process.

O_NONBLOCK

- When opening a FIFO with O_RDONLY or O_WRONLY set:

If O_NONBLOCK is set:

Calling *open()* for reading-only returns without delay. Calling *open()* for writing-only returns an error if no process currently has the FIFO open for reading.

If O_NONBLOCK is clear:

Calling *open()* for reading-only blocks until a process opens the file for writing. Calling *open()* for writing-only blocks until a process opens the file for reading.

- When opening a block special or character special file that supports nonblocking opens:

  If O_NONBLOCK is set:

  The *open()* function returns without waiting for the device to be ready or available. Subsequent behavior of the device is device-specific.

  If O_NONBLOCK is clear:

  The *open()* function waits until the device is ready or available before returning. The definition of when a device is ready is device-specific.

- Otherwise, the behavior of O_NONBLOCK is unspecified.

O_REALIDS — Use the real **`uid`**/**`gid`** for permissions checking.

O_RSYNC — Read I/O operations on the file descriptor complete at the same level of integrity as specified by the O_DSYNC and O_SYNC flags.

O_SYNC — If set, this flag affects subsequent I/O calls; each call to *read()* or *write()* is complete only when both the data has been successfully transferred (either read or written) and all file system information relevant to that I/O operation (including that

required to retrieve said data) is successfully transferred, including file update and/or access times, and so on. See the discussion of a successful data transfer in O_DSYNC, above.

O_TRUNC — If the file exists and is a regular file, and the file is successfully opened O_WRONLY or O_RDWR, the file length is truncated to zero and the mode and owner are left unchanged. O_TRUNC has no effect on FIFO or block or character special files or directories. Using O_TRUNC with O_RDONLY has no effect.

The largest value that can be represented correctly in an object of type **`off_t`** shall be established as the offset maximum in the open file description.

Returns:

A nonnegative integer representing the lowest numbered unused file descriptor. On a file capable of seeking, the file offset is set to the beginning of the file. Otherwise, -1 is returned (*errno* is set).

In QNX Neutrino, the returned file descriptor is the same as the connection ID (or *coid*) used by the Neutrino-specific functions.

Errors:

EACCES — Search permission is denied on a component of the *path* prefix, or the file exists and the permissions specified by *oflag* are denied, or the file doesn't exist and write permission is denied for the parent directory of the file to be created.

EBADFSYS — While attempting to open the named file, either the file itself or a component of the path prefix was found to be corrupted. A system failure — from which no automatic recovery is possible —

	occurred while the file was being written to, or while the directory was being updated. You'll need to invoke appropriate systems-administration procedures to correct this situation before proceeding.
EBUSY	File access was denied due to a conflicting open (see *sopen()*).
EEXIST	The O_CREAT and O_EXCL flags are set, and the named file exists.
EINTR	The *open()* operation was interrupted by a signal.
EINVAL	The requested synchronized modes (O_SYNC, O_DSYNC, O_RSYNC) aren't supported.
EISDIR	The named file is a directory, and the *oflag* argument specifies write-only or read/write access.
ELOOP	Too many levels of symbolic links or prefixes.
EMFILE	Too many file descriptors are currently in use by this process.
ENAMETOOLONG	The length of the *path* string exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.
ENFILE	Too many files are currently open in the system.
ENOENT	The O_CREAT flag isn't set, and the named file doesn't exist; or O_CREAT is set and either the path prefix doesn't exist, or the *path* argument points to an empty string.
ENOSPC	The directory or filesystem that would contain the new file can't be extended.
ENOSYS	The *open()* function isn't implemented for the filesystem specified in *path*.

ENOTDIR	A component of the path prefix isn't a directory.
ENXIO	The O_NONBLOCK flag is set, the named file is a FIFO, O_WRONLY is set, no process has the file open for reading, or the media associated with the file has been removed (e.g. CD, floppy).
EOVERFLOW	The named file is a regular file and the size of the file can't be represented correctly in an object of type **off_t**.
EROFS	The named file resides on a read-only filesystem and either O_WRONLY, O_RDWR, O_CREAT (if the file doesn't exist), or O_TRUNC is set in the *oflag* argument.

Examples:

```
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <stdlib.h>

int main( void )
  {
    int fd;

    /* open a file for output              */
    /* replace existing file if it exists  */
    /* with read/write perms for owner     */

    fd = open( "myfile.dat",
        O_WRONLY | O_CREAT | O_TRUNC,
        S_IRUSR | S_IWUSR );

    /* read a file that is assumed to exist */

    fd = open( "myfile.dat", O_RDONLY );

    /* append to the end of an existing file  */
    /* write a new file if file doesn't exist */
    /* with full read/write permissions       */

    fd = open( "myfile.dat",
        O_WRONLY | O_CREAT | O_APPEND,
        S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP
```

```
        | S_IROTH | S_IWOTH );
  return EXIT_SUCCESS;
}
```

Classification:

open() is POSIX 1003.1; *open64()* is for large-file support

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *open()* function includes POSIX 1003.1-1996 and QNX extensions.

See also:

chmod(), close(), creat(), dup(), dup2(), errno, fcntl(), fstat(), lseek(), read(), write()

opendir()

Open a directory

Synopsis:

```
#include <dirent.h>

DIR * opendir( const char * dirname );
```

Arguments:

dirname	The path of the directory to be opened. It can be relative to the current working directory, or an absolute path.

Library:

libc

Description:

The *opendir()* function is used with *readdir()* and *closedir()* to get the list of file names contained in the directory specified by *dirname*.

You can read more than one directory at the same time using the *opendir()*, *readdir()*, *rewinddir()* and *closedir()* functions.

The result of using a directory stream after one of the *exec*()* or *spawn*()* functions is undefined. After a call to the *fork()* function, either the parent *or* the child (but not both) can continue processing the directory stream using *readdir()* and *rewinddir()*. If both the parent and child processes use these functions, the result is undefined. Either process can use *closedir()*.

Returns:

A pointer to a **DIR** structure required for subsequent calls to *readdir()* to retrieve the file names in *dirname*, or NULL if *dirname* isn't a valid path (*errno* is set).

Errors:

EACCES — Search permission is denied for a component of *dirname*, or read permission is denied for *dirname*.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *dirname* exceeds PATH_MAX, or a pathname component is longer than NAME_MAX.

ENOENT — The named directory doesn't exist.

ENOSYS — The *opendir()* function isn't implemented for the filesystem specified in *dirname*.

ENOTDIR — A component of *dirname* isn't a directory.

Examples:

Get a list of files contained in the directory **/home/fred**:

```
#include <stdio.h>
#include <stdlib.h>
#include <dirent.h>

int main( void )
{
    DIR* dirp;
    struct dirent* direntp;

    dirp = opendir( "/home/fred" );
    if( dirp == NULL ) {
        perror( "can't open /home/fred" );
    } else {
        for(;;) {
            direntp = readdir( dirp );
            if( direntp == NULL ) break;

            printf( "%s\n", direntp->d_name );
        }

        closedir( dirp );
    }

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

closedir(), errno, readdir(), readdir_r(), rewinddir(), seekdir(), telldir()

openfd()

Open for private access a file associated with a given descriptor

Synopsis:

```
#include <unistd.h>

int openfd( int fd,
            int oflag );
```

Arguments:

fd A file descriptor associated with the file that you want to open.

oflag How you want to open the file; a combination of the following bits:

- O_RDONLY — permit the file to be only read.
- O_WRONLY — permit the file to be only written.
- O_RDWR — permit the file to be both read and written.
- O_APPEND — cause each record that's written to be written at the end of the file.
- O_TRUNC — truncate the file to contain no data.

Library:

libc

Description:

The *openfd()* function opens the file associated with the file descriptor, *fd*. This is similar to *dup()*, except the new *fd* has private access modes and offset. The access mode, *oflag*, must be equal to or more restrictive than the access mode of the source *fd*.

Returns:

A file descriptor, or -1 if an error occurred (*errno* is set).

Errors:

EBADF	Invalid file descriptor *fd*.
EACCES	The access mode specified by *oflag* isn't equal to or more restrictive than the access mode of the source *fd*.
EBUSY	Sharing mode (*sflag*) was denied due to a conflicting open (see *sopenfd()*).

Examples:

```
#include <unistd.h>
#include <stdlib.h>
#include <fcntl.h>

int main ( void )
{
    int fd, fd2, oflag;

    fd = open ("etc/passwd", O_RDONLY);
    fd2 = openfd ( fd, O_RDONLY );
    return EXIT_SUCCESS;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

dup(), *sopenfd()*

openlog()

Open the system log

Synopsis:

```
#include <syslog.h>

void openlog( const char * ident,
              int logopt,
              int facility );
```

Arguments:

ident A string that you want to prepend to every message.

logopt A bit field specifying logging options; a combination of one or more of the following values with an OR operation:

LOG_CONS	If *syslog()* can't pass the message to **syslogd**, it attempts to write the message to the **/dev/console** device. The **/dev/console** device is usually a symlink (see the **ln** command) to a real device (e.g. **/dev/text**, **/dev/con1** or **/dev/ser1**).
LOG_NDELAY	Open the connection to **syslogd** immediately. Normally the opening is delayed until the first message is logged.
LOG_PERROR	Write the message to standard error output as well to the system log.
LOG_PID	Log the process ID with each message. This is useful for identifying instantiations of daemons.

facility Encode a default facility to be assigned to all messages that don't have an explicit facility encoded. In the following list, parameter values marked with an asterisk (*) aren't used by any of the QNX Neutrino standard utilities.

LOG_AUTH *	Authorization system.
LOG_AUTHPRIV *	Same as LOG_AUTH, but logged to a file readable only by selected individuals.
LOG_CRON *	Clock daemon.
LOG_DAEMON	System daemons (such as **routed**) that aren't explicitly provided for by other facilities.
LOG_FTPD	File transfer protocol daemon.
LOG_KERN *	Messages generated by the kernel. These can't be generated by any user processes.
LOG_LPR	Line printer spooling system.
LOG_MAIL	Mail system.
LOG_NEWS *	Network news system.
LOG_SYSLOG	Messages generated internally by **syslogd**.
LOG_USER*	Messages generated by random user processes. This is the default facility identifier if none is specified.
LOG_UUCP *	The uucp system.
LOG_LOCAL0 through LOG_LOCAL7 *	Reserved for local use.

Library:

libc

Description:

The *openlog()* function opens the system log and provides for more specialized processing of the messages sent by *syslog()* and *vsyslog()*.

Examples:

See *syslog()*.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

closelog(), *setlogmask()*, *syslog()*, *vsyslog()*

`logger`, **`syslogd`** in the *Utilities Reference*

openpty()

Find an available pseudo-tty

Synopsis:

```
#include <unix.h>

int openpty( int* amaster,
             int* aslave,
             char* name,
             struct termios* termp,
             struct winsize* winp );
```

Arguments:

amaster	A pointer to a location where *forkpty()* can store the file descriptor of the master side of the pseudo-tty.
aslave	A pointer to a location where *forkpty()* can store the file descriptor of the slave side of the pseudo-tty.
name	NULL, or a pointer to a buffer where *forkpty()* can store the filename of the slave side of the pseudo-tty.
termp	NULL, or a pointer to a **termios** structure that describes the terminal's control attributes to apply to the slave side of the pseudo-tty.
winp	A pointer to a **winsize** structure that defines the window size to use for the slave side of the pseudo-tty.

Library:

libc

Description:

The *openpty()* function finds and opens an available pseudo-tty.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

ENOENT	There are no ttys available.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

fork(), *forkpty()*, *login_tty()*, **termios**

out8()

Write an 8-bit value to a port

Synopsis:

```
#include <hw/inout.h>

void out8( uintptr_t port,
           uint8_t val );
```

Arguments:

port The port you want to write the value to.

val The value that you want to write.

Library:

libc

Description:

The *out8()* function writes an 8-bit value, specified by *val*, to the specified *port*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

See also:

in8(), in8s(), in16(), in16s(), in32(), in32s(), mmap_device_io(), out8s(), out16(), out16s(), out32(), out32s()

out8s()

Write 8-bit values to a port

Synopsis:

```
#include <hw/inout.h>

void * out8s( const void * buff,
              unsigned len,
              uintptr_t port );
```

Arguments:

val	A pointer to a buffer that holds the values that you want to write.
len	The number of values that you want to write.
port	The port you want to write the values to.

Library:

libc

Description:

The *out8s()* function writes *len* 8-bit values from the buffer pointed to by *buff* to the specified *port*.

Returns:

A pointer to the end of the written data.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

See also:

in8(), in8s(), in16(), in16s(), in32(), in32s(), mmap_device_io(), out8(), out16(), out16s(), out32(), out32s()

out16(), *outbe16()*, *outle16()*

Write a 16-bit value to a port

Synopsis:

```
#include <hw/inout.h>

void out16( uintptr_t port,
            uint16_t val );

#define outbe16( port,
                 val ) ...

#define outle16( port,
                 val ) ...
```

Arguments:

port The port you want to write the value to.

val The value that you want to write.

Library:

libc

Description:

The *out16()* function writes the native-endian 16-bit value, specified by *val*, to the specified *port*.

The *outbe16()* and *outle16()* macros write the native-endian 16-bit value, specified by *val*, to the specified *port* in big-endian or little-endian format, respectively.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

outbe16() and *outle16()* are implemented as macros.

See also:

in8(), in8s(), in16(), in16s(), in32(), in32s(), mmap_device_io(), out8(), out8s(), out16s(), out32(), out32s()

out16s()

Write words to a port

Synopsis:

```
#include <hw/inout.h>

void * out16s( const void * buff,
               unsigned len,
               uintptr_t port );
```

Arguments:

val	A pointer to a buffer that holds the values that you want to write.
len	The number of values that you want to write.
port	The port you want to write the values to.

Library:

libc

Description:

The *out16s()* function writes *len* words from the buffer pointed to by *buff* to the specified *port*.

Returns:

A pointer to the end of the written data.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

See also:

in8(), *in8s()*, *in16()*, *in16s()*, *in32()*, *in32s()*, *mmap_device_io()*, *out8()*, *out8s()*, *out16()*, *out32()*, *out32s()*

out32(), *outbe32()*, *outle32()*

Write a 32-bit value to a port

Synopsis:

```
#include <hw/inout.h>

void out32( uintptr_t port,
            uint32_t val );

#define outbe16( port,
                 val ) ...

#define outle32( port,
                 val ) ...
```

Arguments:

port The port you want to write the value to.

val The value that you want to write.

Library:

libc

Description:

The *out32()* function writes the 32-bit value, specified by *val*, to the specified *port*.

The *outbe32()* and *outle32()* functions macros the native-endian 32-bit value, specified by *val*, to the specified *port* in big-endian or little-endian format, respectively.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

outbe16() and *outle16()* are implemented as macros.

See also:

in8(), in8s(), in16(), in16s(), in32(), in32s(), mmap_device_io(), out8(), out8s(), out16(), out16s(), out32s()

out32s()

Write longs to a port

Synopsis:

```
#include <hw/inout.h>

void * out32s( const void * buff,
               unsigned len,
               uintptr_t port );
```

Arguments:

val A pointer to a buffer that holds the values that you want to write.

len The number of values that you want to write.

port The port you want to write the values to.

Library:

libc

Description:

The *out32s()* function writes *len* longs from the buffer pointed to by *buff* to the specified *port*.

Returns:

A pointer to the end of the written data.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

The calling thread must have I/O privileges; see *ThreadCtl()*'s _NTO_TCTL_IO command for details.

The calling process must also use *mmap_device_io()* to access the device's I/O registers.

See also:

in8(), *in8s()*, *in16()*, *in16s()*, *in32()*, *in32s()*, *mmap_device_io()*, *out8()*, *out8s()*, *out16()*, *out16s()*, *out32()*

pathconf()

Return the value of a configurable limit

Synopsis:

```
#include <unistd.h>

long pathconf( const char* path,
               int name );
```

Arguments:

path The name of the file whose limit you want to get.

name The name of the configurable limit; see below.

Library:

libc

Description:

The *pathconf()* function returns a value of a configurable limit indicated by *name*, which is associated with the filename given in *path*.

Configurable limits are defined in **<confname.h>**, and include at least the following values:

_PC_LINK_MAX

Maximum value of a file's link count.

_PC_MAX_CANON

Maximum number of bytes in a terminal's canonical input buffer (edit buffer).

_PC_MAX_INPUT

Maximum number of bytes in a terminal's raw input buffer.

_PC_NAME_MAX

Maximum number of bytes in a file name (not including the terminating null).

_PC_PATH_MAX

Maximum number of bytes in a pathname (not including the terminating null).

_PC_PIPE_BUF

Maximum number of bytes that can be written atomically when writing to a pipe.

_PC_CHOWN_RESTRICTED

If defined (not -1), indicates that the use of the *chown()* function is restricted to a process with **root** privileges, and to changing the group ID of a file to the effective group ID of the process or to one of its supplementary group IDs.

_PC_NO_TRUNC

If defined (not -1), indicates that the use of pathname components longer than the value given by _PC_NAME_MAX will generate an error.

_PC_VDISABLE

If defined (not -1), this is the character value which can be used to individually disable special control characters in the **termios** control structure.

Returns:

The requested configurable limit, or -1 if an error occurs (*errno* is set).

Errors:

EACCES	Search permission is denied for a component of *path*.
EINVAL	The *name* argument is invalid, or the indicated limit isn't supported.
ELOOP	Too many levels of symbolic links or prefixes.
ENAMETOOLONG	The *path* argument, or a component of *path*, is too long.

ENOENT	The file doesn't exist.
ENOSYS	The *pathconf()* function isn't implemented for the filesystem specified in *path*.
ENOTDIR	A component of the path prefix isn't a directory.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main( void )
  {
    long value;

    value = pathconf( "/dev/con1", _PC_MAX_INPUT );
    printf( "Input buffer size is %ld bytes\n",
        value );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chown(), *confstr()*, *errno*, *fpathconf()*, *sysconf()*, **termios**

getconf in the *Utilities Reference*

Understanding System Limits chapter of the Neutrino *User's Guide*

pathfind(), pathfind_r()

Search for a file in a list of directories

Synopsis:

```
#include <libgen.h>

char *pathfind( const char *path,
                const char *name,
                const char *mode );

char *pathfind_r( const char *path,
                  const char *name,
                  const char *mode,
                  char *buff,
                  size_t buff_size );
```

Arguments:

path A string that specifies the list of the directories that you want to search. The directories named in *path* are separated by colons.

name The name of the file you're looking for. If *name* begins with a slash, the name is treated as an absolute pathname, and *path* is ignored.

mode A string of option letters chosen from:

- **r** Readable.
- **w** Writable.
- **x** Executable.
- **f** Normal file.
- **b** Block special.
- **c** Character special.
- **d** Directory.
- **p** FIFO (pipe).
- **u** Set user ID bit.
- **g** Set group ID bit.

`k`	Sticky bit.
`s`	Size nonzero.

buff (*pathfind_r()* only) A pointer to a buffer where *pathfind_r()* can store the path of the file found.

buff_size (*pathfind_r()* only) The size of the buffer that *buff* points to.

Library:

`libc`

Description:

The *pathfind()* function searches the directories named in *path* for the file *name*. The *pathfind_r()* function is a thread-safe version of *pathfind()*.

Options read, write, and execute are checked relative to the real (not the effective) user ID and group ID of the current process.

If the file *name*, with all the characteristics specified by *mode*, is found in any of the directories specified by *path*, then these functions return a pointer to a string containing the member of *path*, followed by a slash character (`/`), followed by *name*.

An empty path member is treated as the current directory. If *name* is found in the current directory, a slash isn't prepended to it; the unadorned name is returned.

The *pathfind_r()* also includes a buffer, *buff*, and its size, *buff_size*. This buffer is used to hold the path of the file found.

Returns:

The path found, or NULL if the file couldn't be found.

Examples:

Find the `ls` command using the **PATH** environment variable:

```
pathfind (getenv ("PATH"), "ls", "rx");
```

Classification:

Unix

pathfind()

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

pathfind_r()

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The string pointed to by the returned pointer is stored in an area that's reused on subsequent calls to *pathfind()*. Don't free this string.

Use *pathfind_r()* in multithreaded applications.

See also:

access(), getenv(), mknod(), stat()

sh in the *Utilities Reference*

pathmgr_symlink()

Create a symlink

Synopsis:

```
#include <sys/pathmgr.h>

int pathmgr_symlink( const char * symlink,
                     const char * path );
```

Arguments:

symlink	The name of the link that you want to create.
path	The path that you want to link to.

Library:

libc

Description:

The *pathmgr_symlink()* function creates a symbolic link, *path*, in the process manager that redirects to the path specified by *symlink*.

The *pathmgr_unlink()* function removes the link.

The symbolic link isn't permanent and is lost when the system reboots.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <sys/pathmgr.h>

int main(int argc, char **argv) {

    /* Create a link /mytmp --> /dev/shmem */
```

```
    if(pathmgr_symlink("/dev/shmem", "/mytmp") == -1) {
            perror("Can't make link");
    }

    getchar();
    if(pathmgr_unlink("/mytmp") == -1) {
            perror("Can't unlink ");
    }

    return 0;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pathmgr_unlink(), *symlink()*, *unlink()*

pathmgr_unlink()

Remove a link

Synopsis:

```
#include <sys/pathmgr.h>

int pathmgr_unlink( const char * path );
```

Arguments:

path The link that you want to remove.

Library:

libc

Description:

The *pathmgr_unlink()* function removes the link created by *pathmgr_symlink()*.

Returns:

0 Success.

-1 An error occurred.

Examples:

See *pathmgr_symlink()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pathmgr_symlink(), symlink(), unlink()

pause()

Suspend the process until delivery of a signal

Synopsis:

```
#include <unistd.h>

int pause( void );
```

Library:

libc

Description:

The *pause()* function suspends the calling process until delivery of a signal whose action is either to execute a signal handler or to terminate the process.

If the action is to terminate the process, *pause()* doesn't return. If the action is to execute a signal handler, *pause()* returns after the signal handler returns.

Returns:

On error, *pause()* returns -1 and sets *errno* to EINTR; otherwise, it never returns.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main( void )
  {

    /* set an alarm to go off in 5 seconds */
    alarm( 5 );

    /*
     * Wait until we receive a SIGALRM signal. However,
     * since we don't have a signal handler, any signal
     * will kill us.
     */
    printf( "Hang around, "
        " waiting to die in 5 seconds\n" );
```

```
    pause();
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

alarm(), *errno*, *sigaction()*

pccard_arm()

Arm the **devp-pccard** *server*

Synopsis:

```
#include <sys/pccard.h>

int pccard_arm( pccard_t handle,
                int devtype,
                unsigned event,
                int coid );
```

Arguments:

handle The handle returned by *pccard_attach()*.

devtype The type of device that your application wants to be informed about. Valid devices are:

_PCCARD_DEV_AIMS — Auto Incrementing Mass Storage.
_PCCARD_DEV_ALL — all devices.
_PCCARD_DEV_FIXED_DISK — any hard drive.
_PCCARD_DEV_GPIB — General Purpose Interface Bus card.
_PCCARD_DEV_MEMORY — memory type device.
_PCCARD_DEV_NETWORK — any network adapter.
_PCCARD_DEV_PARALLEL — PC parallel device.
_PCCARD_DEV_SCSI — any SCSI interface.
_PCCARD_DEV_SERIAL — 16450 serial device.
_PCCARD_DEV_SOUND — any sound adapter.
_PCCARD_DEV_VIDEO — any video adapter.

event The type of event that you want to be notified of:

- _PCCARD_ARM_INSERT_REMOVE — card insertion/removal.

coid A connection ID, obtained from *ConnectAttach()*, that's used to send the pulse.

Library:

libpccard

Description:

The *pccard_arm()* function call is used to request that the **devp-pccard** server notify the user application, via a pulse, when the specified event occurs.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid *handle* parameter.

Examples:

```
/*
 * Ask to be informed when a Network card is inserted
 */

#include    <stdio.h>
#include    <stdlib.h>
#include    <fcntl.h>
#include    <sys/neutrino.h>
#include    <sys/pccard.h>

int     main (void)

{
pccard_t    handle;
int         chid, coid;
char        buf [10];
struct _pccard_info io;

   if ((handle = pccard_attach (0)) == -1) {
       printf ("Unable to attach to PCCARD\n");
       exit (EXIT_FAILURE);
       }

   if ((chid = ChannelCreate (_NTO_CHF_FIXED_PRIORITY)) == -1) {
```

```
    printf ("Unable to create channel\n");
    exit (EXIT_FAILURE);
    }

if ((coid = ConnectAttach (0, 0, chid, _NTO_SIDE_CHANNEL,
         0)) == -1) {
    printf ("Unable to ConnectAttach\n");
    exit (EXIT_FAILURE);
    }

if (pccard_arm (handle, _PCCARD_DEV_NETWORK,
        _PCCARD_ARM_INSERT_REMOVE, coid) == -1) {
    perror ("Arm failed");
    exit (EXIT_FAILURE);
    }

/* To be informed about any card insertion/removal event,
 * change _PCCARD_DEV_NETWORK to _PCCARD_DEV_ALL.
 */

/*
 * MsgReceive (chid, ....);
 * Other user logic...
 */

/* Get information from socket 0 - function 0 */
if (pccard_info (handle, 0, &io, sizeof (io)) == -1) {
    perror ("Info failed");
    exit (EXIT_FAILURE);
    }
if (io.flags & _PCCARD_FLAG_CARD) {
    printf ("Card inserted in socket 1 - Type %x\n",
             io.window [0].device & 0xff00);
/* Now lock the card in socket 1 with exclusive access */
    if (pccard_lock (handle, 0, 0, O_RDWR | O_EXCL) == -1) {
        perror ("Lock failed");
        exit (EXIT_FAILURE);
        }
/* Read 2 bytes of the CIS from offset 0 in attribute memory */
    if (pccard_raw_read (handle, 0, _PCCARD_MEMTYPE_ATTRIBUTE,
                         0, 2, buf) == -1) {
        perror ("Raw read");
        exit (EXIT_FAILURE);
        }
    /* More user logic... */
    }
pccard_unlock (handle, 0, 0);
pccard_detach (handle);

return (EXIT_SUCCESS);
```

```
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pccard_attach(), *pccard_detach()*, *pccard_info()*, *pccard_lock()*, *pccard_raw_read()*, *pccard_unlock()*

pccard_attach()

Attach to the **devp-pccard** *server*

Synopsis:

```
#include <sys/pccard.h>

pccard_t pccard_attach( int reserved );
```

Arguments:

reserved Pass 0 for this argument.

Library:

libpccard

Description:

The *pccard_attach()* function attaches a user application to the **devp-pccard** server. You must call this function before using any of the other PC card functions, because it returns a handle that all the other PC Card functions use.

Returns:

>0 A value to be used as *handle* in all other PC Card function calls.

-1 Can't locate the **devp-pccard** server.

-2 Send to **devp-pccard** server failed.

-3 The **devp-pccard** server returned an error (*errno* is set).

Errors:

EBUSY The **devp-pccard** server is unable to service this request.

Examples:

See *pccard_arm()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pccard_arm(), *pccard_detach()*, *pccard_info()*, *pccard_lock()*, *pccard_raw_read()*, *pccard_unlock()*

pccard_detach()

Detach from the **devp-pccard** *server*

Synopsis:

```
#include <sys/pccard.h>

int pccard_detach( pccard_t handle );
```

Arguments:

handle The handle returned by *pccard_attach()*.

Library:

libpccard

Description:

The *pccard_detach()* function detaches the user application from the **devp-pccard** server. Any locks that you previously applied with *pccard_lock()* are freed.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid *handle* parameter.

Examples:

See *pccard_arm()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pccard_arm(), *pccard_attach()*, *pccard_info()*, *pccard_lock()*, *pccard_raw_read()*, *pccard_unlock()*

pccard_info()

Obtain socket information from the **devp-pccard** *server*

Synopsis:

```
#include <sys/pccard.h>

int pccard_info( pccard_t handle,
                 int socket,
                 struct _pccard_info* info,
                 unsigned size );
```

Arguments:

handle	The handle returned by *pccard_attach()*.
socket	Contains both the socket number as well as the function within the socket. This is achieved by shifting the function number left 8 bits and ORing it with the socket number. The socket number is zero-based.
info	A pointer to a **_pccard_info** structure that the function fills with the socket information. For more information, see below.
size	Size of the **_pccard_info** structure.

Library:

libpccard

Description:

The *pccard_info()* function call retrieves socket setup information from the **devp-pccard** server. The information is returned in the **_pccard_info** structure.

_pccard_info structure

The **_pccard_info** structure is defined in **<pccard.h>** as:

```
struct _pccard_info {
    int16_t             socket;         // Socket number (0 based)
    uint16_t            status;         // Card status (from socket services spec)
    uint32_t            flags;          // Flags (_PCCARD_FLAG_*)
    uint8_t             vcc;            // Current Vcc (in tenths of volts)
    uint8_t             vpp;            // Current Vpp (in tenths of volts)
    uint8_t             num_windows;    // Number of windows described below
    uint8_t             index;          // Index for CardBus devices
    uint16_t            manufacturer;   // Manufacturer ID from PCCARD
    uint16_t            card_type;      // Card Type from PCCARD
    uint16_t            device_id;      // CardBus device id
    uint16_t            vendor_id;      // CardBus vendor id
    uint16_t            busnum;         // PCI bus number
    uint16_t            devfuncnum;     // PCI device and function number
    struct _pccard_window {
        uint16_t                window;     // Window type (_PCCARD_WINDOW_*)
        uint16_t                flags;      // Window flags (_PCCARD_WINFLAG_*)
        mpid_t                  pid;        // Locking pid
        uint16_t                device;     // Device type (_PCCARD_DEV_*)
        uint16_t                dummy;
        uint32_t                dev_size;   // Size of memory device
        uint32_t                reserved3;
        union {
            struct _pccard_irq {
                uint16_t            flags;          // (_PCCARD_IRQFLAG_*)
                uint16_t            irq;
            }                       irq;
            struct _pccard_memio {
                uint32_t            base;           // Base address (in host address space)
                uint32_t            size;           // Size of window
                uint32_t            offset;         // offset of region from base of card
                uint16_t            flags;          // (_PCCARD_MEMIOFLAG_*)
                uint16_t            dummy2;
            }                       memio;
        } un;
    } window[_PCCARD_MAX_WINDOWS];
};
```

Returns:

A positive integer

Success. The *socket* parameter is returned.

-1 An error occurred (*errno* is set).

Errors:

ENODEV Invalid *socket* parameter.

Examples:

See *pccard_arm()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pccard_arm(), *pccard_attach()*, *pccard_detach()*, *pccard_lock()*, *pccard_raw_read()*, *pccard_unlock()*

pccard_lock()

Lock the window of the card in the selected socket

Synopsis:

```
#include <sys/pccard.h>

int pccard_lock( pccard_t handle,
                 int socket,
                 int index,
                 int oflag );
```

Arguments:

handle	The handle returned by *pccard_attach()*.
socket	Contains both the socket number as well as the function within the socket. This is achieved by shifting the function number left 8 bits and ORing it with the socket number. The socket number is zero-based.
index	The window/function number that you want to lock. You can get the window number from the **_pccard_info** structure (see *pccard_info()*).
oflag	Created by ORing the values required (e.g. O_RDWR | O_EXCL) for read/write and exclusive access.

Library:

libpccard

Description:

The *pccard_lock()* function call provides exclusive or shared access to the PC Card in *socket* and also sets access permissions.

Returns:

A positive integer

Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF	Invalid *handle* parameter.
EBUSY	The window is already locked by another process.
ENODEV	Invalid *socket* parameter, no PC Card is present in the socket, or invalid *index* parameter.

Examples:

See *pccard_arm()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pccard_arm(), *pccard_attach()*, *pccard_detach()*, *pccard_info()*, *pccard_raw_read()*, *pccard_unlock()*

pccard_raw_read()

Read the raw CIS data from the PC Card

Synopsis:

```
#include <sys/pccard.h>

ssize_t pccard_raw_read( pccard_t handle,
                         int socket,
                         int type,
                         unsigned addr,
                         ssize_t len,
                         void* buf );
```

Arguments:

handle The handle returned by *pccard_attach()*.

socket Contains both the socket number as well as the function within the socket. This is achieved by shifting the function number left 8 bits and ORing it with the socket number. The socket number is zero-based.

type The type of memory that you want to read. Valid values are:

- _PCCARD_MEMTYPE_COMMON
- _PCCARD_MEMTYPE_ATTRIBUTE

addr The memory address that you want to read from the CIS.

len The size of the memory that you want to read.

buf A pointer to a buffer where the function can store the information that it reads from the PC Card.

Library:

libpccard

Description:

The *pccard_raw_read()* function returns the raw CIS (Card Information Structure) data from the PC Card.

Returns:

A positive integer

Success. The length read is returned.

-1 An error occurred (*errno* is set).

Errors:

EBADF	Invalid *handle* parameter.
ENODEV	Invalid *socket* parameter.

Examples:

See *pccard_arm()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pccard_arm(), *pccard_attach()*, *pccard_detach()*, *pccard_info()*, *pccard_lock()*, *pccard_unlock()*

pccard_unlock()

Unlock the window of the card in the selected socket

Synopsis:

```
#include <sys/pccard.h>

int pccard_unlock( pccard_t handle,
                   int socket,
                   int index );
```

Arguments:

handle	The handle returned by *pccard_attach()*.
socket	Contains both the socket number as well as the function within the socket. This is achieved by shifting the function number left 8 bits and ORing it with the socket number. The socket number is zero-based.
index	The window/function number that you want to unlock. You can get the window number from the **_pccard_info** structure (see *pccard_info()*).

Library:

libpccard

Description:

The *pccard_unlock()* function unlocks a window previously locked by a call to *pccard_lock()*. It can only unlock a window locked by the same process ID — you can't unlock a window locked by another process.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EBADF	Invalid *handle* parameter.
ENODEV	Invalid *socket* parameter, no PC Card is present in the socket, or invalid *index* parameter.

Examples:

See *pccard_arm()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pccard_arm(), *pccard_attach()*, *pccard_detach()*, *pccard_info()*, *pccard_lock()*, *pccard_raw_read()*

pci_attach()

Connect to the PCI server

Synopsis:

```
#include <hw/pci.h>

int pci_attach( unsigned flags );
```

Arguments:

flags There are currently no flags defined for this function.

Library:

libc

Description:

The *pci_attach()* function connects to the Peripheral Component Interconnect (PCI) server.

☞ You must call *pci_attach()* before calling any of the other PCI functions.

Returns:

A handle used for calling *pci_detach()*, or **-1** if an error occurs.

Errors:

See *open()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach_device(), *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config16()*, *pci_write_config32()*

"Peripheral Component Interconnect (**`pci-*`**)" in the Utilities Summary chapter of the *Utilities Reference*

pci_attach_device()

Attach a driver to a PCI device

Synopsis:

```
#include <hw/pci.h>

void* pci_attach_device(
          void* handle,
          uint32_t flags,
          uint16_t idx,
          struct pci_dev_info* info );
```

Arguments:

handle A handle that identifies the device. The first time you call this function, set *handle* to NULL. This function returns a handle that you can use in a subsequent call to allocate resources for the device.

flags Flags that tell the PCI server how you want it to handle resources, which resources to scan for, and which resources to allocate; see "Flags," below.

idx The index of the device: 0 for the first device, 1 for the second, and so on.

info A pointer to a **pci_dev_info** structure that specifies the class code, vendor/device ID, or bus number and device/function number that you want to scan for. The function fills in this structure with information about the device.

Library:

libc

Description:

The *pci_attach_device()* function attaches a driver to a PCI device.

You must successfully call *pci_attach()* before calling any of the other PCI functions.

Typically drivers use this function to attach themselves to a PCI device, so that other drivers can't attach to the same device. If you specify the PCI_SHARE flag (see "Flags," below), then multiple drivers can attach to the same device.

The server can scan based on a class code, vendor/device ID, or bus number and device/function number. To control the server scanning, initialize the appropriate fields of the *info* structure and set the appropriate flags.

When you first attach to an uninitialized device, the PCI server assigns all the I/O ports, memory and IRQs required for the device. It also does the IRQ routing for you. Once this has completed successfully, it fills in all these values into your **pci_dev_info** structure to return these values to your application.

When a driver attaches to a device, the PCI server allocates the necessary resources for the device from **procnto** using the *rsrcdbmgr** calls. On X86 BIOS systems, these resources are normally allocated by the BIOS, but on non-x86 systems, these resources have to be allocated from **procnto**.

You can detach the device by passing its handle to *pci_detach_device()*. If you call *pci_detach()*, any resources that *pci_attach_device()* allocates are freed.

pci_dev_info structure

This function fills in a **pci_dev_info** structure that describes an occurrence of a device.

The *pci_attach_device()* function doesn't map any of the I/O or memory regions into the process's address space. The addresses returned in the **pci_dev_info** structure are all physical addresses.

This structure has the following members:

uint16_t *DeviceId*

The device ID (input/output).

uint16_t *VendorId*

The vendor ID (input/output).

uint16_t *SubsystemId*

The subsystem ID (output).

uint16_t *SubsystemVendorId*

The subsystem vendor ID (output).

uint8_t *BusNumber*

The bus number (output).

uint8_t *DevFunc*

The device/function number (output).

uint8_t *Revision*

The device revision (output).

uint32_t *Class* The class code (input/output).

uint32_t *Irq* The interrupt number (output).

uint64_t *CpuIoTranslation*

The CPU-to-PCI translation value (*pci_addr* = *cpu_addr* - *translation*).

uint64_t *CpuMemTranslation*

The CPU-to-PCI memory translation (*pci_addr* = *cpu_addr* - *translation*).

uint64_t *CpuIsaTranslation*

The CPU-to-ISA memory translation (*pci_addr* = *cpu_addr* - *translation*).

uint64_t *CpuBmstrTranslation*

The translation from the CPU busmaster address to the PCI busmaster address (*pci_addr* = *cpu_addr* + *translation*).

uint64_t *PciBaseAddress* [6]

The PCI base address (array of six **uint64_t** items).

☞ This function decodes bits 1 and 2 to see whether the register is 32 or 64 bits wide, hence the 64-bit values for the base registers.

---

uint64_t *CpuBaseAddress* [6]

The CPU base address (an array of six **uint64_t** items).

Some platforms translate addresses across PCI bridges, so that there's one address on the PCI side of the bridge and another on the CPU side. Under x86, the *PciBaseAddress* and *CpuBaseAddress* are the same, but under other platforms, these will be different. In your user application you should always use the *CpuBaseAddress*.

uint32_t *BaseAddressSize* [6]

The size of the base address aperture into the board (an array of six **uint32_t** items).

uint64_t *PciRom*

The PCI ROM address.

uint64_t *CpuRom*

The CPU ROM address.

uint32_t *RomSize*

The size of the aperture into the board.

Flags

The *flags* parameter tells the PCI server how resources are to be handled, which resources to scan for, and which resources to allocate.

These bits control how resources are handled:

PCI_SHARE	Allow resources to be shared with other drivers. If this isn't set, no other driver can attach to the device.
PCI_PERSIST	Resources persist after the device is detached.

The following bits ask the PCI server to scan for a device based on the fields that you specified in the structure pointed to by *info*:

PCI_SEARCH_VEND

VendorID

PCI_SEARCH_VENDEV

DeviceId and *VendorId*

PCI_SEARCH_CLASS

Class

PCI_SEARCH_BUSDEV

BusNumber and *DevFunc*

These bits specify which members of the structure the server should initialize:

PCI_INIT_IRQ	*Irq*
PCI_INIT_ROM	*PciRom* and *CpuRom*

PCI_INIT_BASE0 . . . PCI_INIT_BASE5

The specified entries of the *PciBaseAddress* and *CpuBaseAddress* arrays

PCI_INIT_ALL All members except *PciRom* and *CpuRom*

If you pass 0 for the flags, the default is PCI_SEARCH_VENDEV.

Testing and converting addresses

To facilitate the testing of addresses returned by the PCI server, at least the following macros are defined in the **<pci.h>** header file:

PCI_IS_IO(*address*)

Test whether the address is an I/O address.

PCI_IS_MEM(*address*)

Test whether the address is a memory address.

PCI_IO_ADDR(*address*)

Convert the address returned by the PCI server to an I/O address.

PCI_MEM_ADDR(*address*)

Convert the address returned by the PCI server to a memory address.

PCI_ROM_ADDR(*address*)

Convert the address returned by the PCI server to a ROM address.

For example:

```
{
    uint64_t    port;

    /* Test the address returned by the pci server */
    if (PCI_IS_IO(addr))
        port = (PCI_IO_ADDR(addr));
}
```

Returns:

A handle to be used for other *pci_** calls associated with a handle, or NULL if an error occurs (*errno* is set).

Errors:

EBUSY	An application has already attached to the device. If it's safe to share the device, specify PCI_SHARE in the *flags* field.
EINVAL	The function couldn't attach a resource to the device.
ENODEV	This device wasn't found.

Examples:

Attach to and allocate all resources for the first occurrence of an Adaptec 2940 adapter:

```
#include <hw/pci.h>
#include <hw/pci_devices.h>
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    int pidx;
    void* hdl;
    int phdl;
    struct pci_dev_info inf;

    /* Connect to the PCI server */
    phdl = pci_attach( 0 );
    if( phdl == -1 ) {
        fprintf( stderr, "Unable to initialize PCI\n" );

        return EXIT_FAILURE;
    }

    /* Initialize the pci_dev_info structure */
    memset( &inf, 0, sizeof( inf ) );
    pidx = 0;
    inf.VendorId = PCI_VENDOR_ID_ADAPTEC;
    inf.DeviceId = PCI_DEVICE_ID_ADAPTEC_2940F;
```

```
    hdl = pci_attach_device( NULL, PCI_INIT_ALL, pidx, &inf );
    if( hdl == NULL ) {
        fprintf( stderr, "Unable to locate adapter\n" );
    } else {
        /* Do something to the adapter */
        pci_detach_device( hdl );
    }

    /* Disconnect from the PCI server */
    pci_detach( phdl );

    return EXIT_SUCCESS;
}
```

Attach to the first occurrence of an Adapter 2940 adapter and allocate resources in a second call:

```
#include <hw/pci.h>
#include <hw/pci_devices.h>
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    int pidx;
    void* hdl;
    void* retval;
    int phdl;
    struct pci_dev_info inf;

    phdl = pci_attach( 0 );
    if( phdl == -1 ) {
        fprintf( stderr, "Unable to initialize PCI\n" );

        return EXIT_FAILURE;
    }

    memset( &inf, 0, sizeof( inf ) );
    pidx = 0;
    inf.VendorId = PCI_VENDOR_ID_ADAPTEC;
    inf.DeviceId = PCI_DEVICE_ID_ADAPTEC_2940F;

    hdl = pci_attach_device( NULL, 0, pidx, &inf );
    if( hdl == NULL ) {
        fprintf( stderr, "Unable to locate adapter\n" );
    }

    retval = pci_attach_device( hdl, PCI_INIT_ALL, pidx, &inf );
    if( retval == NULL ) {
```

```
        fprintf( stderr, "Unable allocate resources\n" );
    }

    pci_detach( phdl );

    return EXIT_SUCCESS;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*

pci_detach()

Disconnect from the PCI server

Synopsis:

```
#include <hw/pci.h>

int pci_detach( unsigned handle );
```

Arguments:

handle The value returned by a successful call to *pci_attach()*.

Library:

libc

Description:

The *pci_detach()* function disconnects from the PCI server. Any resources allocated with *pci_attach_device()* are released.

The *pci_attach()* function opens a file descriptor against the PCI server, and all of the low-level library calls to the PCI server use this fd. When you call *pci_detach()*, the low-level code does a *close()* on the file descriptor, which tells the PCI server to clean up any allocations associated with it.

Don't call any of the other *pci_*()* functions after calling *pci_detach()* (unless you've reattached with *pci_attach()*).

Returns:

PCI_SUCCESS.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), pci_attach_device(), pci_detach_device(), pci_find_class(), pci_find_device(), pci_present(), pci_read_config(), pci_read_config8(), pci_read_config16(), pci_read_config32(), pci_rescan_bus(), pci_write_config(), pci_write_config8(), pci_write_config16(), pci_write_config32()

pci_detach_device()

Detach a driver from a PCI device

Synopsis:

```
#include <hw/pci.h>

int pci_detach_device( void* handle );
```

Arguments:

handle The handle returned by *pci_attach_device()*.

Library:

libc

Description:

The *pci_detach_device()* function detaches a driver from a PCI device. Any resources allocated with *pci_attach_device()* are released, unless you attached the device with the PCI_PERSIST flag set.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_DEVICE_NOT_FOUND

No device could be found for *handle*.

PCI_SUCCESS

Success.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), pci_attach_device(), pci_detach(), pci_find_class(), pci_find_device(), pci_present(), pci_read_config(), pci_read_config8(), pci_read_config16(), pci_read_config32(), pci_rescan_bus(), pci_write_config(), pci_write_config8(), pci_write_config16(), pci_write_config32()

pci_find_class()

Find devices that have a specific class code

Synopsis:

```
#include <hw/pci.h>

int pci_find_class( unsigned long class_code,
                    unsigned index,
                    unsigned* bus,
                    unsigned* dev_func );
```

Arguments:

class_code	The class of device or function that you want to find.
index	The index of the device or function that you want to find: 0 for the first, 1 for the second, and so on.
bus	The bus number, in the range [0...255].
dev_func	The device or function number of the *n*th device or function of the given class. The device number is in bits 7 through 3, and the function number in bits 2 through 0.

Library:

libc

Description:

The *pci_find_class()* function determines the location of the *n*th PCI device or function that has the specified class code.

You must successfully call *pci_attach()* before calling any of the other PCI functions.

You can find all the devices having the same class code by making successive calls to this function, starting with an index of 0, and incrementing it until PCI_DEVICE_NOT_FOUND is returned.

Returns:

PCI_DEVICE_NOT_FOUND

The device or function wasn't found.

PCI_SUCCESS

The device or function was found.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config16()*, *pci_write_config32()*

pci_find_device()

Find the PCI device with a given device ID and vendor ID

Synopsis:

```
#include <hw/pci.h>

int pci_find_device( unsigned device,
                     unsigned vendor,
                     unsigned index,
                     unsigned* bus,
                     unsigned* dev_func );
```

Arguments:

device	The Device ID.
vendor	The Vendor ID.
index	The index (*n*) of the device or function sought.
bus	A pointer to a location where the function can store the bus number of the device or function found.
dev_func	A pointer to a location where the function can store the device or function ID of the *n*th device or function found with the specified device and vendor IDs. The device number is in bits 7 through 3, and the function number in bits 2 through 0.

Library:

libc

Description:

The *pci_find_device()* function returns the location of the *n*th PCI device that has the specified Device ID and Vendor ID.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

You can find all the devices having the same Device and Vendor IDs by making successive calls to this function, starting with an index of 0, and incrementing it until PCI_DEVICE_NOT_FOUND is returned.

Returns:

PCI_DEVICE_NOT_FOUND

The device or function wasn't found.

PCI_SUCCESS

The device or function was found.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config16()*, *pci_write_config32()*

pci_irq_routing_options()

Retrieve PCI IRQ routing information

Synopsis:

```
#include <hw/pci.h>

int pci_irq_routing_options(
                    IRQRoutingOptionsBuffer * buf,
                    uint32_t * irq );
```

Arguments:

buf A pointer to a **IRQRoutingOptionsBuffer** structure where the function can store the IRQ routing information. For information about the layout of this buffer, see *PCI BIOS SPECIFICATION* Revision 2.1. You can get it from the PCI Special Interest Group at **http://pcisig.com/**.

irq A pointer to a location where the function can store the current state of interrupts.

Library:

libc

Description:

The *pci_irq_routing_options()* function returns the following:

- PCI interrupt routing options available on the system motherboard
- the current state of interrupts that are currently exclusively assigned to PCI.

Routing information is returned in a data buffer that contains an IRQ routing for each PCI device or slot.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_SUCCESS	Success.
-1	You haven't called *pci_attach()*, or the call to it failed.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
#include <inttypes.h>
#include <hw/pci.h>
#include <sys/neutrino.h>

struct {
IRQRoutingOptionsBuffer buf;
uint8_t databuf [2048];
} route_buf;

int main (void)
{
int phdl;
uint32_t irq;


if ((phdl = pci_attach (0)) == -1) {
printf ("Unable to attach - errno %s\n", strerror (errno));
exit (1);
}

memset (route_buf.databuf, 0, sizeof (route_buf.databuf));
route_buf.buf.BufferSize = sizeof (route_buf.databuf);
if (pci_irq_routing_options (&route_buf.buf, &irq) != PCI_SUCCESS) {
printf ("Routing option failed - errno %s\n", strerror (errno));
exit (1);
}

printf ("PCI Irq Map = %x\n", irq);
pci_detach (phdl);
return (0);
}
```


Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), pci_attach_device(), pci_detach(), pci_detach_device(), pci_find_class(), pci_find_device(), pci_present(), pci_read_config(), pci_read_config8(), pci_read_config16(), pci_read_config32(), pci_rescan_bus(), pci_write_config(), pci_write_config8(), pci_write_config16(), pci_write_config32()

pci_map_irq()

Map an interrupt pin to an IRQ

Synopsis:

```
#include <hw/pci.h>

int pci_map_irq( unsigned bus,
                 unsigned dev_func,
                 short intno,
                 short intpin );
```

Arguments:

bus	The bus number of the device.
dev_func	The device or function number of the device. The device number is in bits 7 through 3, and the function number is in bits 2 through 0.
intno	The interrupt to be mapped (0 - 15).
intpin	The PCI interrupt pin (**0x0a** - **0x0d**).

Library:

libc

Description:

The *pci_map_irq()* function maps a PCI interrupt pin to a specific interrupt request (IRQ).

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_SUCCESS

Success.

PCI_SET_FAILED

The PCI server was unable to map the *intno*/*intpin*.

PCI_UNSUPPORTED_FUNCTION
: This function isn't supported by the BIOS.

-1
: You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config16()*, *pci_write_config32()*

pci_present()

Determine whether or not PCI BIOS is present

Synopsis:

```
#include <hw/pci.h>

int pci_present( unsigned* lastbus,
                 unsigned* version,
                 unsigned* hardware );
```

Arguments:

lastbus The number of the last PCI bus in the system. PCI buses are numbered from 0, up to and including this value.

version The version number of the PCI interface.

hardware The specific hardware characteristics the platform supports with regard to accessing configuration space and generating PCI Special Cycles.

The PCI specification defines two hardware mechanisms for accessing configuration space. Bit 0 of *hardware* is set (1) if mechanism 1 is supported, and reset (0) otherwise. Bit 1 is set (1) if mechanism 2 is supported, and reset (0) otherwise.

The specification also defines hardware mechanisms for generating Special Cycles. Bit 4 of *hardware* is set (1) if the platform supports Special Cycle generation based on Config Mechanism 1, and reset (0) otherwise. Bit 5 is set (1) if the platform supports Special Cycle generation based on Config Mechanism 2, and reset (0) otherwise.

The arguments can be NULL if you just want to check for PCI capabilities.

Library:

libc

Description:

The *pci_present()* function determines whether or not the PCI BIOS interface function set is present. It also determines the following:

- the current interface version
- what hardware mechanism for accessing configuration space is supported
- whether or not the hardware supports the generation of PCI Special Cycles.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

-1 PCI BIOS isn't present.

PCI_SUCCESS
PCI BIOS is present.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), pci_attach_device(), pci_detach(), pci_detach_device(), pci_find_class(), pci_find_device(), pci_read_config(), pci_read_config8(), pci_read_config16(), pci_read_config32(), pci_rescan_bus(), pci_write_config(), pci_write_config8(), pci_write_config16(), pci_write_config32()

pci_read_config()

Read from the configuration space of a PCI device

Synopsis:

```
#include <hw/pci.h>

int pci_read_config( void* handle,
                     unsigned offset,
                     unsigned count,
                     size_t size,
                     void* buff );
```

Arguments:

handle	The handle returned by *pci_attach_device()*.
offset	The offset into the configuration space where you want to read from.
count	The number of objects that you want to read.
size	The size of each object.
buff	A pointer to a buffer where the function can store the objects that it reads.

Library:

libc

Description:

The *pci_read_config()* function reads *count* objects of the specified *size* into *buff* at the given *offset* from the configuration space of the PCI device specified by *handle*.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_BAD_REGISTER_NUMBER

The offset is invalid.

PCI_BUFFER_TOO_SMALL

The PCI BIOS server reads only 100 bytes at a time; *size* is too large.

PCI_DEVICE_NOT_FOUND

The *handle* is invalid.

PCI_SUCCESS

Success.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config16()*, *pci_write_config32()*

pci_read_config8()

Read a byte from the configuration space of a device

Synopsis:

```
#include <hw/pci.h>

int pci_read_config8( unsigned bus,
                      unsigned dev_func,
                      unsigned offset,
                      unsigned count,
                      char* buff );
```

Arguments:

bus	The bus number.
dev_func	The name of the device or function.
offset	The register offset into the configuration space, in the range [0...255].
count	The number of bytes to read.
buff	A pointer to a buffer where the requested bytes are placed.

Library:

libc

Description:

The *pci_read_config8()* function reads the specified number of bytes from the configuration space of the given device or function.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_BAD_REGISTER_NUMBER

An invalid register offset was given.

PCI_BUFFER_TOO_SMALL

The PCI BIOS server reads only 100 bytes at a time; *count* is too large.

PCI_SUCCESS

The device or function was found.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config16()*, *pci_write_config32()*

pci_read_config16()

Read 16-bit values from the configuration space of a device

Synopsis:

```
#include <hw/pci.h>

int pci_read_config16( unsigned bus,
                       unsigned dev_func,
                       unsigned offset,
                       unsigned count,
                       char* buff );
```

Arguments:

bus	The bus number.
dev_func	The name of the device or function.
offset	The register offset into the configuration space. This offset must be aligned to a 16-bit boundary (that is 0, 2, 4, . . . , 254 bytes).
count	The number of 16-bit values to read.
buff	A pointer to a buffer where the requested 16-bit values are placed.

Library:

libc

Description:

The *pci_read_config16()* function reads the specified number of 16-bit values from the configuration space of the given device or function.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_BAD_REGISTER_NUMBER

An invalid offset register number was given.

PCI_BUFFER_TOO_SMALL

The PCI BIOS server reads only 50 words at a time; *count* is too large.

PCI_SUCCESS

The device or function was found.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config16()*, *pci_write_config32()*

pci_read_config32()

Read 32-bit values from the configuration space of a device

Synopsis:

```
#include <hw/pci.h>

int pci_read_config32( unsigned bus,
                       unsigned dev_func,
                       unsigned offset,
                       unsigned count,
                       char* buff );
```

Arguments:

bus	The bus number.
dev_func	The name of the device or function.
offset	The register offset into the configuration space. This offset must be aligned to a 32-bit boundary (that is 0, 4, 8, . . . , 252 bytes).
count	The number of 32-bit values to read.
buff	A pointer to a buffer where the requested 32-bit values are placed.

Library:

libc

Description:

The *pci_read_config32()* function reads the specified number of 32-bit values from the configuration space of the given device or function.

You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_BAD_REGISTER_NUMBER

An invalid register offset was given.

PCI_SUCCESS

The device or function was found.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config16()*, *pci_write_config32()*

pci_rescan_bus()

Rescan the PCI bus for added or removed devices

Synopsis:

```
#include <hw/pci.h>

int pci_rescan_bus( void );
```

Library:

libc

Description:

The *pci_rescan_bus()* function asks the PCI server to rescan the PCI bus(es) for devices that have been inserted or removed. This is used in hot swap situations such as for CardBus cards. The PCI server updates its internal configuration to reflect any changes.

You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_SUCCESS
: Success.

-1
: The function failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), pci_attach_device(), pci_detach(), pci_detach_device(), pci_find_class(), pci_find_device(), pci_present(), pci_read_config(), pci_read_config8(), pci_read_config16(), pci_read_config32(), pci_write_config(), pci_write_config8(), pci_write_config16(), pci_write_config32()

pci_write_config()

Write to the configuration space of a PCI device

Synopsis:

```
#include <hw/pci.h>

int pci_write_config( void* handle,
                      unsigned offset,
                      unsigned count,
                      size_t size,
                      const void* buff );
```

Arguments:

handle	The handle returned by *pci_attach_device()*.
offset	The offset into the configuration space where you want to write the data.
count	The number of objects that you want to write.
size	The size of each object.
buff	A pointer to the data that you want to write.

Library:

libc

Description:

The *pci_write_config()* function writes *count* objects of the specified *size* from *buff* at the given *offset* to the configuration space of the PCI device specified by *handle*.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_BAD_REGISTER_NUMBER

The *offset* specified is invalid.

PCI_BUFFER_TOO_SMALL

The *size* argument is too large.

PCI_SET_FAILED

An error occurred writing to the configuration space of the device.

PCI_SUCCESS

Success.

PCI_UNSUPPORTED_FUNCT

This device doesn't support writing to its configuration space.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*,

pci_rescan_bus(), pci_write_config8(), pci_write_config16(), pci_write_config32()

pci_write_config8()

Write bytes to the configuration space of a PCI device

Synopsis:

```
#include <hw/pci.h>

int pci_write_config8( unsigned bus,
                       unsigned dev_func,
                       unsigned offset,
                       unsigned count,
                       char* buff );
```

Arguments:

bus	The bus number.
dev_func	The device or function ID. The device number is in bits 7 through 3, and the function number in bits 2 through 0.
offset	The register offset into the configuration space, in the range [0...255].
count	The number of bytes to write.
buff	A pointer to a buffer containing the data to be written into the configuration space.

Library:

libc

Description:

The *pci_write_config8()* function writes individual bytes to the configuration space of the specified device.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_BAD_REGISTER_NUMBER

An invalid offset register number was given.

PCI_BUFFER_TOO_SMALL

The *size* argument is greater than 100 bytes.

PCI_SUCCESS

The device or function was found.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config16()*, *pci_write_config32()*

pci_write_config16()

Write 16-bit values to the configuration space of a device

Synopsis:

```
#include <hw/pci.h>

int pci_write_config16( unsigned bus,
                        unsigned dev_func,
                        unsigned offset,
                        unsigned count,
                        char* buff );
```

Arguments:

bus	The bus number.
dev_func	The device or function ID. The device number is in bits 7 through 3, and the function number in bits 2 through 0.
offset	The offset into the configuration space. This must be aligned to a 16-bit boundary (that is 0, 2, 4, . . . , 254 bytes).
count	The number of 16-bit values to write.
buff	A pointer to a buffer containing the data to be written into the configuration space.

Library:

libc

Description:

The *pci_write_config16()* function writes individual 16-bit values to the configuration space of the specified device.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_BAD_REGISTER_NUMBER

An invalid register offset was given.

PCI_BUFFER_TOO_SMALL

The *size* argument is greater than 50 words.

PCI_SUCCESS

The device or function was found.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config32()*

pci_write_config32()

Write 32-bit values to the configuration space of a device

Synopsis:

```
#include <hw/pci.h>

int pci_write_config32( unsigned bus,
                        unsigned dev_func,
                        unsigned offset,
                        unsigned count,
                        char* buff );
```

Arguments:

bus	The bus number.
dev_func	The device or function ID. The device number is in bits 7 through 3, and the function number in bits 2 through 0.
offset	The register offset into the configuration space. This must be aligned to a 32-bit boundary (that is 0, 4, 8, . . . , 252 bytes).
count	The number of 32-bit values to write.
buff	A pointer to a buffer containing the data to be written into the configuration space.

Library:

libc

Description:

The *pci_write_config32()* function writes individual 32-bit values to the configuration space of the specified device.

☞ You must successfully call *pci_attach()* before calling any of the other PCI functions.

Returns:

PCI_BAD_REGISTER_NUMBER

An invalid register offset was given.

PCI_SUCCESS

The device or function was found.

-1 You haven't called *pci_attach()*, or the call to it failed.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pci_attach(), *pci_attach_device()*, *pci_detach()*, *pci_detach_device()*, *pci_find_class()*, *pci_find_device()*, *pci_present()*, *pci_read_config()*, *pci_read_config8()*, *pci_read_config16()*, *pci_read_config32()*, *pci_rescan_bus()*, *pci_write_config()*, *pci_write_config8()*, *pci_write_config16()*

pclose()

Close a pipe

Synopsis:

```
#include <stdio.h>

int pclose( FILE* stream );
```

Arguments:

stream The stream pointer for the pipe that you want to close, that you obtained by calling *popen()*.

Library:

libc

Description:

The *pclose()* function closes the pipe associated with *stream*, and waits for the subprocess created by *popen()* to terminate.

Returns:

The termination status of the command language interpreter, or -1 if an error occurred (*errno* is set).

Errors:

EINTR The *pclose()* function was interrupted by a signal while waiting for the child process to terminate.

ECHILD The *pclose()* function was unable to obtain the termination status of the child process.

Examples:

See *popen()*.

Classification:

POSIX 1003.1a

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

errno, *popen()*, *pipe()*

Synopsis:

```
#include <stdio.h>

void perror( const char *prefix );
```

Arguments:

prefix NULL, or a string that you want to print before the error message.

Library:

libc

Description:

The *perror()* function prints the following to *stderr*:

- the given *prefix*, followed by "**:** "
- the error message returned by *strerror()* for the current value of *errno*
- a newline character.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
  {
    FILE *fp;

    fp = fopen( "data.fil", "r" );
    if( fp == NULL ) {
      perror( "Unable to open file" );
      return EXIT_FAILURE;
    }
    return EXIT_SUCCESS;
  }
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fprintf(), stderr, strerror()

Synopsis:

```
#include <unistd.h>

int pipe( int fildes[2] );
```

Arguments:

fildes An array where the function can store the file descriptors for the ends of the pipe.

Library:

libc

Description:

The *pipe()* function creates a pipe (an unnamed FIFO) and places a file descriptor for the read end of the pipe in *fildes*[0], and a file descriptor for the write end of the pipe in *fildes*[1]. Their integer values are the two lowest available at the time of the *pipe()* function call. The O_NONBLOCK flag is cleared for both file descriptors. (You can use *fcntl()* to set the O_NONBLOCK flag.)

You can write data to file descriptor *fildes*[1] and read it from file descriptor *fildes*[0]. If you read from file descriptor *fildes*[0], it returns the data written to *fildes*[1] on a first-in-first-out (FIFO) basis.

The pipe buffer is allocated by the **pipe** resource manager.

You typically use this function to connect standard utilities acting as filters, passing the write end of the pipe to the data-producing process as its STDOUT_FILENO, and the read end of the pipe to the data-consuming process as its STDIN_FILENO (either via the traditional *fork()*, *dup2()*, or *exec**, or the more efficient *spawn** calls).

If successful, *pipe()* marks the *st_ftime*, *st_ctime*, *st_atime* and *st_mtime* fields of the pipe for updating.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EMFILE The calling process doesn't have at least 2 unused file descriptors available.

ENFILE The number of simultaneously open files in the system would exceed the configured limit.

ENOSPC There's insufficient space available to allocate the pipe buffer.

ENOSYS There's no pipe manager running.

EROFS The pipe pathname space is a read-only filesystem.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *fcntl()*, *nbaconnect()*, *open()*, *popen()*, *read()*, *write()*

`pipe` in the *Utilities Reference*

Synopsis:

```
#include <sys/poll.h>
int poll(struct pollfd fds*, nfds_t nfds, int timeout)
```

Arguments:

fds	The array of interest.
nfds	Number of elements in the *fds* array.
timeout	Timeout in milliseconds.

Library:

libc

Description:

The *poll()* function provides applications with a mechanism for multiplexing input/output over a set of file descriptors.

The *pollfd* structure has the following components:

```
struct pollfd {
    int fd;
    short events;
    short revents;
};
```

For each member of the array pointed to by *fds*, *poll()* examines the given file descriptor for the event(s) specified in events. The number of *pollfd* structures in the *fds* array is specified by *nfds*. The array's members are *pollfd* structures within which *fd* specifies an open file descriptor, *events* and *revents* are bitmasks constructed by OR'ing a combination of the following event flags:

POLLERR	An error has occurred on the device. This flag is valid only in the *revents* bitmask; it's ignored in the *events* member.

POLLHUP — The device has been disconnected. This event and POLLOUT are mutually exclusive; a device can never be writable if a hangup has occurred. However, this event and POLLIN, POLLRDNORM, POLLRDBAND, or POLLPRI are not mutually exclusive. If the remote end of a socket is closed, *poll()* indicates a POLLIN event rather than POLLHUP. This flag is valid only in the *revents* bitmask; it's ignored in the *events* member.

POLLIN — Data other than high-priority data may be read without blocking. This is equivalent to POLLRDNORM | POLLRDBAND.

POLLNVAL — The specified fd value is invalid. This flag is only valid in the revents member; it shall ignored in the events member.

POLLOUT — Normal data may be written without blocking.

POLLPRI — High-priority data may be read without blocking.

POLLRDBAND — Priority data may be read without blocking.

POLLRDNORM — Normal data may be read without blocking.

POLLWRBAND — Priority data may be written.

POLLWRNORM — Equivalent to POLLOUT.

The significance and semantics of normal, priority, and high-priority data are file- and device-specific.

If the value of *fd* is less than 0, events are ignored; and *revents* are set to 0 in that entry on return from *poll()*.

In each *pollfd* structure, *poll()* clears the *revents* member, except that where the application requested a report on a condition by setting one of the bits of events listed above, *poll()* sets the corresponding bit in *revents* if the requested condition is true. In addition, *poll()* sets the POLLHUP, POLLERR, and POLLNVAL flag in revents if the condition is true, even if the application didn't set the corresponding bit in events.

If none of the defined events occurs on any selected file descriptor, *poll()* waits at least *timeout* milliseconds for an event to occur on any of the selected file descriptors. If the value of timeout is 0, *poll()* returns immediately. If the value of timeout is -1, *poll()* blocks until a requested event occurs or until the call is interrupted.

The *poll()* function isn't affected by the O_NONBLOCK flag.

The *poll()* function reports regular files, terminal and pseudo-terminal devices, FIFOs, and pipes.

Regular files always poll TRUE for reading and writing.

A file descriptor for a socket that's listening for connections indicates that it's ready for reading, once connections are available. A file descriptor for a socket that connects asynchronously indicates that it's ready for writing, once a connection has been established.

Returns:

> 0	Total number of file descriptors that have been selected.
0	The call timed out, and no file descriptor has been selected.
-1	Failure, and *errno* is set.

Errors:

EAGAIN	The allocation of internal data structures failed but a subsequent request may succeed.
EINTR	A signal was caught during *poll()*
EFAULT	The *fds* argument pointed to a nonexistent portion of the calling process's address space.

Examples:

```
#include <sys/socket.h>
#include <netinet/in.h>
#include <sys/poll.h>
#include <arpa/inet.h>
#include <unistd.h>
#include <stdio.h>
#include <pthread.h>
#include <fcntl.h>
#include <errno.h>
#include <string.h>

struct sockaddr_in sad;

void *
client(void *arg)
{
   int s;
   const char *p = "Some data\n";

   if ((s = socket(AF_INET, SOCK_STREAM, 0)) == -1) {
      perror("socket");
      return NULL;
   }

   if (connect(s, (struct sockaddr *)&sad, sizeof(sad)) == -1) {
       perror("connect");
       return NULL;
   }

   write(s, p, strlen(p));
   close(s);

   return NULL;
}

int
main(void)
{
   struct pollfd fds;
   int s = -1, s2 = -1, done_accept = 0, oflags, ret;
   char buf[100];

   if ((s = socket(AF_INET, SOCK_STREAM, 0)) == -1) {
      perror("socket");
      return 1;
   }

   sad.sin_family      = AF_INET;
   sad.sin_len         = sizeof(sad);
```

```
sad.sin_addr.s_addr = inet_addr("127.0.0.1");
sad.sin_port        = htons(1234);

fds.fd = s;
fds.events = POLLRDNORM;

oflags = fcntl(s, F_GETFL);
oflags |= O_NONBLOCK;
fcntl(s, F_SETFL, oflags);

if (bind(s, (struct sockaddr *)&sad, sizeof(sad)) == -1) {
   perror("bind");
   return 1;
}

listen(s, 5);

if ((ret = pthread_create(NULL, NULL, client, NULL)) != EOK) {
   fprintf(stderr, "pthread_create: %s\n", strerror(ret));
   return 1;
}

for (;;) {
   if ((ret = poll(&fds, 1, -1)) == -1) {
      perror("poll");
      break;
   }

   else if (ret != 1 || (fds.revents & POLLRDNORM) == 0) {
      break;
   }

   if (done_accept) {
      if ((ret = read(s2, buf, sizeof(buf))) <= 0) {
         break;
      }

      printf("%s", buf);

   }
   else {
      if ((s2 = accept(s, NULL, 0)) == -1) {
         perror("accept");
         break;
      }

      fds.fd = s2;
      done_accept = 1;
   }
}
```

```
    close(s);
    close(s2);

    return 0;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

Not all managers support POLLPRI, POLLPRI, POLLERR, and POLLHUP.

See also:

read(), *select()*, *write()*

<sys/poll.h>

Synopsis:

```
#include <stdio.h>

FILE* popen( const char* command,
             const char* mode );
```

Arguments:

command	The command that you want to execute.
mode	The I/O mode for the pipe, which must be **"r"** or **"w"**; see below.

Library:

libc

Description:

The *popen()* function executes the command specified by *command* and creates a pipe between the calling process and the executed command.

Depending on the *mode* argument, you can use the returned stream pointer to read from or write to the pipe.

The executed command has the same environment as its parents. The command is started as follows:

```
spawnlp (P_NOWAIT, shell_command, shell_command,
         "-c", command, (char* )NULL );
```

where *shell_command* is the command specified by the **SHELL** environment variable (if it exists), or the **sh** utility.

The *mode* argument to *popen()* is a string that specifies an I/O mode for the pipe:

- If *mode* is **"r"**, then when the child process is started:

  - Its file descriptor, STDOUT_FILENO, is the writable end of the pipe.
  - The *fileno*(*stream*) in the calling process is the readable end of the pipe, where *stream* is the stream pointer returned by *popen()*.

- If *mode* is **"w"**, then when the child process is started:
  - Its file descriptor, STDIN_FILENO, is the readable end of the pipe.
  - The *fileno*(*stream*) in the calling process is the writable end of the pipe, where *stream* is the stream pointer return by *popen()*.
- If *mode* is any other value, the result is undefined.

☞ Use *pclose()* to close a stream that you used *popen()* to open.

Returns:

A non-NULL stream pointer on successful completion. If *popen()* is unable to create either the pipe or the subprocess, it returns a NULL stream pointer and sets *errno*.

Errors:

EINVAL The *mode* argument is invalid.

ENOSYS There's no pipe manager running.

The *popen()* function may also set *errno* values as described by the *pipe()* and *spawnl()* functions.

Examples:

```
/*
 * upper:  executes a given program, converting all input
 *      to upper case.
 */
#include <stdio.h>
#include <stdlib.h>
```

```
#include <string.h>
#include <ctype.h>
#include <unistd.h>
#include <limits.h>

char   buffer[_POSIX_ARG_MAX];

int main( int argc, char** argv )
  {
    int  i;
    int  c;
    FILE* f;

    for( i = 1; i < argc; i++ ) {
      strcat( buffer, argv[i] );
      strcat( buffer, " " );
    }
    if( ( f = popen( buffer, "w" ) ) == NULL ) {
      perror( "popen" );
      return EXIT_FAILURE;
    }
    while( ( c = getchar() ) != EOF ) {
      if( islower( c ) )
        c = toupper( c );
      putc( c, f );
    }
    pclose( f );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

errno, pclose(), pipe(), spawnlp()

posix_mem_offset(), posix_mem_offset64()

Get the offset of a mapped typed memory block

Synopsis:

```
#include <sys/mman.h>

int posix_mem_offset( const void * addr,
                      size_t length,
                      off_t * offset,
                      size_t * contig_len,
                      int * fd );

int posix_mem_offset64( const void * addr,
                        size_t length,
                        off64_t * offset,
                        size_t * contig_len,
                        int * fd );
```

Library:

libc

Description:

☞ The *posix_mem_offset()* and *posix_mem_offset64()* functions aren't currently supported.

The *posix_mem_offset()* and *posix_mem_offset64()* functions set the variable pointed to by *offset* to the offset (or location), within a typed memory object, of the memory block currently mapped at *addr*.

Returns:

-1 (*errno* is set).

Errors:

ENOSYS The *posix_mem_offset()* function isn't supported by this implementation.

Classification:

posix_mem_offset() is POSIX 1003.1j (draft); *posix_mem_offset64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mem_offset(), *mem_offset64()*, *mmap()*

posix_memalign()

Allocate aligned memory

Synopsis:

```
#include <stdlib.h>

int posix_memalign( void ** memptr,
                    size_t alignment,
                    size_t size );
```

Arguments:

memptr	A pointer to a location where *posix_memalign()* can store a pointer the memory.
alignment	The alignment to use for the memory. This must be a multiple of **`size( void * )`**.
size	The size, in bytes, of the block to allocate.

Library:

`libc`

Description:

The *posix_memalign()* function allocates *size* bytes aligned on a boundary specified by *alignment*. It returns a pointer to the allocated memory in *memptr*.

The buffer allocated by *posix_memalign()* is contiguous in virtual address space, but not physical memory. Since some platforms don't allocate memory in 4K page sizes, you shouldn't assume that the memory allocated will be physically contiguous if you specify a size of 4K or less.

You can obtain the physical address of the start of the buffer using *mem_offset()* with *fd*=NOFD.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL The value of *alignment* isn't a multiple of `sizeof( void * )`.

ENOMEM There's insufficient memory available with the requested alignment.

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *free()*, *malloc()*, *memalign()*

pow(), powf()

Raise a number to a given power

Synopsis:

```
#include <math.h>

double pow( double x,
            double y );

float powf( float x,
            float y );
```

Arguments:

x The number you want to raise.

y The power you want to raise the number to.

Library:

libm

Description:

The *pow()* and *powf()* functions compute *x* raised to the power of *y*.

A domain error occurs if $x = 0$, and $y \leq 0$, or if *x* is negative, and *y* isn't an integer. A range error may also occur.

Returns:

The value of x^y.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

int main( void )
{
    printf( "%f\n", pow( 1.5, 2.5 ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
2.755676
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *exp()*, *log()*, *sqrt()*

pread(), pread64()

Read from a file without moving the file pointer

Synopsis:

```
#include <unistd.h>

ssize_t pread(int filedes,
              void *buff,
              size_t nbytes,
              off_t offset );

ssize_t pread64( int filedes,
                 void *buff,
                 size_t nbytes,
                 off64_t offset );
```

Arguments:

filedes	The descriptor of the file that you want to read from.
buff	A pointer to a buffer where the function can store the data that it reads.
nbytes	The number of bytes that you want to read.
offset	The desired position inside the file.

Library:

libc

Description:

The *pread()* function performs the same action as *read()*, except that it reads from a given position in the file without changing the file pointer.

The *pread()* function reads up to the maximum offset value that can be represented in an **off_t** for regular files. An attempt to perform a *pread()* on a file that's incapable of seeking results in an error.

The *pread64()* function is a 64-bit version of *pread()*.

Returns:

The number of bytes actually read, or -1 if an error occurred (*errno* is set).

Errors:

EAGAIN	The O_NONBLOCK flag is set for the file descriptor, and the process would be delayed in the read operation.
EBADF	The file descriptor, *fildes*, isn't a valid file descriptor open for reading.
EINTR	The read operation was interrupted by a signal, and either no data was transferred, or the resource manager responsible for that file does not report partial transfers.
EIO	A physical I/O error occurred (for example, a bad block on a disk). The precise meaning is device-dependent.
ENOSYS	The *pread()* function isn't implemented for the filesystem specified by *filedes*.

Classification:

pread() is standard Unix; *pread64()* is for large-file support

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

close(), creat(), dup(), dup2(), errno, fcntl(), lseek(), open(), pipe(), pwrite(), read(), readblock(), readv(), select(), write(), writeblock(), writev()

printf()

Write formatted output to stdout

Synopsis:

```
#include <stdio.h>

int printf( const char * format,
            ... );
```

Arguments:

format A string that controls the format of the output, as described below. The formatting string determines what additional arguments you need to provide.

Library:

libc

Description:

The *printf()* function writes output to the *stdout* stream, under control of the argument *format*.

If the format string contains invalid multibyte characters, processing stops, and the rest of the format string, including the `%` characters, is printed. This can happen, for example, if you specify international characters, accents, and diacritical marks using ISO 8859-1 instead of UTF-8. If you call:

```
setlocale( LC_CTYPE, "C-TRADITIONAL" );
```

before calling *printf()*, the locale switches multibyte processing from UTF-8 to 1-to-1, and *printf()* safely transfers the misformed multibyte characters.

Format Arguments

If there are leftover arguments after processing *format*, they're ignored.

The *printf()* family of functions allows for language-dependent radix characters. The default character is ".", but is controlled by LC_NUMERIC and *setlocale()*.

Format control string

The format control string consists of:

multibyte characters

These are copied to the output stream exactly as they occur in the *format* string. An ordinary character in the *format* string is any character, other than a percent character (**%**), that isn't part of a conversion specifier.

conversion specifiers

These cause argument values to be written as they're encountered during the processing of the *format* string. A conversion specifier is a sequence of characters in the *format* string that begins with "%" and is followed by:

- zero or more *format control flags* that can modify the final effect of the format directive
- an optional decimal integer, or an asterisk (*****), that specifies a *minimum field width* to be reserved for the formatted item
- an optional *precision specification* in the form of a period (**.**), followed by an optional decimal integer or an asterisk (*****)
- an optional *type length* specification, one of: **h**, **hh**, **j**, **l**, **ll**, **L**, **t** or **z**.
- a character that specifies the type of conversion to be performed. See below.

Format control flags

The valid format control flags are:

`-`	Left-justify the formatted item within the field; normally, items are right-justified.
`+`	Always start a signed, positive object with a plus character (`+`); normally, only negative items begin with a sign.
space	Always start a signed, positive object with a space character; if both `+` and a space are specified, `+` overrides the space.
`#`	Use an alternate conversion form: • For `o` (unsigned octal) conversions, increment the precision, if necessary, so that the first digit is `0`. • For `x` or `X` (unsigned hexadecimal) conversions, prepend a nonzero value with `0x` or `0X`. • For `e`, `E`, `f`, `g`, or `G` (any floating-point) conversions, always include a decimal-point character in the result, even if no digits follow it; normally, a decimal-point character appears in the result only if there is a digit to follow it. • In addition, for `g` or `G` conversions, don't remove trailing zeros from the result.
`0` (zero)	Use leading zeros to pad the field width for `d`, `i`, `o`, `u`, `x`, `X`, `e`, `E`, `f`, `g` and `G` conversions. The "`-`" flag overrides the this flag.

Field width

If you don't specify a field width, or if the given value is less than the number of characters in the converted value (subject to any precision value), a field of sufficient width to contain the converted value is used.

If the converted value has fewer characters than specified by the field width, the value is padded on the left (or right, subject to the

left-justification flag) with spaces or zero characters (`0`). If the field width begins with a zero, the value is padded with zeros; otherwise, the value is padded with spaces.

If the field width is `*` (or `0*`), a value of type `int` from the argument list is used (before a precision argument or a conversion argument) as the minimum field width. A negative field width value is interpreted as a left-justification flag, followed by a positive field width.

Precision specifier

As with the field width specifier, a precision specifier of `*` causes a value of type `int` from the argument list to be used as the precision specifier. If you give a precision specifier of `*`, but there's no precision value in the argument list, a precision of 0 is used.

The precision value affects the following conversions:

- For `d`, `i`, `o`, `u`, `x` and `X` (integer) conversions, the precision specifies the minimum number of digits to appear.
- For `e`, `E` and `f` (fixed-precision, floating-point) conversions, the precision specifies the number of digits to appear after the decimal-point character.
- For `g` and `G` (variable-precision, floating-point) conversions, the precision specifies the maximum number of significant digits to appear.
- For `s` (string) conversions, the precision specifies the maximum number of characters to appear.

Type length specifier

A type length specifier affects the conversion as follows:

- `h` causes a `d`, `i`, `o`, `u`, `x` or `X` (integer) format conversion to treat the argument as a `short` or `unsigned short` argument.

  Note that, although the argument may have been promoted to an `int` as part of the function call, the value is converted to the smaller type before it's formatted.
- `h` causes an `n` (converted length assignment) operation to assign the converted length to an object of type `short`.

- **hh** is similar to **h**, but treats the argument as a **signed char** or an **unsigned char**.
- **j** causes a **d**, **i**, **o**, **u**, **x**, **X** format conversion to process a **intmax_t** or **uintmax_t**.
- **j** causes an **n** format conversion to process an **intmax_t**.
- **L** causes an **a**, **A**, **e**, **E**, **f**, **g**, **G** (double) format conversion to process a **long double** argument.
- **l** ("el") causes a **c** format conversion to process a **wint_t** argument.
- **l** ("el") causes an **s** format conversion to process a **wchar_t** argument.
- **l** ("el") causes a **d**, **i**, **o**, **u**, **x**, or **X** (integer) format conversion to process a **long** or **unsigned long** argument.
- **l** ("el") causes an **n** (converted length assignment) operation to assign the converted length to an object of type **long**.
- **ll** (double "el") causes a **d**, **i**, **o**, **u**, **x**, or **X** (integer) format conversion to assign the converted value to an object of type **long long** or **unsigned long long**.
- **ll** (double "el") causes an **n** (converted length assignment) operation to assign the number of characters that have been read to an object of type **long long**.
- **t** causes a **d**, **i**, **o**, **u**, **x**, **X** format conversion to process a **ptrdiff_t** or the corresponding **unsigned** type argument.
- **t** causes an **n** format conversion to process a **ptrdiff_t** argument.
- **z** causes a **d**, **i**, **o**, **u**, **x**, **X** format conversion to process a **size_t** argument.
- **z** causes a **n** format conversion to process a **size_t** argument.

Conversion type specifiers

The valid conversion type specifiers are:

a, **A** Convert an argument of type **double** in the style **[-]0xh.hhhh p1d**, where there's one nonzero hexadecimal digit before the decimal point. The number of hexadecimal digits after the decimal point is equal to the precision. If the precision is missing and FLT_RADIX is a power of 2, then the precision is sufficient for an exact representation. If the precision is zero and you don't specify the **#** flag, no decimal point is shown.

The **a** conversion uses the letters **abcdef** and produces **x** and **p**; the **A** conversion **ABCDEF**, **X** and **P**. The exponent always has one digit, even if it's **0**, and no more digits than necessary. The values for infinity or NaN are converted in the style of an **f** or **F**.

c Convert an argument of type **int** into a value of type **unsigned char** and write the corresponding ASCII character code to the output stream.

An **l** ("el") qualifier causes a **wint_t** argument to be converted as if by an **ls** conversion into a **wchar_t**, the first element being the **wint_t** and the second being a null wide character.

d, **i** Convert an argument of type **int** into a signed decimal notation and write it to the output stream. The default precision is 1, but if more digits are required, leading zeros are added.

e, **E** Convert an argument of type **double** into a decimal notation in the form **[-]***d.ddd***e[+|-]***dd*. The leading sign appears (subject to the format control flags) only if the argument is negative.

If the argument is nonzero, the digit before the decimal-point character is nonzero. The precision is used as the number of digits following the decimal-point character. If you don't specify the precision, a default precision of six is used. If the

precision is 0, the decimal-point character is suppressed. The value is rounded to the appropriate number of digits.

The exponent sign and the exponent (that indicates the power of ten by which the decimal fraction is multiplied) are always produced. The exponent is at least two digits long.

For **E** conversions, the exponent begins with the character **E**, rather than **e**.

The arguments infinity or **NaN** are converted in the style of the **f** or **F** conversion specifiers.

f, **F** Convert an argument of type **double** into a decimal notation in the form *[-]ddd.ddd* with the number of digits after the decimal point being equal to the precision specification. The leading sign appears (subject to the format control flags) only if the argument is negative.

The precision is used as the number of digits following the decimal-point character. If you don't specify the precision, a default precision of six is used. If the precision is 0, the decimal-point character is suppressed; otherwise, at least one digit is produced before the decimal-point character. The value is rounded to the appropriate number of digits.

An argument of type **double** that represents infinity or NaN is converted to **[-]inf** or **[-]nan**. The **F** specifier produces **[-]INF** or **[-]NAN**.

g, **G** Convert an argument of type **double** using either the **e** or **f** (or **E**, for a **G** conversion) style of conversion, depending on the value of the argument. In either case, the precision specifies the number of significant digits that are contained in the result. The **e** style conversion is used only if the exponent from such a conversion would be less than -4 or greater than the precision. Trailing zeros are removed from the result, and a decimal-point character only appears if it is followed by a digit.

Arguments representing infinity or NaN are converted in the style of the **f** or **F** conversion specifiers.

n Assign the number of characters that have been written to the output stream to the integer pointed to by the argument. No output is produced.

o Convert an argument of type **unsigned** into an unsigned octal notation, and write it to the output stream. The default precision is 1, but if more digits are required, leading zeros are added.

p Convert an argument of type **void *** into a value of type **int**, and format the value as for a hexadecimal (**x**) conversion.

s Write the characters from the string specified by an argument of type **char ***, up to, but not including the terminating NUL character (**'\0'**), to the output stream. If you specify a precision, no more than that many characters are written.

If you use an **l** ("el") qualifier, the argument is interpreted as a pointer to a **wchar_t** array, and each wide character, including the terminating NUL, is converted as if by a call to *wcrtomb()*. The terminating NUL is written only if you don't specify the precision, or if you specify the precision and the length of the character sequence is less than the precision.

u Convert an argument of type **unsigned** into an unsigned decimal notation, and write it to the output stream. The default precision is 1, but if more digits are required, leading zeros are added.

x, **X** Convert an argument of type **unsigned** into an unsigned hexadecimal notation, and write it to the output stream. The default precision is 1, but if more digits are required, leading zeros are added.

Hexadecimal notation uses the digits **0** through **9** and the characters **a** through **f** or **A** through **F** for **x** or **X** conversions, respectively, as the hexadecimal digits. Subject to the alternate-form control flag, **0x** or **0X** is prepended to the output.

`%` Print a `%` character (The entire specification is `%%`).

Any other conversion type specifier character, including another percent character (`%`), is written to the output stream with no special interpretation.

The arguments must correspond with the conversion type specifiers, left to right in the string; otherwise, indeterminate results will occur.

If the value corresponding to a floating-point specifier is infinity, or not a number (NAN), then the output will be **`inf`** or **`-inf`** for infinity, and **`nan`** or **`-nan`** for NANs.

For example, a specifier of the form **`%8.*f`** defines a field to be at least 8 characters wide, and gets the next argument for the precision to be used in the conversion.

Returns:

The number of characters written, excluding the terminating NULL, or a negative number if an error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char *weekday, *month;

    weekday = "Saturday";
    month = "April";
    printf( "%s, %s %d, %d\n", weekday, month, 10, 1999 );
    printf( "f1 = %8.4f f2 = %10.2E x = %#08x i = %d\n",
        23.45, 3141.5926, 0x1db, -1 );
    return EXIT_SUCCESS;
}
```

produces the output:

```
Saturday, April 10, 1999
f1 =  23.4500 f2 =  3.14E+003 x = 0x0001db i = -1
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fprintf(), fwprintf(), snprintf(), sprintf(), swprintf(), vfprintf(), vfwprintf(), vprintf(), vsnprintf(), vsprintf(), vswprintf(), vwprintf(), wprintf()

procmgr_daemon()

Run a process in the background

Synopsis:

```
#include <sys/procmgr.h>

int procmgr_daemon( int status,
                    unsigned flags );
```

Arguments:

status The status that you want to return to the parent process.

flags The flags currently defined (in **<sys/procmgr.h>**) are:

- PROCMGR_DAEMON_NOCHDIR — unless this flag is set, *procmgr_daemon()* changes the current working directory to the root "**/**".
- PROCMGR_DAEMON_NOCLOSE — unless this flag is set, *procmgr_daemon()* closes all file descriptors other than standard input, standard output and standard error.
- PROCMGR_DAEMON_NODEVNULL — unless this flag is set, *procmgr_daemon()* redirects standard input, standard output and standard error to **/dev/null**.
- PROCMGR_DAEMON_KEEPUMASK — unless this flag is set, *procmgr_daemon()* sets the umask to **0** (zero).

Library:

libc

Description:

The function *procmgr_daemon()* function lets programs detach themselves from the controlling terminal and run in the background as system daemons. This also puts the caller into session 1. The argument *status* is returned to the parent process as if *exit()* were called; the returned value is normally EXIT_SUCCESS.

Returns:

A nonnegative integer, or -1 if an error occurs.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

daemon(), *exit()*, *procmgr_event_notify()*, *procmgr_event_trigger()*, *procmgr_guardian()*, *procmgr_session()*

procmgr_event_notify()

Ask to be notified of system-wide events

Synopsis:

```
#include <sys/procmgr.h>

int procmgr_event_notify
            ( unsigned flags,
              const struct sigevent * event );
```

Arguments:

flags Flags currently defined in **<sys/procmgr.h>** are:

- PROCMGR_EVENT_DAEMON_DEATH — notify the caller when any process in session 1 dies. This is most useful for watching for the death of daemon processes that use *procmgr_daemon()* to put themselves in session 1 as well as close and redirect file descriptors. As a result of this closing and redirecting, the death of daemons are difficult to detect otherwise.

☞ Notification is via the given event, so no information is provided as to which process died. Once you've received the event, you'll need to do something else to find out if processes you care about had died. You can do this by walking through the list of all processes, looking for specific process IDs or process names. If you don't find one, then it has died. The sample code below demonstrates how this can be done.

- PROCMGR_EVENT_SYNC — notify the caller of any calls to *sync()* the filesystems.

Setting *flags* to `0` (zero) unarms the event.

event A pointer to a **sigevent** structure that specifies how you want to notified.

Library:

libc

Description:

The *procmgr_event_notify()* function requests that the process manager notify the caller of the system-wide events identified by the given *flags*. A process may have only one notification request active at a time.

Returns:

-1 on error; any other value indicates success.

Examples:

```
/*
 * This demonstrates procmgr_event_notify() with the
 * PROCMGR_DAEMON_DEATH flag. This flag allows you to
 * be notified if any process in session 1 dies.
 * Daemons are processes that do things that make
 * their death hard to detect (they become daemons by calling
 * procmgr_daemon()).  One of the things that happens is that
 * daemons end up in session 1.  Hence, the usefulness of the
 * PROCMGR_DAEMON_DEATH flag.
 *
 * When you are notified, you're not told who died.
 * It's up to you to know who should be running.  Once notified,
 * you could then walk through the list of which processes are
 * still running and see if all the expected processes are still
 * running. If you know the process id of the processes you
 * are watching out for then this is easiest.  If you don't know
 * the process id then your next option may be by process name.
 * The code below does a lookup by process name.
 */

#include <devctl.h>
#include <dirent.h>
#include <errno.h>
#include <fcntl.h>
#include <libgen.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <sys/neutrino.h>
#include <sys/procfs.h>
#include <sys/procmgr.h>

static int check_if_running( char *process );

#define DAEMON_DIED_CODE   (_PULSE_CODE_MINAVAIL)
```

```
struct dinfo_s {
    procfs_debuginfo    info;
    char                pathbuffer[PATH_MAX];
};

int
main( int argc, char **argv )
{
    char            *daemon_to_watch;
    int             chid, coid, rcvid;
    struct sigevent event;
    struct _pulse   msg;

    if (argc != 2) {
        printf( "use: %s process_to_watch_for\n", argv[0] );
        exit( EXIT_FAILURE );
    }

    daemon_to_watch = argv[1];   /* the process to watch for */

    chid = ChannelCreate( 0 );
    coid = ConnectAttach( 0, 0, chid, _NTO_SIDE_CHANNEL, 0 );
    SIGEV_PULSE_INIT( &event, coid, SIGEV_PULSE_PRIO_INHERIT,
                      DAEMON_DIED_CODE, 0 );

    /*
     * Ask to be notified via a pulse whenever a
     * daemon process dies
     */

    if (procmgr_event_notify( PROCMGR_EVENT_DAEMON_DEATH,
                              &event ) == -1) {
        fprintf( stderr, "procmgr_event_notify() failed" );
        exit( EXIT_FAILURE );
    }

    while (1) {
        rcvid = MsgReceive( chid, &msg, sizeof(msg), NULL );
        if (rcvid != 0) {
            /* not a pulse, could be unexpected message or error */
            exit( EXIT_FAILURE );
        }

        if (check_if_running( daemon_to_watch ) == 0)
            printf( "%s is no longer running\n", daemon_to_watch );
    }
    return 0;
}

/*
```

```
 * check_if_running - This will walk through all processes
 * to see if this particular one is still running.
 */

static int
check_if_running( char *process )
{
    DIR             *dirp;
    struct dirent   *dire;
    char            buffer[20];
    int             fd, status;
    pid_t           pid;
    struct dinfo_s  dinfo;

    if ((dirp = opendir( "/proc" )) == NULL) {
        perror( "Could not open '/proc'" );
        return -1;
    }
    while (1) {
        if ((dire = readdir( dirp )) == NULL)
            break;
        if (isdigit( dire->d_name[0] )) {
            pid = strtoul( dire->d_name, NULL, 0 );

            sprintf( buffer, "/proc/%d/as", pid );
            if ((fd = open( buffer, O_RDONLY )) != NULL) {
                status = devctl( fd, DCMD_PROC_MAPDEBUG_BASE,
                                 &dinfo, sizeof(dinfo), NULL );
                if (status == EOK) {
                    if (!strcmp( process, basename( dinfo.info.path ) ))
                    {
                        closedir (dirp);
                        return 1;
                    }
                } /* else some errors are expected, e.g. procnto has
                     no MAPDEBUG info and there is a timing issue
                     with getting info on the process that died,
                     ignore errors */
                close( fd );
            }
        }
    }
    closedir( dirp );
    return 0;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

procmgr_daemon(), *procmgr_event_trigger()*, **_pulse**, **sigevent**

procmgr_event_trigger()

Trigger a system-wide event

Synopsis:

```
#include <sys/procmgr.h>

int procmgr_event_trigger( unsigned flags );
```

Arguments:

flags The type of event that you want to trigger (defined in **<sys/procmgr.h>**):

- PROCMGR_EVENT_SYNC — notify filesystems to *sync()*.

Library:

libc

Description:

The function *procmgr_event_trigger()* triggers a system-wide event. The event is sent to all processes that requested (via *procmgr_event_notify()*) to be notified of the event identified by *flags*.

Returns:

-1 on error; any other value indicates success.

Examples:

```
#include <sys/procmgr.h>

int main ( void )
{
   procmgr_event_trigger( PROCMGR_EVENT_SYNC );
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

procmgr_event_notify(), sync()

procmgr_guardian()

Let a daemon process take over as a parent

Synopsis:

```
#include <sys/procmgr.h>

pid_t procmgr_guardian( pid_t pid );
```

Arguments:

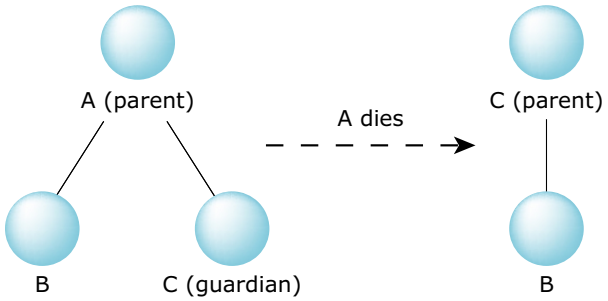
pid The ID of the child process that you want to become the guardian of the calling process's other children.

Library:

libc

Description:

The function *procmgr_guardian()* allows a daemon process to declare a child process to take over as parent to its children in the event of its death:



Specifying a guardian for child processes.

Returns:

-1 on error; any other value on success.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <fcntl.h>
#include <spawn.h>
#include <sys/procmgr.h>
#include <sys/wait.h>

pid_t     child = -1;
pid_t     guardian = -1;

/*
 * Build a list of the currently running children
 */
void check_children(void) {
    if(child > 0) {
        if(kill(child, 0) == -1) {
            child = -1;
        }
    }
    if(guardian > 0) {
        if(kill(guardian, 0) == -1) {
            guardian = -1;
        }
    }
}

void start_needed_children(void) {
    if(guardian == -1) {
        /* Make a child that will just sit around
           and wait for parent to die */
        while((guardian = fork()) == 0) {
            pid_t parent = getppid();

            /* Wait for parent to die.... */
            fprintf(stderr, "guardian %d waiting on parent %d\n",
                    getpid(), parent);

            while(waitpid(parent, 0, 0) != parent);
            /* Then loop around and take over */
        }
        if(guardian == -1) {
            fprintf(stderr, "Unable to start guardian\n");
        } else {
            /* Declare the child a guardian */
            procmgr_guardian(guardian);
        }
    }
```

```
    if(child == -1) {
        static char    *args[] = { "sleep", "1000000", 0 };

        if((child = spawnp("sleep", 0, 0, 0, args, 0)) == -1) {
            fprintf(stderr, "Couldn't start child\n");
            child = 0;    /* don't try again */
        }
    }
}

int main(int argc, char *argv[]) {
    fprintf(stderr, "parent %d checking children\n", getpid());
    do {
        fprintf(stderr, "checking children\n");

        /* Learn about the newly adopted children */
        check_children();

        /* If anyone is missing, start them */
        start_needed_children();
    } while(wait(0));     /* Then wait for someone to die... */
    return EXIT_SUCCESS;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

procmgr_daemon(), procmgr_event_notify(), procmgr_event_trigger()

procmgr_session()

Provide process manager session support

Synopsis:

```
#include <sys/procmgr.h>

int procmgr_session( uint32_t nd,
                     pid_t sid,
                     int id,
                     unsigned event);
```

Arguments:

The interpretation of the arguments depends on the *event*.

nd A node descriptor.

sid A session ID.

id A file descriptor, process group, or signal, depending on the event.

event The event; one of:

- PROCMGR_SESSION_TCSETSID
- PROCMGR_SESSION_SETSID
- PROCMGR_SESSION_SETPGRP
- PROCMGR_SESSION_SIGNAL_PID
- PROCMGR_SESSION_SIGNAL_PGRP
- PROCMGR_SESSION_SIGNAL_LEADER

For more information, see below.

Library:

libc

Description:

The *procmgr_session()* function provides session support to character device terminal drivers in their resource managers, C library functions, and session management applications.

The arguments that you provide need to match the event:

PROCMGR_SESSION_TCSETSID

Used by the *tcsetsid()* function to set the file descriptor, *id*, to be the controlling terminal for the session headed by the session leader, *sid*.

PROCMGR_SESSION_SETSID

Used by the *setsid()* function to create a new session with the calling process becoming the session leader. Pass zero for both *sid* and *id* arguments.

PROCMGR_SESSION_SETPGRP

Used by a character device resource manager to change the process group upon the request of a client calling the *tcsetpgrp()* function. Set the *sid* argument to the client's current session and the *id* argument to the new target process group for the client.

PROCMGR_SESSION_SIGNAL_PID,
PROCMGR_SESSION_SIGNAL_PGRP,
PROCMGR_SESSION_SIGNAL_LEADER

Used by a character device resource manager to drop a signal of the type specified as the *id* argument (generally a terminal/job control signal) on the appropriate member of the session specified by the *sid* argument.

Returns:

0 Success.

-1 Failure.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

setsid(), tcsetpgrp(), tcsetsid()

Synopsis:

```
char * __progname
```

Description:

This global variable holds the basename of the program being executed.

☞ This variable isn't defined in any header file. If you want to refer to it, you need to add your own **extern** statement.

Classification:

QNX Neutrino

See also:

_cmdfd(), _cmdname()

protoent

Structure for information from the protocol database

Synopsis:

```
#include <netdb.h>

struct protoent {
     char *  p_name;
     char ** p_aliases;
     int     p_proto;
};
```

Description:

The **protoent** structure holds information from the network protocols database, **/etc/protocols**.

The members of this structure are:

p_name	The name of the protocol.
p_aliases	A zero-terminated list of alternate names for the protocol.
p_proto	The protocol number.

Classification:

Unix, POSIX 1003.1-2001

See also:

endprotoent(), *getprotobyname()*, *getprotobynumber()*, *getprotoent()*, *setprotoent()*

/etc/protocols in the *Utilities Reference*

pthread_abort()

Unconditionally terminate the target thread

Synopsis:

```
#include <pthread.h>

int pthread_abort( pthread_t thread );
```

Arguments:

thread The ID of the thread that you want to terminate, which you can get when you call *pthread_create()* or *pthread_self()*.

Library:

libc

Description:

The *pthread_abort()* function terminates the target thread. Termination takes effect immediately and isn't a function of the cancelability state of the target thread. No cancellation handlers or thread-specific-data destructor functions are executed. Thread abortion doesn't release any application-visible process resources, including, but not limited to, mutexes and file descriptors. (The behavior of POSIX calls following a call to *pthread_abort()* is unspecified.)

The status of PTHREAD_ABORTED is available to any thread joining with the target thread. The constant PTHREAD_ABORTED expands to a constant expression, of type **void *** . Its value doesn't match any pointer to an object in memory, or the values NULL and PTHREAD_CANCELED.

The side effects of aborting a thread that's suspended during a call of a POSIX 1003.1 function are the same as the side effects that may be seen in a single-threaded process when a call to a POSIX 1003.1 function is interrupted by a signal and the given function returns EINTR. Any such side effects occur before the thread terminates.

Returns:

EOK	Success.
ESRCH	No thread with the given ID was found.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cancel(), *pthread_detach()*, *pthread_exit()*, *ThreadDestroy()*

pthread_atfork()

Register fork handlers

Synopsis:

```
#include <process.h>

int pthread_atfork( void (*prepare)(void),
                    void (*parent)(void),
                    void (*child)(void) );
```

Arguments:

prepare	NULL, or a pointer to the handler to call before the fork.
parent	NULL, or a pointer to the handler to call after the fork in the parent process.
child	NULL, or a pointer to the handler to call after the fork in the child process.

Library:

libc

Description:

The *pthread_atfork()* function registers fork handler functions to be called before and after a *fork()*, in the context of the thread that called *fork()*. You can set one or more of the arguments to NULL to indicate no handler.

You can register multiple *prepare*, *parent*, and *child* fork handlers, by making additional calls to *pthread_atfork()*. In this case, the *parent* and *child* handlers are called in the order they were registered, and the *prepare* handlers are called in the reverse order.

You can't use the *pthread_atfork()* function for useful purposes as the C library doesn't have the necessary handlers. It also implies that Neutrino currently doesn't support *fork()* in multi-threaded programs.

Returns:

EOK	Success.
ENOMEM	Insufficient memory to record fork handlers.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

atexit(), *fork()*

pthread_attr_destroy()

Destroy a thread-attribute object

Synopsis:

```
#include <pthread.h>

int pthread_attr_destroy( pthread_attr_t * attr );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that you want to destroy.

Library:

libc

Description:

The *pthread_attr_destroy()* function destroys the given thread-attribute object.

The QNX implementation of this function doesn't actually free the memory used by the **pthread_attr_t** structure. To conform to the POSIX standard, don't reuse the attribute object unless you reinitialize it by calling *pthread_attr_init()*.

You can use a thread-attribute object to define the attributes of new threads when you call *pthread_create()*.

Returns:

0 for success, or an error number.

Errors:

EOK Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_init(), *pthread_create()*

pthread_attr_getdetachstate()

Get thread detach state attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_getdetachstate(
                      const pthread_attr_t* attr,
                      int* detachstate );
```

Arguments:

attr	A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.
detachstate	A pointer to a location where the function can store the thread detach state. For more information, see *pthread_attr_setdetachstate()*.

Library:

libc

Description:

The *pthread_attr_getdetachstate()* function gets the thread detach state attribute from the thread attribute object *attr* and returns it in *detachstate*.

Returns:

EOK Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_setdetachstate(), *pthread_attr_init()*, *pthread_create()*.

pthread_attr_getguardsize()

Get the size of the thread's guard area

Synopsis:

```
#include <pthread.h>

int pthread_attr_getguardsize(
              const pthread_attr_t* attr,
              size_t* guardsize );
```

Arguments:

attr	A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.
guardsize	A pointer to a location where the function can store the size of the thread's guard area. For more information, see *pthread_attr_setguardsize()*.

Library:

libc

Description:

The *pthread_attr_getguardsize()* function gets the value of the thread guardsize attribute from the attribute structure *attr*.

Returns:

EOK	Success.
EINVAL	Invalid pointer, *attr*, to a **pthread_attr_t** structure.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_setguardsize()

pthread_attr_getinheritsched()

Get a thread's inherit-scheduling attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_getinheritsched(
                    const pthread_attr_t* attr,
                    int* inheritsched );
```

Arguments:

attr	A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.
inheritsched	A pointer to a location where the function can store the value of the inherit-scheduling attribute. For more information, see *pthread_attr_setinheritsched()*.

Library:

libc

Description:

The *pthread_attr_getinheritsched()* function gets the thread inherit-scheduling attribute from the attribute object *attr* and returns it in *inheritsched*.

The inherit-scheduling attribute determines whether a thread inherits the scheduling policy of its parent.

Returns:

EOK	Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_setinheritsched(), pthread_attr_init(), pthread_create()

pthread_attr_getschedparam()

Get thread scheduling parameters attribute

Synopsis:

```
#include <pthread.h>
#include <sched.h>

int pthread_attr_getschedparam(
                    const pthread_attr_t * attr,
                    struct sched_param * param );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

param A pointer to a **sched_param** structure where the function can store the current scheduling parameters.

Library:

libc

Description:

The *pthread_attr_getschedparam()* function gets the thread scheduling parameters attribute from the thread attribute object *attr* and returns it in *param*.

Returns:

EOK Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_setschedparam(), *pthread_attr_init()*, *pthread_create()*, **sched_param**

pthread_attr_getschedpolicy()

Get thread scheduling policy attribute

Synopsis:

```
#include <pthread.h>
#include <sched.h>

int pthread_attr_getschedpolicy(
                    const pthread_attr_t* attr,
                    int* policy );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

policy The current thread scheduling policy. For more information, see *pthread_attr_setschedpolicy()*.

Library:

libc

Description:

The *pthread_attr_getschedpolicy()* function gets the thread scheduling policy attribute from the thread attribute object *attr* and returns it in *policy*.

Returns:

EOK Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_setschedpolicy(), *pthread_attr_init()*, *pthread_create()*.

pthread_attr_getscope()

Get thread contention scope attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_getscope(
                  const pthread_attr_t *attr,
                  int *scope );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

scope A pointer to a location where the function can store the current contention scope. For more information, see *pthread_attr_setscope()*.

Library:

libc

Description:

The *pthread_attr_getscope()* function gets the thread contention scope attribute from the thread attribute object *attr* and returns it in *scope*.

Returns:

EOK Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_setscope(), *pthread_attr_init()*, *pthread_create()*.

pthread_attr_getstackaddr()

Get thread stack address attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_getstackaddr(
                    const pthread_attr_t* attr,
                    void** stackaddr );
```

Arguments:

attr	A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.
stackaddr	A pointer to a location where the function can store the address of the thread stack.

Library:

libc

Description:

The *pthread_attr_getstackaddr()* function gets the thread stack address attribute from the thread attribute object *attr* and returns it in *stackaddr*.

For more information about the thread stack, see *pthread_attr_setstackaddr()*

Returns:

EOK Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_setstackaddr(), *pthread_attr_init()*, *pthread_create()*.

pthread_attr_getstacklazy()

Get the thread lazy-stack attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_getstacklazy(
                    const pthread_attr_t * attr,
                    int *lazystack );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

lazystack A pointer to a location where the function can store the current lazy-stack attribute. For more information, see *pthread_attr_setstacklazy()*.

Library:

libc

Description:

The *pthread_attr_getstacklazy()* function gets the thread lazy-stack attribute in the attribute object *attr* and stores it in the location pointed to by *lazystack*.

Returns:

EOK Success.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_setinheritsched(), pthread_attr_setstacklazy()

pthread_attr_getstacksize()

Get the thread stack-size attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_getstacksize(
                    const pthread_attr_t* attr,
                    size_t* stacksize );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

stacksize A pointer to a location where the function can store the stack size to be used for new threads.

Library:

libc

Description:

The *pthread_attr_getstacksize()* function gets the thread stack size attribute from the thread attribute object *attr* and returns it in *stacksize*.

You can set the stack size by calling *pthread_attr_setstacksize()*.

Returns:

EOK Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_setstacksize(), *pthread_attr_init()*, *pthread_create()*.

pthread_attr_init()

Initialize a thread-attribute object

Synopsis:

```
#include <pthread.h>

int pthread_attr_init( pthread_attr_t *attr );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that you want to initialize. For more information, see below.

Library:

libc

Description:

The *pthread_attr_init()* function initializes the thread attributes in the thread attribute object *attr* to their default values:

Attribute	Default Value
detachstate	PTHREAD_CREATE_JOINABLE
schedpolicy	PTHREAD_INHERIT_SCHED
schedparam	Inherited from parent thread
contentionscope	PTHREAD_SCOPE_SYSTEM
stacksize	4K bytes
stackaddr	NULL

After initialization, you can use the *pthread_attr_** family of functions to get and set the attributes:

Get	Set
pthread_attr_getdetachstate()	*pthread_attr_setdetachstate()*
pthread_attr_getguardsize()	*pthread_attr_setguardsize()*
pthread_attr_getinheritsched()	*pthread_attr_setinheritsched()*
pthread_attr_getschedparam()	*pthread_attr_setschedparam()*
pthread_attr_getschedpolicy()	*pthread_attr_setschedpolicy()*
pthread_attr_getscope()	*pthread_attr_setscope()*
pthread_attr_getstackaddr()	*pthread_attr_setstackaddr()*
pthread_attr_getstacklazy()	*pthread_attr_setstacklazy()*
pthread_attr_getstacksize()	*pthread_attr_setstacksize()*

You can also set some non-POSIX attributes; for more information, see "QNX extensions," in the documentation for *pthread_create()*.

You can then pass the attribute object to *pthread_create()* to create a thread with the required attributes. You can use the same attribute object in multiple calls to *pthread_create()*.

The effect of initializing an already-initialized thread-attribute object is undefined.

Returns:

EOK Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_destroy(), *pthread_create()*

pthread_attr_setdetachstate()

Set thread detach state attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_setdetachstate(
                  pthread_attr_t* attr,
                  int detachstate );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

detachstate The new value for the thread detach state:

- PTHREAD_CREATE_JOINABLE — create the thread in a joinable state.
- PTHREAD_CREATE_DETACHED — create the thread in a detached state.

Library:

libc

Description:

The *pthread_attr_setdetachstate()* function sets the thread detach state attribute in the thread attribute object *attr* to *detachstate*.

The default value for the thread detach state is PTHREAD_CREATE_JOINABLE.

Returns:

EOK Success.

EINVAL Invalid thread detach state value.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_getdetachstate(), *pthread_attr_init()*, *pthread_create()*, *pthread_detach()*, *pthread_join()*.

pthread_attr_setguardsize()

Set the size of the thread's guard area

Synopsis:

```
#include <pthread.h>

int pthread_attr_setguardsize(
            pthread_attr_t* attr,
            size_t guardsize );
```

Arguments:

attr	A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.
guardsize	The new value for the size of the thread's guard area.

Library:

libc

Description:

The *pthread_attr_setguardsize()* function sets the size of the thread's guard area in the attribute structure *attr* to *guardsize*.

If *guardsize* is `0`, threads created with *attr* have no guard area; otherwise, a guard area of at least *guardsize* bytes is provided. You can get the default *guardsize* value by specifying _SC_PAGESIZE in a call to *sysconf()*.

The guardsize attribute controls the size of the guard area for the thread's stack. This guard area helps protect against stack overflows; *guardsize* bytes of extra memory is allocated at the overflow end of the stack. If a thread overflows into this buffer, it receives a SIGSEGV signal.

The guardsize attribute is provided because:

- Stack overflow protection can waste system resources. An application that creates many threads can save system resources by

turning off guard areas if it trusts its threads not to overflow the stack.

- When threads allocate large objects on the stack, a large *guardsize* is required to detect stack overflows.

Returns:

EOK	Success.
EINVAL	Invalid pointer, *attr*, to a **`pthread_attr_t`** structure, or *guardsize* is invalid.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

If you provide a stack (using *attr*'s *stackaddr* attribute; see *pthread_attr_setstackaddr()*), the *guardsize* is ignored, and there's no stack overflow protection for that thread.

The *guardsize* argument is completely ignored when using a physical mode memory manager.

See also:

pthread_attr_getguardsize(), *pthread_attr_init()*, *pthread_attr_setstackaddr()*. *sysconf()*

pthread_attr_setinheritsched()

Set a thread's inherit-scheduling attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_setinheritsched(
                    pthread_attr_t * attr,
                    int inheritsched );
```

Arguments:

attr — A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

inheritsched — The new value for the thread's inherit-scheduling attribute:

- PTHREAD_INHERIT_SCHED — the thread inherits the scheduling policy of the parent thread.
- PTHREAD_EXPLICIT_SCHED — use the scheduling policy specified in *attr* for the thread.

Library:

libc

Description:

The *pthread_attr_setinheritsched()* function sets the thread inherit scheduling attribute in the attribute object *attr* to *inheritsched*.

The default value of the thread inherit scheduling attribute is PTHREAD_INHERIT_SCHED.

Returns:

EOK	Success.
EINVAL	Invalid thread attribute object *attr*.
ENOTSUP	Invalid thread inherit scheduling attribute *inheritsched*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_getinheritsched(), *pthread_attr_init()*, *pthread_create()*.

pthread_attr_setschedparam()

Set a thread's scheduling parameters attribute

Synopsis:

```
#include <pthread.h>
#include <sched.h>

int pthread_attr_setschedparam(
            pthread_attr_t * attr,
            const struct sched_param * param );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

param A pointer to a **sched_param** structure that defines the thread's scheduling parameters.

Library:

libc

Description:

The *pthread_attr_setschedparam()* function sets the thread scheduling parameters attribute in the thread attribute object *attr* to *param*.

The thread scheduling parameters are used only if you've set the thread inherit scheduling attribute to PTHREAD_EXPLICIT_SCHED by calling *pthread_attr_setinheritsched()*. By default, a thread inherits its parent's priority.

Returns:

EOK	Success.
EINVAL	Invalid thread attribute object *attr*.
ENOTSUP	Invalid thread scheduling parameters attribute *param*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_getschedparam(), *pthread_attr_setinheritsched()*, *pthread_attr_init()*, *pthread_create()*, **sched_param**

pthread_attr_setschedpolicy()

Set the thread scheduling policy attribute

Synopsis:

```
#include <pthread.h>
#include <sched.h>

int pthread_attr_setschedpolicy(
                pthread_attr_t* attr,
                int policy );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

policy The new value for the scheduling policy:

- SCHED_FIFO — first-in first-out scheduling.
- SCHED_RR — round-robin scheduling.
- SCHED_OTHER — currently the same as SCHED_RR.
- SCHED_NOCHANGE — don't change the policy.
- SCHED_SPORADIC — sporadic scheduling.

Library:

libc

Description:

The *pthread_attr_setschedpolicy()* function sets the thread scheduling policy attribute in the thread attribute object *attr* to *policy*.

The *policy* attribute is used only if you've set the thread inherit-scheduling attribute to PTHREAD_EXPLICIT_SCHED by calling *pthread_attr_setinheritsched()*.

For descriptions of the scheduling policies, see "Scheduling algorithms" in the chapter on the Neutrino microkernel in the *System Architecture* guide.

Returns:

EOK	Success.
EINVAL	Invalid thread attribute object *attr*.
ENOTSUP	Invalid thread scheduling policy *policy*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_getschedpolicy(), *pthread_attr_init()*, *pthread_create()*.

pthread_attr_setscope()

Set thread contention scope attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_setscope( pthread_attr_t* attr,
                           int scope );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

scope The new value for the contention scope attribute:

- PTHREAD_SCOPE_SYSTEM — schedule all threads together.

Library:

libc

Description:

The *pthread_attr_setscope()* sets the thread contention scope attribute in the thread attribute object *attr* to *scope*.

Returns:

EOK	Success.
EINVAL	Invalid thread attribute object *attr*.
ENOTSUP	Invalid thread contention scope attribute *scope*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_getscope(), *pthread_attr_init()*, *pthread_create()*.

pthread_attr_setstackaddr()

Set the thread stack address attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_setstackaddr( pthread_attr_t * attr,
                               void * stackaddr );
```

Arguments:

attr	A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.
stackaddr	A pointer to the block of memory that you want a new thread to use as its stack.

Library:

libc

Description:

The *pthread_attr_setstackaddr()* function sets the thread stack address attribute in the attribute object *attr* to *stackaddr*.

The default value for the thread stack address attribute is NULL. A thread created with a NULL stack address attribute will have a stack dynamically allocated by the system of minimum size PTHREAD_STACK_MIN. If the system allocates a stack, it reclaims the space when the thread terminates. If you allocate a stack, you must free it.

Returns:

EOK	Success.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The QNX interpretation of PTHREAD_STACK_MIN is enough memory to run a thread that does nothing:

```
void nothingthread( void )
{
    return;
}
```

See also:

pthread_attr_getstackaddr(), *pthread_attr_init()*, *pthread_create()*.

pthread_attr_setstacklazy()

Set the thread lazy-stack attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_setstacklazy(
                    pthread_attr_t * attr,
                    int lazystack );
```

Arguments:

attr A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.

lazystack One of:

- PTHREAD_STACK_LAZY — allocate physical memory for the thread stack on demand (the default).
- PTHREAD_STACK_NOTLAZY — allocate physical memory for the whole stack up front. Use this value to ensure that your server processes don't die later on because they're unable to allocate stack memory. We recommend that you set the stack size as well, because the default stack size is probably much larger than you really need.

Library:

libc

Description:

The *pthread_attr_setstacklazy()* function sets the thread stack attribute in the attribute object *attr* to *lazystack*.

Returns:

EOK	Success.
EINVAL	The thread-attribute object that *attr* points to is invalid.
ENOTSUP	The value of *lazystack* is invalid.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_getstacklazy(), *pthread_attr_setinheritsched()*

pthread_attr_setstacksize()

Set the thread stack-size attribute

Synopsis:

```
#include <pthread.h>

int pthread_attr_setstacksize( pthread_attr_t * attr,
                               size_t stacksize );
```

Arguments:

attr	A pointer to the **pthread_attr_t** structure that defines the attributes to use when creating new threads. For more information, see *pthread_attr_init()*.
stacksize	The size of the stack you want to use in new threads. The minimum value of the thread stack-size attribute is PTHREAD_STACK_MIN.

Library:

libc

Description:

The *pthread_attr_setstacksize()* function sets the thread stack size attribute in the thread attribute object *attr* to *stacksize*.

Returns:

EOK	Success.
EINVAL	The value of *stacksize* is less than PTHREAD_STACK_MIN or greater than the system limit.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The QNX interpretation of PTHREAD_STACK_MIN is enough memory to run a thread that does nothing:

```
void nothingthread( void )
{
    return;
}
```

See also:

pthread_attr_getstacksize(), *pthread_attr_init()*, *pthread_create()*.

pthread_barrier_destroy()

Destroy a barrier object

Synopsis:

```
#include <pthread.h>

int pthread_barrier_destroy( pthread_barrier_t * barrier );
```

Arguments:

barrier	A pointer to the **pthread_barrier_t** object that you want to destroy.

Library:

libc

Description:

The *pthread_barrier_destroy()* function destroys the barrier referenced by *barrier* and releases any resources used by the barrier. Subsequent use of the barrier is undefined until you reinitialize the barrier by calling *pthread_barrier_init()*.

Returns:

EBUSY	The *barrier* is in use.
EINVAL	Invalid *barrier*.
EOK	Success.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

pthread_barrier_init(), *pthread_barrier_wait()*

pthread_barrier_init()

Initialize a barrier object

Synopsis:

```
#include <pthread.h>

int pthread_barrier_init(
                    pthread_barrier_t * barrier,
                    const pthread_barrierattr_t * attr
                    unsigned int count );
```

Arguments:

barrier	A pointer to the **pthread_barrier_t** object that you want to initialize.
attr	NULL, or a pointer to a **pthread_barrierattr_t** structure that specifies the attributes that you want to use for the barrier.
count	The number of threads that must call *pthread_barrier_wait()* before any of them successfully returns from the call. This value must be greater than zero.

Library:

libc

Description:

The *pthread_barrier_init()* function allocates any resources required to use the barrier referenced by *barrier* and initializes the barrier with attributes referenced by *attr*. If *attr* is NULL, the default barrier attributes are used. The effect is the same as passing the address of a default barrier attributes object. Once it's initialized, you can use the barrier any number of times without reinitializing it.

If *pthread_barrier_init()* fails, the barrier isn't initialized.

In cases where the default barrier attributes are appropriate, you can use *PTHREAD_BARRIER_INITIALIZER()* macro to initialize barriers

that are statically allocated. The effect is equivalent to dynamic initialization by a call to *pthread_barrier_init()* with parameter *attr* specified as NULL, except that no error checks are performed.

Returns:

EAGAIN	The system lacks the necessary resources to initialize another barrier.
EBUSY	Attempt to reinitialize a barrier while it's in use.
EFAULT	A fault occurred when the kernel tried to access *barrier* or *attr*.
EINVAL	Invalid value specified by *attr*.
EOK	Success.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_barrierattr_init(), *pthread_barrier_destroy()*, *pthread_barrier_wait()*

pthread_barrier_wait()

Synchronize participating threads at the barrier

Synopsis:

```
#include <sync.h>

int pthread_barrier_wait( pthread_barrier_t * barrier );
```

Arguments:

barrier A pointer to the **pthread_barrier_t** object that you want to use to synchronize the threads. You must initialize the barrier by calling *pthread_barrier_init()*, before calling *pthread_barrier_wait()*.

Library:

libc

Description:

The *pthread_barrier_wait()* function synchronizes participating threads at the barrier referenced by *barrier*. The calling thread blocks — that is, doesn't return from *pthread_barrier_wait()* — until the required number of threads have called *pthread_barrier_wait()*, specifying the barrier.

When the required number of threads have called *pthread_barrier_wait()* specifying the barrier, the constant BARRIER_SERIAL_THREAD is returned to one unspecified thread, and zero is returned to each of the remaining threads. At this point, the barrier is reset to the state it occupied as a result of the most recent *pthread_barrier_init()* function that referenced it.

The constant BARRIER_SERIAL_THREAD is defined in **<pthread.h>**, and its value is distinct from any other value that *pthread_barrier_wait()* returns.

If a signal is delivered to a thread blocked on a barrier, on return from the signal handler, the thread resumes waiting at the barrier as if it hadn't been interrupted.

Returns:

BARRIER_SERIAL_THREAD for a single (arbitrary) thread synchronized at the barrier and zero for each of the other threads; otherwise, an error number is returned:

EINVAL The *barrier* argument isn't initialized.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_barrier_destroy(), *pthread_barrier_init()*

pthread_barrierattr_destroy()

Destroy a barrier-attributes object

Synopsis:

```
#include <pthread.h>

int pthread_barrierattr_destroy(
                    pthread_barrierattr_t * attr );
```

Arguments:

attr A pointer to the **pthread_barrierattr_t** object that you want to destroy.

Library:

libc

Description:

The *pthread_barrierattr_destroy()* function destroys the barrier-attributes object *attr*. Subsequent use of the object is undefined until you reinitialize the object by calling *pthread_barrierattr_init()*.

Once you've used a barrier-attributes object to initialize one or more barriers, any changes to the attributes object (including destroying it) don't affect any previously initialized barriers.

Returns:

EOK Success.

EINVAL Invalid barrier attribute object *attr*.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_barrier_destroy(), pthread_barrierattr_getpshared(), pthread_barrierattr_init(), pthread_barrierattr_setpshared()

pthread_barrierattr_getpshared()

Get the value of a barrier's process-shared attribute

Synopsis:

```
#include <pthread.h>

int pthread_barrierattr_getpshared(
                    const pthread_barrierattr_t * attr
                    int * pshared );
```

Arguments:

attr A pointer to the **pthread_barrierattr_t** object whose attribute you want to query. You must have initialized this object by calling *pthread_barrierattr_init()* before calling *pthread_barrierattr_getpshared()*.

pshared A pointer to a location where the function can store the value of the process-shared attribute. For information about the possible values, see *pthread_barrierattr_setpshared()*.

Library:

libc

Description:

The *pthread_barrierattr_getpshared()* function gets the value of the process-shared attribute from the attributes object referenced by *attr* and stores the value in the object referenced by *pshared*.

Returns:

EOK Success.

EINVAL Invalid barrier attribute object *attr*.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_barrier_init(), pthread_barrierattr_destroy(), pthread_barrierattr_init(), pthread_barrierattr_setpshared()

pthread_barrierattr_init()

Initialize a barrier attributes object

Synopsis:

```
#include <pthread.h>

int pthread_barrierattr_init(
                    pthread_barrierattr_t * attr );
```

Arguments:

attr A pointer to the **pthread_barrierattr_t** object that you want to initialize.

Library:

libc

Description:

The *pthread_barrierattr_init()* function initializes the barrier attributes object *attr* with the default value for all of the attributes.

Returns:

EOK	Success.
ENOMEM	Insufficient memory to initialize barrier attribute object *attr*.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_barrier_init(), *pthread_barrierattr_destroy()*,
pthread_barrierattr_getpshared(), *pthread_barrierattr_setpshared()*

pthread_barrierattr_setpshared()

Set the value of a barrier's process-shared attribute

Synopsis:

```
#include <sync.h>

int pthread_barrierattr_setpshared(
                          pthread_barrierattr_t * attr
                          int pshared );
```

Arguments:

attr A pointer to the **pthread_barrierattr_t** object whose attribute you want to set. You must have initialized this object by calling *pthread_barrierattr_init()* before calling *pthread_barrierattr_setpshared()*.

pshared The new value of the process-shared attribute; one of:

- PTHREAD_PROCESS_SHARED — allow a barrier to be operated upon by any thread that has access to the memory where the barrier is allocated.
- PTHREAD_PROCESS_PRIVATE (default behavior) — allow a barrier to be operated on only by threads created within the same process as the thread that initialized the barrier. If threads of different processes attempt to operate on such a barrier, the behavior is as if PTHREAD_PROCESS_SHARED were set.

Library:

libc

Description:

The *pthread_barrierattr_setpshared()* function sets the process-shared attribute in an initialized attributes object referenced by *attr*.

Returns:

EOK	Success.
EINVAL	The attribute object, *attr*, or the new value specified in *pshared* isn't valid.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_barrier_init() pthread_barrierattr_destroy(), pthread_barrierattr_getpshared(), pthread_barrierattr_init()

pthread_cancel()

Cancel a thread

Synopsis:

```
#include <pthread.h>

int pthread_cancel( pthread_t thread );
```

Arguments:

thread The ID of the thread that you want to cancel, which you can get when you call *pthread_create()* or *pthread_self()*.

Library:

libc

Description:

The *pthread_cancel()* function requests that the target thread *thread* be canceled (terminated). The cancellation type and state of the target determine when the cancellation takes effect.

When the cancellation is acted on, the target's cancellation cleanup handlers are called. When the last cancellation cleanup handler returns, the target's thread-specific-data destructor functions are called. When the last destructor function returns, the target is terminated. Cancellation processing in the target thread runs asynchronously with respect to the calling thread.

Returns:

EOK Success.

ESRCH No thread with thread ID *thread* exists.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cleanup_push(), *pthread_cleanup_pop()*, *pthread_cond_wait()*, *pthread_cond_timedwait()*, *pthread_exit()*, *pthread_join()*, *pthread_key_create()*, *pthread_setcancelstate()*, *pthread_setcanceltype()*, *pthread_testcancel()*, *ThreadCancel()*.

pthread_cleanup_pop()

Pop a function off of a thread's cancellation-cleanup stack

Synopsis:

```
#include <pthread.h>

void pthread_cleanup_pop( int execute );
```

Arguments:

execute Zero if you don't want to execute the handler; nonzero if you do.

Library:

libc

Description:

The *pthread_cleanup_pop()* macro pops the top cancellation-cleanup handler from the calling thread's cancellation-cleanup stack and invokes the handler if *execute* is nonzero.

☞ The *pthread_cleanup_pop()* macro expands to a few lines of code that end with a closing brace (}), but don't have a matching opening brace ({). You must pair *pthread_cleanup_pop()* with *pthread_cleanup_push()* within the same lexical scope.

Examples:

See *pthread_cleanup_push()*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cleanup_push(), *pthread_cancel()*, *pthread_exit()*

pthread_cleanup_push()

Push a function onto a thread's cancellation-cleanup stack

Synopsis:

```
#include <pthread.h>

void pthread_cleanup_push( void (routine)(void*),
                           void* arg );
```

Arguments:

routine	The handler that you want to push onto the thread's stack.
arg	A pointer to whatever data you want to pass to the function when it's called.

Library:

libc

Description:

The *pthread_cleanup_push()* function pushes the given cancellation-cleanup handler *routine* onto the calling thread's cancellation-cleanup stack.

The cancellation-cleanup handler is popped from the stack and invoked with argument *arg* when the thread:

- exits (i.e. calls *pthread_exit()*)
- acts on a cancellation request
- calls *pthread_cleanup_pop()* with a nonzero argument.

The *pthread_cleanup_push()* macro expands to a few lines of code that start with an opening brace ({), but don't have a matching closing brace (}). You must pair *pthread_cleanup_push()* with *pthread_cleanup_pop()* within the same lexical scope.

Examples:

Use a cancellation cleanup handler to free resources, such as a mutex, when a thread is terminated:

```
#include <pthread.h>

pthread_mutex_t lock = PTHREAD_MUTEX_INITIALIZER;

void unlock( void * arg )
{
   pthread_mutex_unlock( &lock );
}

void * function( void * arg )
{
   while( 1 )
   {
      pthread_mutex_lock( &lock );
      pthread_cleanup_push( &unlock, NULL );

      /*
       Any of the possible cancellation points could
       go here.
      */
      pthread_testcancel();

      pthread_cleanup_pop( 1 );
   }
}
```

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cleanup_pop(), pthread_cancel(), pthread_exit()

pthread_cond_broadcast()

Unblock threads waiting on condition

Synopsis:

```
#include <pthread.h>

int pthread_cond_broadcast( pthread_cond_t* cond );
```

Arguments:

cond A pointer to the **pthread_cond_t** object for which you want to unblock the threads.

Library:

libc

Description:

The *pthread_cond_broadcast()* function unblocks all threads currently blocked on the condition variable *cond*. The threads are unblocked in priority order.

If more than one thread at a particular priority is blocked, those threads are unblocked in FIFO order.

Returns:

EOK Success.

EFAULT A fault occurred trying to access the buffers provided.

EINVAL Invalid condition variable *cond*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_signal(), *pthread_cond_wait()*, *SyncCondvarSignal()*

pthread_cond_destroy()

Destroy condition variable

Synopsis:

```
#include <pthread.h>

int pthread_cond_destroy( pthread_cond_t* cond );
```

Arguments:

cond A pointer to the **pthread_cond_t** object that you want to destroy.

Library:

libc

Description:

The *pthread_cond_destroy()* function destroys the condition variable *cond*. After you've destroyed a condition variable, you shouldn't reuse it until you've reinitialized it by calling *pthread_cond_init()*.

Returns:

EOK	Success.
EBUSY	Another thread is blocked on the condition variable *cond*.
EINVAL	Invalid condition variable *cond*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_init(), SyncDestroy()

pthread_cond_init()

Initialize a condition variable

Synopsis:

```
#include <pthread.h>

pthread_cond_t cond = PTHREAD_COND_INITIALIZER;

int pthread_cond_init( pthread_cond_t* cond,
                       pthread_condattr_t* attr );
```

Arguments:

cond A pointer to the **pthread_cond_t** object that you want to initialize.

attr NULL, or a pointer to a **pthread_condattr_t** object that specifies the attributes that you want to use for the condvar. For more information, see *pthread_condattr_init()*.

Library:

libc

Description:

The *pthread_cond_init()* function initializes the condition variable *cond* with the attributes in the condition variable attribute object *attr*. If *attr* is NULL, *cond* is initialized with the default values for the attributes.

If the condition variable is statically allocated, you can initialize it with the default attribute values by assigning to it the macro **PTHREAD_COND_INITIALIZER**.

Condition variables have at least the following attributes defined:

PTHREAD_PROCESS_PRIVATE

The condition variable can only be accessed by threads created within the same process as the thread that initialized the condition variable.

PTHREAD_PROCESS_SHARED

Any thread that has access to the memory where the condition variable is allocated can access the condition variable.

For more information about these attributes, see *pthread_condattr_getpshared()* and *pthread_condattr_setpshared()*.

Returns:

EOK	Success.
EAGAIN	All kernel synchronization objects are in use.
EBUSY	Previously initialized condition variable, *cond*, hasn't been destroyed.
EFAULT	A fault occurred when the kernel tried to access *cond* or *attr*.
EINVAL	The value specified by *cond* is invalid.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_condattr_init(), *pthread_cond_destroy()*

pthread_cond_signal()

Unblock a thread that's waiting on a condition variable

Synopsis:

```
#include <pthread.h>

int pthread_cond_signal( pthread_cond_t* cond );
```

Arguments:

cond A pointer to the **pthread_cond_t** object for which you want to unblock the highest-priority thread.

Library:

libc

Description:

The *pthread_cond_signal()* function unblocks the highest priority thread that's waiting on the condition variable, *cond*.

If more than one thread at the highest priority is waiting, *pthread_cond_signal()* unblocks the one that has been waiting the longest.

Returns:

EOK Success.

EFAULT A fault occurred trying to access the buffers provided.

EINVAL Invalid condition variable *cond*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_broadcast(), *pthread_cond_wait()*, *SyncCondvarSignal()*.

pthread_cond_timedwait()

Wait on a condition variable, with a time limit

Synopsis:

```
#include <pthread.h>
#include <time.h>

int pthread_cond_timedwait(
            pthread_cond_t* cond,
            pthread_mutex_t* mutex,
            const struct timespec* abstime );
```

Arguments:

cond	The condition variable on which to block the thread.
mutex	The mutex associated with the condition variable.
abstime	A pointer to a **timespec** structure that specifies the maximum time to block the thread, expressed as an absolute time.

Library:

libc

Description:

The *pthread_cond_timedwait()* function blocks the calling thread on the condition variable *cond*, and unlocks the associated mutex *mutex*. The calling thread must have locked *mutex* before waiting on the condition variable. Upon return from the function, the mutex is again locked and owned by the calling thread.

The calling thread is blocked until either another thread performs a signal or broadcast on the condition variable, the absolute time specified by *abstime* has passed, a signal is delivered to the thread, or the thread is canceled (waiting on a condition variable is a cancellation point). In all cases, the thread reacquires the mutex before being unblocked.

☞ Don't use a recursive mutex with condition variables.

Returns:

EOK	Success, or the call was interrupted by a signal.
EAGAIN	Insufficient system resources are available to wait on the condition.
EFAULT	A fault occurred trying to access the buffers provided.
EINVAL	One or more of the following is true: • One or more of *cond*, *mutex* and *abstime* is invalid. • Concurrent waits or timed waits on *cond* used different mutexes. • The current thread doesn't own *mutex*.
ETIMEDOUT	The time specified by *abstime* has passed.

Examples:

Wait five seconds while trying to acquire control over a condition variable:

```
#include <errno.h>
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <time.h>
#include <unistd.h>

pthread_mutex_t m = PTHREAD_MUTEX_INITIALIZER;
pthread_cond_t c = PTHREAD_COND_INITIALIZER;

void* t(void* x)
{
    int retval;
```

```
    if (retval = pthread_mutex_lock(&m))    {
        fprintf(stderr, "pthread_mutex_lock: %s\n",
                strerror(errno));

        exit(EXIT_FAILURE);
    }

    /*
     Let pthread_cond_timedwait() break out and try
     to acquire mutex
    */
    fprintf(stderr, "sleeping...\n");
    sleep(30);

    if (retval = pthread_mutex_unlock(&m)) {
        fprintf(stderr, "pthread_mutex_unlock: %s\n",
                strerror(errno));

        exit(EXIT_FAILURE);
    }

    return 0;
}

int main(int argc, char* argv[])
{
    struct timespec to;
    int retval;

    fprintf(stderr, "starting...\n");

    /*
     Here's the interesting bit; we'll wait for
     five seconds FROM NOW when we call
     pthread_cond_timedwait().
    */
    memset(&to, 0, sizeof to);
    to.tv_sec = time(0) + 5;
    to.tv_nsec = 0;

    if (retval = pthread_mutex_lock(&m)) {
        fprintf(stderr, "pthread_mutex_lock %s\n",
                strerror(retval));

        exit(EXIT_FAILURE);
    }

    if (retval = pthread_create(0, 0, t, 0)) {
        fprintf(stderr, "pthread_create %s\n",
```

```
                strerror(retval));

        exit(EXIT_FAILURE);
    }

    if (retval = pthread_cond_timedwait(&c, &m, &to))
    {
        fprintf(stderr, "pthread_cond_timedwait %s\n",
                strerror(retval));

        exit(EXIT_FAILURE);
    }

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_broadcast(), *pthread_cond_init()*, *pthread_cond_signal()*, *pthread_cond_wait()*, *SyncCondvarWait()*, *TimerTimeout()*, **timespec**

pthread_cond_wait()

Wait on condition variable

Synopsis:

```
#include <pthread.h>

int pthread_cond_wait( pthread_cond_t* cond,
                       pthread_mutex_t* mutex );
```

Arguments:

cond A pointer to the **pthread_cond_t** object that you want the threads to block on.

mutex The mutex that you want to unlock.

Library:

libc

Description:

The *pthread_cond_wait()* function blocks the calling thread on the condition variable *cond*, and unlocks the associated mutex *mutex*. The calling thread must have locked *mutex* before waiting on the condition variable. On return from the function, the mutex is again locked and owned by the calling thread.

The calling thread is blocked until either another thread performs a signal or broadcast on the condition variable, a signal is delivered to the thread, or the thread is canceled (waiting on a condition variable is a cancellation point). In all cases, the thread reacquires the mutex before being unblocked.

☞ Don't use a recursive mutex with condition variables.

Returns:

EOK Success, or the call was interrupted by a signal.

EAGAIN Insufficient system resources are available to wait on the condition.

EFAULT A fault occurred trying to access the buffers provided.

EINVAL One or more of the following is true:

- One or more of *cond* or *mutex* is invalid.
- Concurrent waits on *cond* used different mutexes.
- The current thread doesn't own *mutex*.

Examples:

Use condition variables to synchronize producer and consumer threads:

```
#include <stdio.h>
#include <pthread.h>

pthread_mutex_t mutex = PTHREAD_MUTEX_INITIALIZER;
pthread_cond_t cond = PTHREAD_COND_INITIALIZER;
int condition = 0;
int count = 0;

int consume( void )
{
   while( 1 )
   {
      pthread_mutex_lock( &mutex );
      while( condition == 0 )
         pthread_cond_wait( &cond, &mutex );
      printf( "Consumed %d\n", count );
      condition = 0;
      pthread_cond_signal( &cond );
      pthread_mutex_unlock( &mutex );
   }

   return( 0 );
}

void*  produce( void * arg )
{
   while( 1 )
   {
      pthread_mutex_lock( &mutex );
      while( condition == 1 )
         pthread_cond_wait( &cond, &mutex );
      printf( "Produced %d\n", count++ );
      condition = 1;
      pthread_cond_signal( &cond );
```

```
      pthread_mutex_unlock( &mutex );
   }
   return( 0 );
}

int main( void )
{
   pthread_create( NULL, NULL, &produce, NULL );
   return consume();
}
```

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_broadcast(), *pthread_cond_init()*, *pthread_cond_signal()*, *pthread_cond_timedwait()*, *SyncCondvarWait()*

pthread_condattr_destroy()

Destroy a condition-variable attribute object

Synopsis:

```
#include <pthread.h>

int pthread_condattr_destroy(
                          pthread_condattr_t* attr );
```

Arguments:

attr A pointer to the **pthread_condattr_t** object that you want to destroy.

Library:

libc

Description:

The *pthread_condattr_destroy()* function destroys the condition variable attribute object *attr*. Once you've destroyed the condition-variable attribute object, don't reuse it until you've reinitialized it by calling *pthread_condattr_init()*.

Returns:

EOK	Success.
EINVAL	Invalid condition variable attribute object *attr*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

pthread_condattr_init(), *pthread_cond_init()*

pthread_condattr_getclock()

Get the clock attribute from a condition-variable attribute object

Synopsis:

```
#include <pthread.h>

int pthread_condattr_getclock(
                        const pthread_condattr_t * attr,
                        clockid_t * id );
```

Arguments:

attr A pointer to the **pthread_condattr_t** object from which you want to get the clock.

id A pointer to a **clockid_t** object where the function can store the clock ID.

Library:

libc

Description:

The *pthread_condattr_getclock()* function obtains the value of the clock attribute from the attributes object referenced by *attr*.

The clock attribute is the clock ID of the clock that's used to measure the timeout service of *pthread_cond_timedwait()*. The default value of the clock attribute refers to the system clock.

Returns:

EOK Success.

EINVAL Invalid value *attr*.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_init(), *pthread_cond_timedwait()*, *pthread_condattr_destroy()*, *pthread_condattr_getpshared()*, *pthread_condattr_init()*, *pthread_condattr_setclock()*, *pthread_condattr_setpshared()*, *pthread_create()*

pthread_condattr_getpshared()

Get the process-shared attribute from a condition variable attribute object

Synopsis:

```
#include <pthread.h>

int pthread_condattr_getpshared(
            const pthread_condattr_t* attr,
            int* pshared );
```

Arguments:

attr	A pointer to the **pthread_condattr_t** object from which you want to get the attribute.
pshared	A pointer to a location where the function can store the process-shared attribute. For the possible values, see *pthread_condattr_setpshared()*.

Library:

libc

Description:

The *pthread_condattr_getpshared()* function stores, in the memory pointed to by *pshared*, the process-shared attribute from a condition variable attribute object, *attr*.

Returns:

EOK	Success.
EINVAL	Invalid condition variable attribute object specified by *attr*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_condattr_init(), *pthread_condattr_setpshared()*, *pthread_create()*, *pthread_mutex_init()*, *pthread_cond_init()*.

pthread_condattr_init()

Initialize the attribute object for creating condition variables

Synopsis:

```
#include <pthread.h>

int pthread_condattr_init( pthread_condattr_t* attr );
```

Arguments:

attr A pointer to the **pthread_condattr_t** object that you want to initialize.

Library:

libc

Description:

The *pthread_condattr_init()* function initializes the attributes in the condition variable attribute object *attr* to default values. Pass *attr* to *pthread_cond_init()* to define the attributes of the condition variable.

Condition variables have at least the following attributes defined:

PTHREAD_PROCESS_PRIVATE

The condition variable can be accessed only by threads created within the same process as the thread that initialized the condition variable.

PTHREAD_PROCESS_SHARED

Any thread that has access to the memory where the condition variable is allocated can access the condition variable.

For more information about these attributes, see *pthread_condattr_getpshared()* and *pthread_condattr_setpshared()*.

Returns:

EOK	Success.
ENOMEM	Insufficient memory to initialize the condition variable attribute object *attr*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_condattr_destroy(), *pthread_cond_init()*

pthread_condattr_setclock()

Set the clock attribute of a condition-variable attribute object

Synopsis:

```
#include <pthread.h>

int pthread_condattr_setclock(
                      pthread_condattr_t * attr,
                      clockid_t id );
```

Arguments:

attr A pointer to the **pthread_condattr_t** object for which you want to set the clock. You must have initialized this object by calling *pthread_condattr_init()* before calling *pthread_condattr_setclock()*.

id A **clockid_t** object that specifies the ID of the clock that you want to use for the condition variable.

Library:

libc

Description:

The *pthread_condattr_setclock()* function sets the clock attribute in an initialized attributes object referenced by *attr*. If *pthread_condattr_setclock()* is called with an *id* argument that refers to a CPU-time clock, the call fails.

The clock attribute is the clock ID of the clock that you want to use to measure the timeout service of *pthread_cond_timedwait()*. The default value of the clock attribute refers to the system clock.

Returns:

EOK Success.

EINVAL Invalid value *attr*.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_init(), *pthread_cond_timedwait()*, *pthread_condattr_destroy()*, *pthread_condattr_getclock()*, *pthread_condattr_getpshared()*, *pthread_condattr_init()*, *pthread_condattr_setpshared()*, *pthread_create()*

pthread_condattr_setpshared()

Set the process-shared attribute in a condition variable attribute object

Synopsis:

```
#include <pthread.h>

int pthread_condattr_setpshared(
                          pthread_condattr_t* attr,
                          int pshared );
```

Arguments:

attr A pointer to the **pthread_condattr_t** object for which you want to set the attribute.

pshared The new value of the process-shared attribute; one of:

- PTHREAD_PROCESS_SHARED — any thread that has access to the memory where the condition variable is allocated can operate on it, even if the condition variable is allocated in memory that's shared by multiple processes.
- PTHREAD_PROCESS_PRIVATE — the condition variable can be accessed only by threads created within the same process as the thread that initialized the condition variable; if threads from other processes try to access the PTHREAD_PROCESS_PRIVATE condition variable, the behavior is undefined.

Library:

libc

Description:

The *pthread_condattr_setpshared()* function sets the process-shared attribute in a condition variable attribute object, *attr* to the value given by *pshared*.

The default value of the process-shared attribute is PTHREAD_PROCESS_PRIVATE.

Returns:

EOK	Success.
EINVAL	The condition variable attribute object specified by *attr*, or the new value specified in *pshared* isn't valid.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_condattr_init(), *pthread_condattr_getpshared()*, *pthread_create()*, *pthread_mutex_init()*, *pthread_cond_init()*

pthread_create()

Create a thread

Synopsis:

```
#include <pthread.h>

int pthread_create( pthread_t* thread,
                    const pthread_attr_t* attr,
                    void* (*start_routine)(void* ),
                    void* arg );
```

Arguments:

thread — NULL, or a pointer to a **pthread_t** object where the function can store the thread ID of the new thread.

attr — A pointer to a **pthread_attr_t** structure that specifies the attributes of the new thread. Instead of manipulating the members of this structure directly, use *pthread_attr_init()* and the *pthread_attr_set_** functions. For the exceptions, see "QNX extensions," below.

If *attr* is NULL, the default attributes are used (see *pthread_attr_init()*).

If you modify the attributes in *attr* after creating the thread, the thread's attributes aren't affected.

start_routine — The routine where the thread begins, with *arg* as its only argument. If *start_routine()* returns, there's an implicit call to *pthread_exit()*, using the return value of *start_routine()* as the exit status.

The thread in which *main()* was invoked behaves differently. When it returns from *main()*, there's an implicit call to *exit()*, using the return value of *main()* as the exit status.

arg — The argument to pass to *start_routine*.

Library:

libc

Description:

The *pthread_create()* function creates a new thread, with the attributes specified in the thread attribute object *attr*. The created thread inherits the signal mask of the parent thread, and its set of pending signals is empty.

☞

- You must call *pthread_join()* or *pthread_detach()* for threads created with a *detachstate* attribute of PTHREAD_CREATE_JOINABLE (the default) before all of the resources associated with the thread can be released at thread termination.
- If you set the *stacksize* member of *attr*, the thread's actual stack size is rounded up to a multiple of the system page size (which you can get by using the _SC_PAGESIZE constant in a call to *sysconf()*) if the system allocates the stack (the *stackaddr* member of *attr* is set to NULL). If the stack was previously allocated by the application, its size isn't changed.

QNX extensions

If you adhere to the POSIX standard, there are some thread attributes that you can't specify before creating the thread:

- You can't disable cancellation for a thread.
- You can't set the thread's cancellation type.
- You can't specify what happens when a signal is delivered to the thread.

There are no *pthread_attr_set_** functions for these attributes.

As an QNX extension, you can OR the following bits into the *flags* member of the **pthread_attr_t** structure before calling *pthread_create()*:

PTHREAD_CANCEL_ENABLE

Cancellation requests may be acted on according to the cancellation type (the default).

PTHREAD_CANCEL_DISABLE

Cancellation requests are held pending.

PTHREAD_CANCEL_ASYNCHRONOUS

If cancellation is enabled, new or pending cancellation requests may be acted on immediately.

PTHREAD_CANCEL_DEFERRED

If cancellation is enabled, cancellation requests are held pending until a cancellation point (the default).

PTHREAD_MULTISIG_ALLOW

Terminate all the threads in the process (the POSIX default).

PTHREAD_MULTISIG_DISALLOW

Terminate only the thread that received the signal.

After creating the thread, you can change the cancellation properties by calling *pthread_setcancelstate()* and *pthread_setcanceltype()*.

Returns:

EAGAIN	Insufficient system resources to create thread.
EFAULT	An error occurred trying to access the buffers or the *start_routine* provided.
EINVAL	Invalid thread attribute object *attr*.
EOK	Success.

Examples:

Create a thread in a detached state:

```
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>

void*  function( void*  arg )
{
   printf( "This is thread %d\n", pthread_self() );
   return( 0 );
}

int main( void )
{
   pthread_attr_t attr;

   pthread_attr_init( &attr );
   pthread_attr_setdetachstate(
      &attr, PTHREAD_CREATE_DETACHED );
   pthread_create( NULL, &attr, &function, NULL );

   /* Allow threads to run for 60 seconds. */
   sleep( 60 );
   return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_attr_init(), pthread_exit(), pthread_setcancelstate(), pthread_setcanceltype(), sysconf(), ThreadCreate()

pthread_detach()

Detach a thread from a process

Synopsis:

```
#include <pthread.h>

int pthread_detach( pthread_t thread );
```

Arguments:

thread The ID of the thread that you want to detach, which you can get when you call *pthread_create()* or *pthread_self()*.

Library:

libc

Description:

The *pthread_detach()* function detaches the thread with the given ID from its process. When a detached thread terminates, all system resources allocated to that thread are immediately reclaimed.

Returns:

EOK	Success.
EINVAL	The thread *thread* is already detached.
ESRCH	The thread *thread* doesn't exist.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

pthread_join(), *ThreadDetach()*.

pthread_equal()

Compare two thread IDs

Synopsis:

```
#include <pthread.h>

int pthread_equal( pthread_t t1,
                   pthread_t t2 );
```

Arguments:

t1, *t2* The thread IDs that you want to compare. You can get the IDs when you call *pthread_create()* or *pthread_self()*.

Library:

libc

Description:

The *pthread_equal()* function compares the thread IDs of *t1* and *t2*. It doesn't check to see if they're valid thread IDs.

Returns:

A nonzero value

The *t1* and *t2* thread IDs are equal.

0 The thread IDs aren't equal.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_create(), *pthread_self()*

pthread_exit()

Terminate a thread

Synopsis:

```
#include <pthread.h>

void pthread_exit( void* value_ptr );
```

Arguments:

value_ptr A pointer to a value that you want to be made available to any thread joining the thread that you're terminating.

Library:

libc

Description:

The *pthread_exit()* function terminates the calling thread. If the thread is joinable, the value *value_ptr* is made available to any thread joining the terminating thread (only one thread can get the return status). If the thread is detached, all system resources allocated to the thread are immediately reclaimed.

Before the thread is terminated, any cancellation cleanup handlers that have been pushed are popped and executed, and any thread-specific-data destructor functions are executed. Thread termination doesn't implicitly release any process resources such as mutexes or file descriptors, or perform any process-cleanup actions such as calling *atexit()* handlers.

An implicit call to *pthread_exit()* is made when a thread other than the thread in which *main()* was first invoked returns from the start routine that was used to create it. The return value of the start routine is used as the thread's exit status.

☞ Don't call *pthread_exit()* from cancellation-cleanup handlers or thread-specific-data destructor functions.

For the last process thread, *pthread_exit()* behaves as if you called *exit*(0).

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

atexit(), exit(), pthread_create(), pthread_cleanup_push(), pthread_cleanup_pop(), pthread_join(), ThreadDestroy().

pthread_getconcurrency()

Get the level of thread concurrency

Synopsis:

```
#include <pthread.h>

int pthread_getconcurrency( void );
```

Library:

libc

Description:

QNX doesn't support the multiplexing of user threads on top of several kernel scheduled entities. As such, the *pthread_setconcurrency()* and *pthread_getconcurrency()* functions are provided for source code compatibility but they have no effect when called. To maintain the function semantics, the *new_level* parameter is saved when *pthread_setconcurrency()* is called so that a subsequent call to *pthread_getconcurrency()* returns the same value.

Returns:

The concurrency level set by a previous call to *pthread_setconcurrency()*, or 0 if there was no previous call.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_setconcurrency()

pthread_getcpuclockid()

Return the clock ID of the CPU-time clock from a specified thread

Synopsis:

```
#include <sys/types.h>
#include <time.h>
#include <pthread.h>

extern int pthread_getcpuclockid(
                          pthread_t id,
                          clockid_t* clock_id);
```

Arguments:

thread The ID of the thread that you want to get the clock ID for, which you can get when you call *pthread_create()* or *pthread_self()*.

clock_id A pointer to a **clockid_t** object where the function can store the clock ID.

Library:

libc

Description:

The *pthread_getcpuclockid()* function returns the clock ID of the CPU-time clock of the thread specified by *id*, if the thread specified by *id* exists.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

ESRCH The value specified by *id* doesn't refer to an existing thread.

Classification:

POSIX 1003.1d (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_getcpuclockid(), *clock_getres()*, *clock_gettime()*, *ClockId()*, *clock_settime()*, *pthread_getcpuclockid()*, *timer_create()*

pthread_getschedparam()

Get a thread's scheduling parameters

Synopsis:

```
#include <pthread.h>

int pthread_getschedparam(
                const pthread_t thread,
                int *policy,
                struct sched_param *param );
```

Arguments:

thread The ID of the thread that you want to get the scheduling parameters for. You can get a thread ID by calling *pthread_create()* or *pthread_self()*.

policy A pointer to a location where the function can store the scheduling policy; one of SCHED_FIFO, SCHED_RR, SCHED_SPORADIC, or SCHED_OTHER.

param A pointer to a **sched_param** structure where the function can store the scheduling parameters.

Library:

libc

Description:

The *pthread_getschedparam()* function gets the scheduling policy and associated scheduling parameters of thread *thread* and places them in *policy* and *param*.

Returns:

EOK Success.

EFAULT A fault occurred trying to access the buffers provided.

ESRCH Invalid thread ID *thread*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_create(), *pthread_setschedparam()*, **sched_param**

pthread_getspecific()

Get a thread-specific data value

Synopsis:

```
#include <pthread.h>

void* pthread_getspecific( pthread_key_t key );
```

Arguments:

key The key associated with the data that you want to get. See *pthread_key_create()*.

Library:

libc

Description:

The *pthread_getspecific()* function returns the thread-specific data value currently bound to the thread-specific-data key *key* in the calling thread, or NULL if no value is bound or the key doesn't exist. You can call this function from a thread-specific-data destructor function.

☞ You must call this function with a key that you got from *pthread_key_create()*. You can't use a key after destroying it with *pthread_key_delete()*.

Returns:

The data value, or NULL.

Examples:

See *pthread_key_create()*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_key_create(), *pthread_key_delete()*, *pthread_setspecific()*.

pthread_join()

Join thread

Synopsis:

```
#include <pthread.h>

int pthread_join( pthread_t thread,
                  void** value_ptr );
```

Arguments:

thread	The target thread whose termination you're waiting for.
value_ptr	NULL, or a pointer to a location where the function can store the value passed to *pthread_exit()* by the target thread.

Library:

libc

Description:

The *pthread_join()* function blocks the calling thread until the target thread *thread* terminates, unless *thread* has already terminated. If *value_ptr* is non-NULL and *pthread_join()* returns successfully, then the value passed to *pthread_exit()* by the target thread is placed in *value_ptr*. If the target thread has been canceled then *value_ptr* is set to PTHREAD_CANCELED.

The non-POSIX *pthread_timedjoin()* function is similar to *pthread_join()*, except that an error is returned if the join doesn't occur before a given time.

The target thread must be joinable. Multiple *pthread_join()*, *pthread_timedjoin()*, *ThreadJoin()*, and *ThreadJoin_r()* calls on the same target thread aren't allowed. When *pthread_join()* returns successfully, the target thread has been terminated.

Returns:

EOK	Success.
EBUSY	The thread *thread* is already being joined.
EDEADLK	The thread *thread* is the calling thread.
EFAULT	A fault occurred trying to access the buffers provided.
EINTR	The function call was interrupted.
EINVAL	The thread *thread* isn't joinable.
ESRCH	The thread *thread* doesn't exist.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_create(), *pthread_detach()*, *pthread_exit()*, *pthread_timedjoin()*, *ThreadJoin()*, *ThreadJoin_r()*

pthread_key_create()

Create a thread-specific data key

Synopsis:

```
#include <pthread.h>

int pthread_key_create( pthread_key_t * key,
                        void (*destructor)( void * ) );
```

Arguments:

key	A pointer to a **pthread_key_t** object where the function can store the new key.
destructor	NULL, or a function to be called when you destroy the key.

Library:

libc

Description:

The *pthread_key_create()* function creates a thread-specific data key that's available to all threads in the process and binds an optional destructor function *destructor* to the key. If the function completes successfully the new key is returned in *key*.

☞ Although the same key may be used by different threads, the values bound to the key using *pthread_setspecific()* are maintained on a per-thread basis and persist only for the lifetime of the thread.

When you create a key, the value NULL is bound with the key in all active threads. When you create a thread, the value NULL is bound to all defined keys in the new thread.

You can optionally associate a destructor function with each key value. At thread exit, if the key has a non-NULL destructor pointer, and the thread has a non-NULL value bound to the key, the destructor function is called with the bound value as its only argument. The

order of destructor calls is unspecified if more than one destructor exists for a thread when it exits.

If, after all destructor functions have been called for a thread, there are still non-NULL bound values, the destructor function is called repeatedly a maximum of PTHREAD_DESTRUCTOR_ITERATIONS times for each non-NULL bound value.

Returns:

EOK	Success.
EAGAIN	Insufficient system resources to create key or PTHREAD_KEYS_MAX has been exceeded.
ENOMEM	Insufficient memory to create key.

Examples:

This example shows how you can use thread-specific data to provide per-thread data in a thread-safe function:

```
#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>

pthread_key_t buffer_key;

void buffer_key_destruct( void *value )
{
    free( value );
    pthread_setspecific( buffer_key, NULL );
}

char *lookup( void )
{
    char *string;

    string = (char *)pthread_getspecific( buffer_key );
    if( string == NULL ) {
        string = (char *) malloc( 32 );
        sprintf( string, "This is thread %d\n", pthread_self() );
        pthread_setspecific( buffer_key, (void *)string );
    }
```

```
    return( string );
}

void *function( void *arg )
{
    while( 1 ) {
        puts( lookup() );
    }

    return( 0 );
}

int main( void )
{
    pthread_key_create( &buffer_key,
                        &buffer_key_destruct );
    pthread_create( NULL, NULL, &function, NULL );

    /* Let the threads run for 60 seconds. */
    sleep( 60 );

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The *pthread_key_create()* function is part of the POSIX 1003.1-1996 draft standard; its specific behavior may vary from system to system.

Before each destructor is called, the thread's value for the corresponding key is set to NULL. Calling:

```
pthread_setspecific( key, NULL );
```

in a key destructor isn't required; this lets you use the same destructor for several keys.

See also:

pthread_getspecific(), *pthread_setspecific()*, *pthread_key_delete()*

pthread_key_delete()

Delete a thread-specific data key

Synopsis:

```
#include <pthread.h>

int pthread_key_delete( pthread_key_t key );
```

Arguments:

key The key, which you created by calling *pthread_key_create()*, that you want to delete.

Library:

libc

Description:

The *pthread_key_delete()* function deletes the thread-specific data key *key* that you previously created with *pthread_key_create()*. The destructor function bound to *key* isn't called by this function, and won't be called at thread termination. You can call this function from a thread specific data destructor function.

If you need to release any data bound to the key in any threads, do so before deleting the key.

Returns:

EOK	Success.
EINVAL	Invalid thread-specific data key *key*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_key_create()

pthread_kill()

Send a signal to a thread

Synopsis:

```
#include <signal.h>

int pthread_kill( pthread_t thread,
                  int sig );
```

Arguments:

thread	The ID of the thread that you want to send the signal to, which you can get when you call *pthread_create()* or *pthread_self()*.
sig	The signal that you want to send, or 0 if you just want to check for errors.

Library:

libc

Description:

The *pthread_kill()* function sends the signal *sig* to the thread *thread*. The target thread and calling thread must be in the same process. If *sig* is zero, error checking is performed but no signal is sent.

Returns:

EOK	Success.
EAGAIN	Insufficient system resources are available to deliver the signal.
ESRCH	Invalid thread ID *thread*.
EINVAL	Invalid signal number *sig*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

kill(), ThreadDestroy()

pthread_mutex_destroy()

Destroy a mutex

Synopsis:

```
#include <pthread.h>

int pthread_mutex_destroy( pthread_mutex_t* mutex );
```

Arguments:

mutex A pointer to the **pthread_mutex_t** object that you want to destroy.

Library:

libc

Description:

The *pthread_mutex_destroy()* function destroys the unlocked mutex *mutex*.

You can only destroy a locked mutex provided you're the owner of that mutex.

☞ Once you've destroyed a mutex, don't reuse it without reinitializing it by calling *pthread_mutex_init()*.

Returns:

EOK	Success.
EBUSY	The *mutex* is locked by another thread.
EINVAL	Invalid mutex *mutex*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_init(), SyncDestroy(), SyncMutexRevive()

pthread_mutex_getprioceiling()

Get a mutex's priority ceiling

Synopsis:

```
#include <pthread.h>

int pthread_mutex_getprioceiling(
                      const pthread_mutex_t* mutex,
                      int* prioceiling );
```

Arguments:

mutex	A pointer to the **pthread_mutex_t** object that you want to priority ceiling for.
prioceiling	A pointer to a location where the function can store the priority ceiling.

Library:

libc

Description:

The *pthread_mutex_getprioceiling()* function returns the priority ceiling of *mutex* in *prioceiling*.

Returns:

EOK	Success.
EINVAL	The mutex specified by *mutex* doesn't currently exist.
EPERM	The calling thread doesn't have permission to get the priority ceiling.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_setprioceiling()

pthread_mutex_init()

Initialize mutex

Synopsis:

```
#include <pthread.h>

pthread_mutex_t mutex = PTHREAD_MUTEX_INITIALIZER;

int pthread_mutex_init(
            pthread_mutex_t* mutex,
            const pthread_mutexattr_t* attr );
```

Arguments:

mutex A pointer to the **pthread_mutex_t** object that you want to initialize.

attr NULL, or a pointer to a **pthread_mutexattr_t** object that specifies the attributes that you want to use for the mutex. For more information, see *pthread_mutexattr_init()*.

Library:

libc

Description:

The *pthread_mutex_init()* function initializes the given mutex object, using the attributes specified by the mutex attributes object *attr*. If *attr* is NULL then the mutex is initialized with the default attributes (see *pthread_mutexattr_init()*). After initialization, the mutex is in an unlocked state.

You can initialize a statically allocated mutex with the default attributes by assigning to it the macro PTHREAD_MUTEX_INITIALIZER or PTHREAD_RMUTEX_INITIALIZER (for recursive mutexes).

Returns:

EOK	Success.
EAGAIN	All kernel synchronization objects are in use.
EBUSY	The given mutex was previously initialized and hasn't been destroyed.
EFAULT	A fault occurred when the kernel tried to access *mutex* or *attr*.
EINVAL	The value specified by *attr* is invalid.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutexattr_init(), *pthread_mutex_destroy()*, *SyncTypeCreate()*

pthread_mutex_lock()

Lock a mutex

Synopsis:

```
#include <pthread.h>

int pthread_mutex_lock( pthread_mutex_t* mutex );
```

Arguments:

mutex A pointer to the **pthread_mutex_t** object that you want to lock.

Library:

libc

Description:

The *pthread_mutex_lock()* function locks the mutex object referenced by *mutex*. If the mutex is already locked, then the calling thread blocks until it has acquired the mutex. When the function returns, the mutex object is locked and owned by the calling thread.

If the mutex allows recursive behavior, a call to *pthread_mutex_lock()* while you own the mutex succeeds. You can allow recursive behavior by:

- statically initializing the mutex to PTHREAD_RMUTEX_INITIALIZER

  Or:

- using *pthread_mutexattr_setrecursive()* to set the attribute to PTHREAD_RECURSIVE_ALLOW before calling *pthread_mutex_init()*.

If the mutex is recursive, you must call *pthread_mutex_unlock()* for each corresponding call to lock the mutex. The default POSIX behavior doesn't allow recursive mutexes, and returns EDEADLK.

If a signal is delivered to a thread that's waiting for a mutex, the thread resumes waiting for the mutex on returning from the signal handler.

Returns:

EOK	Success.
EAGAIN	Insufficient system resources available to lock the mutex.
EDEADLK	The calling thread already owns *mutex*, and the mutex doesn't allow recursive behavior.
EINVAL	Invalid mutex *mutex*.

Examples:

This example shows how you can use a mutex to synchronize access to a shared variable. In this example, *function1()* and *function2()* both attempt to access and modify the global variable *count*. Either thread could be interrupted between modifying *count* and assigning its value to the local *tmp* variable. Locking *mutex* prevents this from happening; if one thread has *mutex* locked, the other thread waits until it's unlocked, before continuing.

```
#include <stdio.h>
#include <pthread.h>

pthread_mutex_t mutex = PTHREAD_MUTEX_INITIALIZER;
int count = 0;

void* function1( void* arg )
{
    int tmp = 0;

    while( 1 ) {
        pthread_mutex_lock( &mutex );
        tmp = count++;
        pthread_mutex_unlock( &mutex );
        printf( "Count is %d\n", tmp );

        /* snooze for 1 second */
        sleep( 1 );
    }

    return 0;
}
```

```
void* function2( void* arg )
{
    int tmp = 0;

    while( 1 ) {
        pthread_mutex_lock( &mutex );
        tmp = count--;
        pthread_mutex_unlock( &mutex );
        printf( "** Count is %d\n", tmp );

        /* snooze for 2 seconds */
        sleep( 2 );
    }

    return 0;
}

int main( void )
{
    pthread_create( NULL, NULL, &function1, NULL );
    pthread_create( NULL, NULL, &function2, NULL );

    /* Let the threads run for 60 seconds. */
    sleep( 60 );

    return 0;
}
```

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_init(), pthread_mutexattr_setrecursive(), pthread_mutex_trylock(), pthread_mutex_unlock(), SyncMutexLock()

pthread_mutex_setprioceiling()

Set a mutex's priority ceiling

Synopsis:

```
#include <pthread.h>

int pthread_mutex_setprioceiling(
                        pthread_mutex_t* mutex,
                        int prioceiling,
                        int* old_ceiling );
```

Arguments:

mutex	A pointer to the **pthread_mutex_t** object that you want to priority ceiling for.
prioceiling	The new value for the priority ceiling.
old_ceiling	A pointer to a location where the function can store the old value.

Library:

libc

Description:

The *pthread_mutex_setprioceiling()* function locks *mutex* (or blocks until it can lock it), changes its priority ceiling to *prioceiling*, and releases it. When the change is successful, the previous priority ceiling is returned in *old_ceiling*.

Returns:

EOK	Success.
EINVAL	The mutex specified by *mutex* doesn't currently exist, or the priority requested by *prioceiling* is out of range.
EPERM	The calling thread doesn't have permission to set the priority ceiling.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_getprioceiling()

pthread_mutex_timedlock()

Attempt to lock mutex

Synopsis:

```
#include <pthread.h>
#include <time.h>

int pthread_mutex_timedlock(
                    pthread_mutex_t * mutex,
                    const struct timespec * abs_timeout );
```

Arguments:

mutex	The mutex that you want to lock.
abs_timeout	A pointer to a **timespec** structure that specifies the maximum time to wait to lock the mutex, expressed as an absolute time.

Library:

libc

Description:

The *pthread_mutex_timedlock()* function is called to lock the mutex object referenced by *mutex*. If the mutex is already locked, the calling thread blocks until the mutex becomes available as in the *pthread_mutex_lock* function. If the mutex can't be locked without waiting for another thread to unlock the mutex, the wait is terminated when the specified timeout expires.

The timeout expires when the absolute time specified by *abs_timeout* passes, as measured by the clock on which timeouts are based (i.e., when the value of that clock equals or exceeds *abs_timeout*), or if the absolute time specified by *abs_timeout* has already been passed at the time of the call.

The timeout is based on the CLOCK_REALTIME clock. The **timespec** datatype is defined in the **<time.h>** header.

If the mutex can be locked immediately, the validity of the *abs_timeout* parameter isn't checked, and the function won't fail with a timeout.

As a consequence of the priority inheritance rules (for mutexes initialized with the PRIO_INHERIT protocol), if a timed mutex wait is terminated because its timeout expires, the priority of the owner of the mutex is adjusted as necessary to reflect the fact that this thread is no longer among the threads waiting for the mutex.

Returns:

Zero on success, or an error number to indicate the error.

Errors:

EAGAIN	The mutex couldn't be acquired because the maximum number of recursive locks for the mutex has been exceeded.
EDEADLK	The current thread already owns the mutex.
EINVAL	The mutex was created with the protocol attribute having the value PTHREAD_PRIO_PROTECT and the calling thread's priority is higher than the mutex' current priority ceiling; the process or thread would have blocked, and the *abs_timeout* parameter specified a nanoseconds field value less than zero or greater than or equal to 1000 million; or the value specified by *mutex* doesn't refer to an initialized mutex object.
ETIMEDOUT	The mutex couldn't be locked before the specified timeout expired.

Classification:

POSIX 1003.1d (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_destroy(), *pthread_mutex_lock()*, *pthread_mutex_trylock()*, *pthread_mutex_unlock()*, **`timespec`**

pthread_mutex_trylock()

Attempt to lock a mutex

Synopsis:

```
#include <pthread.h>

int pthread_mutex_trylock( pthread_mutex_t* mutex );
```

Arguments:

mutex A pointer to the **pthread_mutex_t** object that you want to try to lock.

Library:

libc

Description:

The *pthread_mutex_trylock()* function attempts to lock the mutex *mutex*, but doesn't block the calling thread if the mutex is already locked.

Returns:

EOK	Success.
EAGAIN	Insufficient resources available to lock the mutex.
EBUSY	The *mutex* was already locked.
EINVAL	Invalid mutex *mutex*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_lock(), *pthread_mutex_unlock()*

pthread_mutex_unlock()

Unlock mutex

Synopsis:

```
#include <pthread.h>

int pthread_mutex_unlock( pthread_mutex_t* mutex );
```

Arguments:

mutex A pointer to the **pthread_mutex_t** object that you want to unlock.

Library:

libc

Description:

The *pthread_mutex_unlock()* function unlocks the mutex *mutex*. The mutex should be owned by the calling thread. If there are threads blocked on the mutex then the highest priority waiting thread is unblocked and becomes the next owner of the mutex.

If *mutex* has been locked more than once, it must be unlocked the same number of times before the next thread is given ownership of the mutex. This only works for recursive mutexes.

Returns:

EOK	Success.
EINVAL	Invalid mutex *mutex*.
EPERM	Current thread doesn't own *mutex*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_lock(), pthread_mutex_trylock(), SyncMutexUnlock()

pthread_mutexattr_destroy()

Destroy mutex attribute object

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_destroy(
            pthread_mutexattr_t* attr );
```

Arguments:

attr A pointer to the **pthread_mutexattr_t** object that you want to destroy.

Library:

libc

Description:

The *pthread_mutexattr_destroy()* function destroys the mutex attribute object *attr*.

☞ Once you've destroyed a mutex attribute object, don't reuse it without reinitializing it by calling *pthread_mutexattr_init()*.

Returns:

EOK	Success.
EINVAL	Invalid mutex attribute object *attr*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutexattr_init(), pthread_mutex_init()

pthread_mutexattr_getprioceiling()

Get the priority ceiling of a mutex attribute object

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_getprioceiling(
            const pthread_mutexattr_t* attr,
            int* prioceiling );
```

Arguments:

attr	A pointer to the **pthread_mutexattr_t** object that you want to get the attribute from.
prioceiling	A pointer to a location where the function can store the priority ceiling.

Library:

libc

Description:

The *pthread_mutexattr_getprioceiling()* function sets *prioceiling* to the current mutex attribute *attr*'s scheduling priority ceiling. The mutex attribute object *attr* must have been previously created with *pthread_mutexattr_init()*.

Returns:

EOK	Success.
EINVAL	Invalid value specified by *attr* or *prioceiling*.
EPERM	The caller doesn't have the privilege to perform the operation.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_init(), *pthread_create()*, *pthread_mutex_init()*, *pthread_mutexattr_getprotocol()*, *pthread_mutexattr_getrecursive()*, *pthread_mutexattr_setprioceiling()*, *pthread_mutexattr_setrecursive()*

pthread_mutexattr_getprotocol()

Get a mutex's scheduling protocol

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_getprotocol(
            pthread_mutexattr * attr,
            int * protocol );
```

Arguments:

attr A pointer to the **pthread_mutexattr_t** object that you want to get the attribute from.

protocol A pointer to a location where the function can store the scheduling protocol.

Library:

libc

Description:

The *pthread_mutexattr_getprotocol()* function sets *protocol* to the current mutex attribute *attr*'s scheduling protocol. The structure pointed to by *attr* must have been previously created with *pthread_mutexattr_init()*.

The *protocol* attribute defines the protocol for using mutexes: Currently, *protocol* may be set to:

PTHREAD_PRIO_INHERIT

When a thread is blocking higher-priority threads by locking one or more mutexes with this attribute, the thread's priority is raised to that of the highest priority thread waiting on the PTHREAD_PRIO_INHERIT mutex.

PTHREAD_PRIO_PROTECT

The thread executes at the highest priority or priority ceilings of all the mutexes owned by the thread and initialized with

PTHREAD_PRIO_PROTECT, whether other threads are blocked or not.

A thread holding a PTHREAD_PRIO_INHERIT mutex won't be moved to the tail of the scheduling queue if its original priority is changed (by a call to *pthread_schedsetparam()*, for example). This remains true if the thread unlocks the PTHREAD_PRIO_INHERIT mutex.

The POSIX *protocol* of PTHREAD_PRIO_NONE isn't currently supported.

Returns:

EOK	Success.
EINVAL	Invalid mutex attribute *attr*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutexattr_setprotocol(), *pthread_mutexattr_setrecursive()*

pthread_mutexattr_getpshared()

Get the process-shared attribute from a mutex attribute object

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_getpshared(
            const pthread_mutexattr_t* attr,
            int* pshared );
```

Arguments:

attr A pointer to the **pthread_mutexattr_t** object that you want to get the attribute from.

pshared A pointer to a location where the function can store the process-shared attribute.

Library:

libc

Description:

The *pthread_mutexattr_getpshared()* function gets the process-shared attribute from the mutex attribute object *attr* and stores it in the memory pointed to by *pshared*.

If the process-shared attribute is set to PTHREAD_PROCESS_SHARED, any thread that has access to the memory where the condition variable is allocated can operate on it, even if the condition variable is allocated in memory that's shared by multiple processes.

If the process-shared attribute is PTHREAD_PROCESS_PRIVATE, the condition variable can only be accessed by threads created within the same process as the thread that initialized the condition variable; if threads from other processes try to access the PTHREAD_PROCESS_PRIVATE condition variable, the behavior is undefined. The default value of the process-shared attribute is PTHREAD_PROCESS_PRIVATE.

Returns:

EOK	Success.
EINVAL	The mutex attribute object specified by *attr* is invalid.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_init(), *pthread_create()*, *pthread_mutex_init()*, *pthread_mutexattr_setpshared()*, *pthread_mutexattr_setrecursive()*

pthread_mutexattr_getrecursive()

Get the recursive attribute from a mutex attribute object

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_getrecursive(
        const pthread_mutexattr_t* attr,
        int* recursive );
```

Arguments:

attr	A pointer to the **pthread_mutexattr_t** object that you want to get the attribute from.
pshared	A pointer to a location where the function can store the recursive attribute.

Library:

libc

Description:

The *pthread_mutexattr_getrecursive()* function gets the recursive attribute from the mutex attribute object *attr* and stores it in *recursive*.

If the recursive attribute is set to PTHREAD_RECURSIVE_ENABLE, a thread that has already locked the mutex can lock it again without blocking. If the recursive attribute is set to PTHREAD_RECURSIVE_DISABLE, any thread that tries to lock the mutex will block, if that mutex is already locked.

The default value of the recursive attribute is PTHREAD_RECURSIVE_DISABLE.

Returns:

EOK	Success.
EINVAL	Invalid mutex attribute object *attr*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutexattr_init(), *pthread_mutexattr_setrecursive()*

pthread_mutexattr_gettype()

Get a mutex type

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_gettype(
                        const pthread_mutexattr_t * attr,
                        int * type );
```

Arguments:

attr A pointer to the **pthread_mutexattr_t** object that you want to get the attribute from.

type A pointer to a location where the function can store the type.

Library:

libc

Description:

The *pthread_mutexattr_gettype()* function gets the mutex type attribute in the *type* parameter. Valid mutex types include:

PTHREAD_MUTEX_NORMAL

No deadlock detection. A thread that attempts to relock this mutex without first unlocking it deadlocks. Attempts to unlock a mutex locked by a different thread or attempts to unlock an unlocked mutex result in undefined behavior.

PTHREAD_MUTEX_ERRORCHECK

Provides error checking. A thread returns with an error when it attempts to:

- Relock this mutex without first unlocking it.
- Unlock a mutex that another thread has locked.
- Unlock an unlocked mutex.

PTHREAD_MUTEX_RECURSIVE

A thread that attempts to relock this mutex without first unlocking it succeeds in locking the mutex. The relocking deadlock that can occur with mutexes of type PTHREAD_MUTEX_NORMAL can't occur with this mutex type. Multiple locks of this mutex require the same number of unlocks to release the mutex before another thread can acquire the mutex. A thread that attempts to unlock a mutex that another thread has locked, or unlock an unlocked mutex, returns with an error.

PTHREAD_MUTEX_DEFAULT

The default value of the *type* attribute. Attempts to recursively lock a mutex of this type, or unlock a mutex of this type that isn't locked by the calling thread, or unlock a mutex of this type that isn't locked, results in undefined behavior.

Returns:

Zero, and the value of the *type* attribute of *attr* is stored in the object referenced by the *type* parameter; otherwise, an error.

Errors:

EINVAL Invalid value specified by *attr*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

An application shouldn't use a PTHREAD_MUTEX_RECURSIVE mutex with condition variables because the implicit unlock performed for a *pthread_cond_wait()* or *pthread_cond_timedwait()* may not actually release the mutex (if it's been locked multiple times). If this happens, no other thread can satisfy the condition of the predicate.

See also:

pthread_cond_timedwait(), *pthread_cond_wait()*, *pthread_mutexattr_settype()*

pthread_mutexattr_init()

Initialize a mutex attribute object

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_init(
            const pthread_mutexattr_t* attr );
```

Arguments:

attr A pointer to the **pthread_mutexattr_t** object that you want to initialize.

Library:

libc

Description:

The *pthread_mutexattr_init()* function initializes the attributes in the mutex attribute object *attr* to their default values. After initializing a mutex attribute object, you can use it to initialize one or more mutexes by calling *pthread_mutex_init()*.

The mutex attributes and their default values are:

protocol	PTHREAD_PRIO_INHERIT
recursive	PTHREAD_RECURSIVE_DISABLE

After calling this function, you can use the *pthread_mutexattr_** family of functions to make any changes to the attributes:

Get	Set
pthread_mutexattr_getprioceiling(),	*pthread_mutexattr_setprioceiling(),*
pthread_mutexattr_getprotocol(),	*pthread_mutexattr_setprotocol(),*

continued...

Get	Set
pthread_mutexattr_getpshared(),	*pthread_mutexattr_setpshared()*,
pthread_mutexattr_getrecursive(),	*pthread_mutexattr_setrecursive()*,
pthread_mutexattr_gettype(),	*pthread_mutexattr_settype()*

Returns:

EOK	Success.
ENOMEM	Insufficient memory to initialize mutex attribute object *attr*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_init(), *pthread_mutexattr_destroy()*, *pthread_mutexattr_getprioceiling()*, *pthread_mutexattr_getprotocol()*, *pthread_mutexattr_getpshared()*, *pthread_mutexattr_getrecursive()*, *pthread_mutexattr_gettype()*, *pthread_mutexattr_setprioceiling()*, *pthread_mutexattr_setprotocol()*, *pthread_mutexattr_setpshared()*, *pthread_mutexattr_setrecursive()*, *pthread_mutexattr_settype()*

pthread_mutexattr_setprioceiling()

Set the priority ceiling of a mutex attribute object

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_setprioceiling(
                            pthread_mutexattr_t* attr,
                            int prioceiling );
```

Arguments:

attr	A pointer to the **pthread_mutexattr_t** object that you want to set the attribute in.
prioceiling	The new value for the priority ceiling.

Library:

libc

Description:

The *pthread_mutexattr_setprioceiling()* function sets the mutex attribute *attr*'s scheduling priority ceiling to *prioceiling*. Note that *attr* must have been previously created with *pthread_mutexattr_init()*.

Returns:

EOK	Success.
EINVAL	Invalid value specified by *attr* or *prioceiling*.
EPERM	The caller doesn't have the privilege to perform the operation.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_create(), *pthread_mutex_init()*, *pthread_cond_init()*, *pthread_mutexattr_getprioceiling()*, *pthread_mutexattr_getprotocol()*, *pthread_mutexattr_getrecursive()*

pthread_mutexattr_setprotocol()

Set a mutex's scheduling protocol

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_setprotocol(
            pthread_mutexattr * attr,
            int protocol );
```

Arguments:

attr A pointer to the **pthread_mutexattr_t** object that you want to set the attribute in.

protocol The new value of the scheduling protocol; one of:

- PTHREAD_PRIO_INHERIT — when a thread is blocking higher-priority threads by locking one or more mutexes with this attribute, raise the thread's priority to that of the highest priority thread waiting on the PTHREAD_PRIO_INHERIT mutex.
- PTHREAD_PRIO_PROTECT — execute the thread at the highest priority or priority ceilings of all the mutexes owned by the thread and initialized with PTHREAD_PRIO_PROTECT, whether other threads are blocked or not.

The POSIX protocol of PTHREAD_PRIO_NONE isn't currently supported.

Library:

libc

Description:

The *pthread_mutexattr_setprotocol()* function sets the mutex attribute *attr*'s scheduling protocol to *protocol*. The structure pointed to by *attr* must have been previously created with *pthread_mutexattr_init()*.

The *protocol* attribute defines the protocol for using mutexes. A thread holding a PTHREAD_PRIO_INHERIT mutex won't be moved to the tail of the scheduling queue if its original priority is changed (by a call to *pthread_schedsetparam()*, for example). This remains true if the thread unlocks the PTHREAD_PRIO_INHERIT mutex.

Returns:

EOK	Success.
ENOTSUP	The *protocol* argument is an unsupported or an invalid value.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutexattr_getprotocol(), *pthread_mutexattr_getrecursive()*

pthread_mutexattr_setpshared()

Set the process-shared attribute in mutex attribute object

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_setpshared(
                            pthread_mutexattr_t* attr,
                            int pshared );
```

Arguments:

attr A pointer to the **pthread_mutexattr_t** object that you want to set the attribute in.

pshared The new value of the process-shared attribute; one of:

- PTHREAD_PROCESS_SHARED — any thread that has access to the memory where the mutex is allocated can operate on it, even if the mutex is allocated in memory that's shared by multiple processes.
- PTHREAD_PROCESS_PRIVATE — the mutex can be accessed only by threads created within the same process as the thread that initialized the mutex; if threads from other processes try to access the PTHREAD_PROCESS_PRIVATE mutex, the behavior is undefined.

The default value of the process-shared attribute is PTHREAD_PROCESS_PRIVATE.

Library:

libc

Description:

The *pthread_mutexattr_setpshared()* function sets the process-shared attribute in a mutex attribute object, *attr*, to the value given by *pshared*.

Returns:

EOK	Success.
EINVAL	Invalid mutex attribute object, *attr*.
EINVAL	The new value specified in *pshared* isn't PTHREAD_PROCESS_SHARED or PTHREAD_PROCESS_PRIVATE.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_init(), *pthread_create()*, *pthread_mutexattr_getpshared()*, *pthread_mutexattr_getrecursive()*, *pthread_mutex_init()*, *pthread_mutexattr_setrecursive()*

pthread_mutexattr_setrecursive()

Set the recursive attribute in mutex attribute object

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_setrecursive(
        pthread_mutexattr_t* attr,
        int recursive );
```

Arguments:

attr A pointer to the **pthread_mutexattr_t** object that you want to set the attribute in.

recursive The new value for the recursive attribute; one of:

- PTHREAD_RECURSIVE_ENABLE — a thread that has already locked the mutex can lock it again without blocking.
- PTHREAD_RECURSIVE_DISABLE — any thread that tries to lock the mutex blocks, if that mutex is already locked.

The default value of the recursive attribute is PTHREAD_RECURSIVE_DISABLE.

Library:

libc

Description:

The *pthread_mutexattr_setrecursive()* function sets the recursive attribute in a mutex attribute object, *attr*.

Returns:

EOK Success.

EINVAL Invalid mutex attribute object, *attr*, or the value specified by *recursive* isn't PTHREAD_RECURSIVE_ENABLE or PTHREAD_RECURSIVE_DISABLE.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutexattr_getrecursive(), *pthread_mutexattr_init()*

pthread_mutexattr_settype()

Set a mutex type

Synopsis:

```
#include <pthread.h>

int pthread_mutexattr_settype(
                        pthread_mutexattr_t * attr,
                        int type );
```

Arguments:

attr A pointer to the **pthread_mutexattr_t** object that you want to set the attribute in.

type The new type; one of:

- PTHREAD_MUTEX_NORMAL — no deadlock detection. A thread that attempts to relock this mutex without first unlocking it deadlocks. Attempts to unlock a mutex locked by a different thread or attempts to unlock an unlocked mutex result in undefined behavior.
- PTHREAD_MUTEX_ERRORCHECK — provides error checking. A thread returns with an error when it attempts to relock this mutex without first unlocking it, unlock a mutex that another thread has locked, or unlock an unlocked mutex.
- PTHREAD_MUTEX_RECURSIVE — a thread that attempts to relock this mutex without first unlocking it succeeds in locking the mutex. The relocking deadlock that can occur with mutexes of type PTHREAD_MUTEX_NORMAL can't occur with this mutex type. Multiple locks of this mutex require the same number of unlocks to release the mutex before another thread can acquire the mutex. A thread that attempts to unlock a mutex that another thread has locked, or unlock an unlocked mutex, returns with an error.
- PTHREAD_MUTEX_DEFAULT — the default value of the *type* attribute. Attempts to recursively lock a mutex of this type, or unlock a mutex of this type that isn't locked by

the calling thread, or unlock a mutex of this type that isn't locked, results in undefined behavior.

Library:

libc

Description:

The *pthread_mutexattr_settype()* function sets the mutex type attribute in the *type* parameter.

Returns:

Zero for success, or an error number.

Errors:

EINVAL The value specified by *attr* or *type* is invalid.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

An application shouldn't use a PTHREAD_MUTEX_RECURSIVE mutex with condition variables because the implicit unlock performed for a *pthread_cond_wait()* or *pthread_cond_timedwait()* may not

actually release the mutex (if it's been locked multiple times). If this happens, no other thread can satisfy the condition of the predicate.

See also:

pthread_cond_timedwait(), pthread_cond_wait(), pthread_mutexattr_gettype()

pthread_once()

Dynamic package initialization

Synopsis:

```
#include <pthread.h>

pthread_once_t once_control = PTHREAD_ONCE_INIT;

int pthread_once( pthread_once_t* once_control,
                  void (*init_routine)(void) );
```

Arguments:

once_control A pointer to a **pthread_once_t** object that the function uses to determine whether or not to run the initialization code.

☞ You must set the **pthread_once_t** object to the macro PTHREAD_ONCE_INIT before using it for the first time.

init_routine The function that you want to call to do any required initialization.

Library:

libc

Description:

The *pthread_once()* function uses the once-control object *once_control* to determine whether the initialization routine *init_routine* should be called. The first call to *pthread_once()* by any thread in a process, with a given *once_control*, calls *init_routine* with no arguments. Subsequent calls of *pthread_once()* with the same *once_control* won't call *init_routine*.

☞ No thread will execute past this function until the *init_routine* returns.

Returns:

EOK	Success.
EINVAL	Uninitialized once-control object *once_control*.

Examples:

This example shows how you can use once-initialization to initialize a library; both *library_entry_point1()* and *library_entry_point2()* need to initialize the library, but that needs to happen only once:

```
#include <stdio.h>
#include <pthread.h>

pthread_once_t once_control = PTHREAD_ONCE_INIT;

void library_init( void )
{
    /* initialize the library */
}

void library_entry_point1( void )
{
    pthread_once( &once_control, library_init );

    /* do stuff for library_entry_point1... */
}

void library_entry_point2( void )
{
    pthread_once( &once_control, library_init );

    /* do stuff for library_entry_point1... */
}
```

This initializes the library once; if multiple threads call *pthread_once()*, only one actually enters the *library_init()* function. The other threads block at the *pthread_once()* call until *library_init()* has returned. The *pthread_once()* function also ensures that *library_init()* is only ever called once; subsequent calls to the library entry points skip the call to *library_init()*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

pthread_rwlock_destroy()

Destroy a read-write lock

Synopsis:

```
#include <pthread.h>

int pthread_rwlock_destroy( pthread_rwlock_t* rwl );
```

Arguments:

rwl A pointer to a **pthread_rwlock_t** object that you want to destroy.

Library:

libc

Description:

The *pthread_rwlock_destroy()* function destroys the read-write lock referenced by *rwl*, and releases the system resources used by the lock. You can destroy the read-write lock if one of the following is true:

- no thread has a active shared or exclusive lock on *rwl*
- the calling thread has an active exclusive lock on *rwl*.

After successfully destroying a read-write lock, don't use it again without reinitializing it by calling *pthread_rwlock_init()*.

Returns:

EOK Success.

EBUSY The read-write lock *rwl* is still in use. The calling thread doesn't have an exclusive lock.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlock_init(), *pthread_rwlock_rdlock()*, *pthread_rwlock_tryrdlock()*, *pthread_rwlock_trywrlock()*, *pthread_rwlock_unlock()*, *pthread_rwlock_wrlock()*

pthread_rwlock_init()

Initialize a read-write lock

Synopsis:

```
#include <pthread.h>

int pthread_rwlock_init(
                pthread_rwlock_t * rwl,
                const pthread_rwlockattr_t * attr );
```

Arguments:

rwl A pointer to a **pthread_rwlock_t** object that you want to initialize.

attr NULL, or a pointer to a **pthread_rwlockattr_t** object that specifies the attributes you want to use for the read-write lock; see *pthread_rwlockattr_init()*.

Library:

libc

Description:

The *pthread_rwlock_init()* function initializes the read-write lock referenced by *rwl* with the attributes of *attr*. You must initialize read-write locks before using them. If *attr* is NULL, *rwl* is initialized with the default values for the attributes.

Following a successful call to *pthread_rwlock_init()*, the read-write lock is unlocked, and you can use it in subsequent calls to *pthread_rwlock_destroy()*, *pthread_rwlock_rdlock()*, *pthread_rwlock_tryrdlock()*, *pthread_rwlock_trywrlock()*, and *pthread_rwlock_wrlock()*. This lock remains usable until you destroy it by calling *pthread_rwlock_destroy()*.

If the read-write lock is statically allocated, you can initialize it with the default values by setting it to PTHREAD_RWLOCK_INITIALIZER.

More than one thread may hold a shared lock at any time, but only one thread may hold an exclusive lock. This avoids reader and writer starvation during frequent contention by:

- favoring blocked readers over writers after a writer has just released an exclusive lock, and
- favoring writers over readers when there are no blocked readers.

Under heavy contention, the lock alternates between a single exclusive lock followed by a batch of shared locks.

Returns:

EOK	Success.
EAGAIN	Insufficient system resources to initialize the read-write lock.
EBUSY	The read-write lock *rwl* has been initialized or unsuccessfully destroyed.
EFAULT	A fault occurred when the kernel tried to access *rwl* or *attr*.
EINVAL	Invalid read-write lock attribute object *attr*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Beware of *priority inversion* when using read-write locks. A high-priority thread may be blocked waiting on a read-write lock locked by a low-priority thread.

The microkernel has no knowledge of read-write locks, and therefore can't boost the low-priority thread to prevent the priority inversion.

See also:

pthread_rwlockattr_init(), *pthread_rwlock_destroy()*, *pthread_rwlock_rdlock()*, *pthread_rwlock_tryrdlock()*, *pthread_rwlock_trywrlock()*, *pthread_rwlock_wrlock()*, *pthread_rwlock_unlock()*

pthread_rwlock_rdlock()

Acquire a shared read lock on a read-write lock

Synopsis:

```
#include <pthread.h>

int pthread_rwlock_rdlock( pthread_rwlock_t* rwl );
```

Arguments:

rwl A pointer to a **pthread_rwlock_t** object that you want to lock for reading.

Library:

libc

Description:

The *pthread_rwlock_rdlock()* function acquires a shared lock on the read-write lock referenced by *rwl*. If the read-write lock is already exclusively locked, the calling thread blocks until the exclusive lock is released.

If a signal is delivered to a thread waiting to lock a read-write lock, it will resume waiting for the lock after returning from the signal handler.

A thread may hold several read locks on the same read-write lock; it must call *pthread_rwlock_unlock()* multiple times to release its read lock.

Returns:

EOK	Success.
EAGAIN	On the first use of statically initialized read-write lock, insufficient system resources existed to initialize the read-write lock.
EDEADLK	The calling thread already has an exclusive lock for *rwl*.

EFAULT	A fault occurred when the kernel tried to access *rwl*.
EINVAL	The read-write lock *rwl* is invalid.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlock_destroy(), *pthread_rwlock_init()*, *pthread_rwlock_tryrdlock()*, *pthread_rwlock_trywrlock()*, *pthread_rwlock_unlock()*, *pthread_rwlock_wrlock()*

pthread_rwlock_timedrdlock()

Lock a read-write lock for reading

Synopsis:

```
#include <pthread.h>
#include <time.h>

int pthread_rwlock_timedrdlock(
                    pthread_rwlock_t * rwlock,
                    const struct timespec * abs_timeout );
```

Arguments:

rwlock	The read-write lock that you want to lock.
abs_timeout	A pointer to a **timespec** that specifies the maximum time to wait to acquire the lock, expressed as an absolute time.

Library:

libc

Description:

The *pthread_rwlock_timedrdlock()* function applies a read lock to the read-write lock referenced by *rwlock* as in *pthread_rwlock_rdlock()*.

However, if the lock can't be acquired without waiting for other threads to unlock it, this wait terminates when the specified timeout expires. The timeout expires when the absolute time specified by *abs_timeout* passes, as measured by the clock on which timeouts are based (i.e. when the value of that clock equals or exceed *abs_timeout*), or if the absolute time specified by *abs_timeout* has already been passed at the time of the call.

The timeout is based on the CLOCK_REALTIME clock.

If the read-write lock can be locked immediately, the validity of the *abs_timeout* parameter isn't checked, and the function won't fail with a timeout.

If a signal that causes a signal handler to be executed is delivered to a thread blocked on a read-write lock via a call to *pthread_rwlock_timedrdlock()*, upon return from the signal handler the thread resumes waiting for the lock as if it hadn't been interrupted.

The calling thread may deadlock if at the time the call is made it holds a write lock on *rwlock*. The results are undefined if this function is called with an uninitialized read-write lock.

Returns:

Zero if the lock for reading on the read-write lock object referenced by *rwlock* is acquired, or an error number to indicate the error.

Errors:

EAGAIN	Couldn't acquire read lock because the maximum number of read locks for lock would be exceeded.
EDEADLK	The calling thread already holds a write lock on *rwlock*.
EINVAL	The value specified by *rwlock* doesn't refer to an initialized read-write lock object, or the *abs_timeout* nanosecond value is less than zero or greater than or equal to 1,000 million.
ETIMEDOUT	The lock couldn't be acquired before the specified timeout expired.

Classification:

POSIX 1003.1j

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlock_destroy(), *pthread_rwlock_init()*, *pthread_rwlock_timedwrlock()*, *pthread_rwlock_trywrlock()*, *pthread_rwlock_tryrdlock()*, *pthread_rwlock_unlock()*, *pthread_rwlock_wrlock()*, `timespec`

pthread_rwlock_timedwrlock()

Lock a read-write lock for writing

Synopsis:

```
#include <pthread.h>
#include <time.h>

int pthread_rwlock_timedwrlock(
                    pthread_rwlock_t * rwlock,
                    const struct timespec * abs_timeout );
```

Arguments:

rwlock	The read-write lock that you want to lock.
abs_timeout	A pointer to a **timespec** that specifies the maximum time to wait to acquire the lock, expressed as an absolute time.

Library:

libc

Description:

The *pthread_rwlock_timedwrlock()* function applies a write lock to the read-write lock referenced by *rwlock* as in *pthread_rwlock_wrlock()*.

However, if the lock can't be acquired without waiting for other threads to unlock the lock, this wait terminates when the specified timeout expires. The timeout expires when the absolute time specified by *abs_timeout* passes, as measured by the clock on which timeouts are based (i.e. when the value of that clock equals or exceed *abs_timeout*), or if the absolute time specified by *abs_timeout* has already been passed at the time of the call.

The timeout is based on the CLOCK_REALTIME clock.

If the read-write lock can be locked immediately, the validity of the *abs_timeout* parameter isn't checked, and the function won't fail with a timeout.

If a signal that causes a signal handler to be executed is delivered to a thread blocked on a read-write lock via a call to *pthread_rwlock_timedwrlock()*, upon return from the signal handler the thread resumes waiting for the lock as if it hadn't been interrupted.

The calling thread may deadlock if at the time the call is made it holds a write lock on *rwlock*. The results are undefined if this function is called with an uninitialized read-write lock.

Returns:

Zero if the lock for writing on the read-write lock object referenced by *rwlock* is acquired, or an error number to indicate the error.

Errors:

EAGAIN	Couldn't acquire read lock because the maximum number of read locks for lock would be exceeded.
EDEADLK	The calling thread already holds the *rwlock*.
EINVAL	The value specified by *rwlock* doesn't refer to an initialized read-write lock object, or the *abs_timeout* nanosecond value is less than zero or greater than or equal to 1,000 million.
ETIMEDOUT	The lock couldn't be acquired before the specified timeout expired.

Classification:

POSIX 1003.1j

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes

continued...

Safety	
Thread	Yes

See also:

pthread_rwlock_destroy(), *pthread_rwlock_init()*, *pthread_rwlock_timedrdlock()*, *pthread_rwlock_trywrlock()*, *pthread_rwlock_tryrdlock()*, *pthread_rwlock_unlock()*, *pthread_rwlock_wrlock()*, **`timespec`**

pthread_rwlock_tryrdlock()

Attempt to acquire a shared lock on a read-write lock

Synopsis:

```
#include <pthread.h>

int pthread_rwlock_tryrdlock(
                    pthread_rwlock_t* rwl );
```

Arguments:

rwl A pointer to a **pthread_rwlock_t** object that you want to lock for reading.

Library:

libc

Description:

The *pthread_rwlock_tryrdlock()* function attempts to acquire a shared lock on the read-write lock referenced by *rwl*. If the read-write lock is already exclusively locked by any thread (including the calling thread), the function returns immediately instead of blocking until a read lock can be obtained.

Returns:

EOK	Success.
EAGAIN	On the first use of a statically initialized read-write lock, insufficient system resources existed to initialize the read-write lock.
EBUSY	The read-write lock was already write locked.
EDEADLK	The calling thread already has an exclusive lock for *rwl*.
EFAULT	A fault occurred when the kernel tried to access *rwl*.
EINVAL	The read-write lock *rwl* is invalid.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlock_destroy(), *pthread_rwlock_init()*, *pthread_rwlock_rdlock()*, *pthread_rwlock_trywrlock()*, *pthread_rwlock_unlock()*, *pthread_rwlock_wrlock()*

pthread_rwlock_trywrlock()

Attempt to acquire an exclusive lock on a read-write lock

Synopsis:

```
#include <pthread.h>

int pthread_rwlock_trywrlock(
                        pthread_rwlock_t* rwl );
```

Arguments:

rwl A pointer to a **pthread_rwlock_t** object that you want to lock for writing.

Library:

libc

Description:

The *pthread_rwlock_trywrlock()* function attempts to acquire an exclusive lock on the read-write lock referenced by *rwl*. If the read-write lock is already exclusively locked or shared locked, the function returns immediately instead of blocking until an exclusive lock can be obtained.

The function may need to block to determine the state of the read-write lock.

Returns:

EOK	Success.
EAGAIN	On the first use of a statically initialized read-write lock, insufficient system resources existed to initialize the read-write lock.
EBUSY	The read-write lock was already write locked or read locked.
EDEADLK	The calling thread already has an exclusive lock for *rwl*.

EFAULT	A fault occurred when the kernel tried to access *rwl*.
EINVAL	The read-write lock *rwl* is invalid.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlock_destroy(), *pthread_rwlock_init()*, *pthread_rwlock_rdlock()*, *pthread_rwlock_tryrdlock()*, *pthread_rwlock_unlock()*, *pthread_rwlock_wrlock()*

pthread_rwlock_unlock()

Unlock a read-write lock

Synopsis:

```
#include <pthread.h>

int pthread_rwlock_unlock( pthread_rwlock_t* rwl );
```

Arguments:

rwl A pointer to a **pthread_rwlock_t** object that you want to unlock.

Library:

libc

Description:

The *pthread_rwlock_unlock()* function unlocks a read-write lock referenced by *rwl*. The read-write lock may become available for any threads that were blocked on the read-write lock, depending on whether the read-write lock had been locked in exclusive or shared mode.

☞ The read-write lock should be owned by the calling thread. If the calling thread doesn't hold the lock, no error status is returned, and the behavior of this read-write lock is now undefined.

Returns:

EOK	Success.
EAGAIN	On the first use of a statically initialized read-write lock, insufficient system resources existed to initialize the read-write lock.
EFAULT	A fault occurred when the kernel tried to access *rwl*.
EINVAL	The read-write lock *rwl* is invalid.

EPERM — No thread has a read or write lock on *rwl* or the calling thread doesn't have a write lock on *rwl*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlock_destroy(), *pthread_rwlock_init()*, *pthread_rwlock_rdlock()*, *pthread_rwlock_tryrdlock()*, *pthread_rwlock_trywrlock()*, *pthread_rwlock_wrlock()*

pthread_rwlock_wrlock()

Acquire an exclusive write lock on a read-write lock

Synopsis:

```
#include <pthread.h>

int pthread_rwlock_wrlock(
            pthread_rwlock_t* rwl );
```

Arguments:

rwl A pointer to a **pthread_rwlock_t** object that you want to lock for writing.

Library:

libc

Description:

The *pthread_rwlock_wrlock()* function acquires an exclusive lock on the read-write lock referenced by *rwl*. If the read-write lock is already shared-locked by any thread (including the calling thread) or exclusively-locked by any thread (other than the calling thread), the calling thread blocks until all shared locks and exclusive locks are released.

If a signal is delivered to a thread waiting to lock a read-write lock, it resumes waiting for the lock after returning from the signal handler.

Returns:

EOK	Success.
EAGAIN	On the first use of a statically initialized read-write lock, insufficient system resources existed to initialize the read-write lock.
EDEADLK	The calling thread already has an exclusive lock for *rwl*.
EFAULT	A fault occurred when the kernel tried to access *rwl*.

EINVAL The read-write lock *rwl* is invalid.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlock_destroy(), *pthread_rwlock_init()*, *pthread_rwlock_rdlock()*, *pthread_rwlock_tryrdlock()*, *pthread_rwlock_trywrlock()*, *pthread_rwlock_unlock()*

pthread_rwlockattr_destroy()

Destroy a read-write lock attribute object

Synopsis:

```
#include <pthread.h>

int pthread_rwlockattr_destroy(
       pthread_rwlockattr_t* attr );
```

Arguments:

attr A pointer to the **pthread_rwlockattr_t** object that you want to destroy.

Library:

libc

Description:

The *pthread_rwlockattr_destroy()* function destroys a read-write lock attribute object created by *pthread_rwlockattr_init()*.

☞ Don't use a destroyed read-write lock attribute object reinitializing it by calling *pthread_rwlockattr_init()*.

Returns:

EOK Success.

EINVAL The object specified by *attr* is invalid.

Classification:

Standard Unix

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlockattr_getpshared(), *pthread_rwlockattr_init()*, *pthread_rwlockattr_setpshared()*

pthread_rwlockattr_getpshared()

Get the process-shared attribute of a read-write lock attribute object

Synopsis:

```
#include <pthread.h>

int pthread_rwlockattr_getpshared(
        const pthread_rwlockattr_t* attr,
        int* pshared );
```

Arguments:

attr	A pointer to the **pthread_rwlockattr_t** object that you want to get the attribute from.
pshared	A pointer to a location where the function can store the process-shared attribute.

Library:

libc

Description:

The *pthread_rwlockattr_getpshared()* function gets the the process-shared attribute for the read-write lock attribute object specified by *attr*, storing it in *pshared*.

To let any thread with access to the read-write lock object's memory operate it, the process-shared attribute must be set to PTHREAD_PROCESS_SHARED, even if those threads are in different processes. Set the process-shared attribute to PTHREAD_PROCESS_PRIVATE to limit access to threads in the current process.

Returns:

EOK	Success.
EINVAL	The read-write lock attribute object specified by *attr* is invalid.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlockattr_destroy(), *pthread_rwlockattr_init()*, *pthread_rwlockattr_setpshared()*

pthread_rwlockattr_init()

Create a read-write lock attribute object

Synopsis:

```
#include <pthread.h>

int pthread_rwlockattr_init(
        pthread_rwlockattr_t* attr );
```

Arguments:

attr A pointer to the **pthread_rwlockattr_t** object that you want to initialize.

Library:

libc

Description:

The *pthread_rwlockattr_init()* function initializes the specified read-write lock attribute object to its default values.

Changes made to a read-write lock attribute object changes after it's been used to initialize a read-write lock won't affect the previously initialized read-write locks.

Returns:

EOK Success.

ENOMEM There isn't enough memory available to initialize *attr*.

Classification:

Standard Unix

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlockattr_destroy(), *pthread_rwlockattr_getpshared()*, *pthread_rwlockattr_setpshared()*

pthread_rwlockattr_setpshared()

Set the process-shared attribute of a read-write lock attribute object

Synopsis:

```
#include <pthread.h>

int pthread_rwlockattr_setpshared(
       pthread_rwlockattr_t* attr,
       int pshared );
```

Arguments:

attr A pointer to the **pthread_rwlockattr_t** object that you want to set the attribute for.

pshared The new value of the process-shared attribute; one of:

- PTHREAD_PROCESS_SHARED — let any thread with access to the read-write lock object's memory operate it, even if those threads are in different processes.
- PTHREAD_PROCESS_PRIVATE — limit access to threads in the current process.

Library:

libc

Description:

The *pthread_rwlockattr_setpshared()* function sets the process-shared attribute for the read-write lock attribute object specified by *attr* to *pshared*.

Returns:

EOK Success.

EINVAL The *pshared* argument is invalid.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_rwlockattr_destroy(), *pthread_rwlockattr_getpshared()*, *pthread_rwlockattr_init()*

pthread_self()

Get the calling thread's ID

Synopsis:

```
#include <pthread.h>

pthread_t pthread_self( void );
```

Library:

libc

Description:

The *pthread_self()* function returns the thread ID of the calling thread.

Returns:

The ID of the calling thread.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_create(), pthread_equal()

pthread_setcancelstate()

Set a thread's cancellation state

Synopsis:

```
#include <pthread.h>

int pthread_setcancelstate( int state,
                            int* oldstate );
```

Arguments:

state The new cancellation state.

oldstate A pointer to a location where the function can store the old cancellation state.

Library:

libc

Description:

The *pthread_setcancelstate()* function sets the calling thread's cancellation state to *state* and returns the previous cancellation state in *oldstate*.

The cancellation state can have the following values:

PTHREAD_CANCEL_DISABLE

Cancellation requests are held pending.

PTHREAD_CANCEL_ENABLE

Cancellation requests may be acted on according to the cancellation type; see *pthread_setcanceltype()*.

The default cancellation state for a thread is PTHREAD_CANCEL_ENABLE.

You can set this attribute (in a non-POSIX way) before creating the thread; for more information, see "QNX extensions," in the documentation for *pthread_create()*.

Returns:

EOK	Success.
EINVAL	The cancellation state specified by *state* is invalid.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cancel(), *pthread_setcanceltype()*, *pthread_testcancel()*

pthread_setcanceltype()

Set a thread's cancellation type

Synopsis:

```
#include <pthread.h>

int pthread_setcanceltype( int type,
                           int* oldtype );
```

Arguments:

type	The new cancellation type.
oldtype	A pointer to a location where the function can store the old cancellation type.

Library:

libc

Description:

The *pthread_setcanceltype()* function sets the calling thread's cancellation type to *type* and returns the previous cancellation type in *oldtype*.

The cancellation type can have the following values:

PTHREAD_CANCEL_ASYNCHRONOUS

If cancellation is enabled, new or pending cancellation requests may be acted on immediately.

PTHREAD_CANCEL_DEFERRED

If cancellation is enabled, cancellation requests are held pending until a cancellation point.

The default cancellation state for a thread is PTHREAD_CANCEL_DEFERRED. Note that the standard POSIX and C library calls aren't asynchronous-cancellation safe.

☞ You can set this attribute (in a non-POSIX way) before creating the thread; for more information, see "QNX extensions," in the documentation for *pthread_create()*.

Returns:

EOK	Success.
EINVAL	Invalid cancelability type *type*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cancel(), *pthread_setcancelstate()*, *pthread_testcancel()*

pthread_setconcurrency()

Set the concurrency level for a thread

Synopsis:

```
#include <pthread.h>

int pthread_setconcurrency( int new_level );
```

Arguments:

new_level	The new value for the concurrency level.

Library:

libc

Description:

QNX Neutrino doesn't support the multiplexing of user threads on top of several kernel scheduled entities. As such, the *pthread_setconcurrency()* and *pthread_getconcurrency()* functions are provided for source code compatibility but they have no effect when called. To maintain the function semantics, the *new_level* parameter is saved when *pthread_setconcurrency()* is called so that a subsequent call to *pthread_getconcurrency()* returns the same value.

Returns:

EOK	Success.
EINVAL	Negative argument *new_level*.
EAGAIN	The value specified by *new_level* would cause a system resource to be exceeded.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_getconcurrency()

pthread_setschedparam()

Set thread scheduling parameters

Synopsis:

```
#include <pthread.h>

int pthread_setschedparam(
                pthread_t thread,
                int policy,
                const struct sched_param *param );
```

Arguments:

thread The ID of the thread that you want to get the scheduling parameters for. You can get a thread ID by calling *pthread_create()* or *pthread_self()*.

policy The new scheduling policy; one of:

- SCHED_FIFO — a fixed-priority scheduler in which the highest priority, ready thread runs until it blocks or is preempted by a higher priority thread.
- SCHED_RR — the same as SCHED_FIFO, except threads at the same priority level time slice (round robin) every 50 msec.
- SCHED_OTHER — currently the same as SCHED_RR.

Currently, you can set a thread's scheduling policy to SCHED_SPORADIC only when you create the thread. If you use sporadic scheduling, you can't change the policy later. For more information, see *pthread_attr_setschedpolicy()*.

param A pointer to a **sched_param** structure that specifies the scheduling parameters that you want to use.

Library:

libc

Description:

The *pthread_setschedparam()* function sets the scheduling policy and associated scheduling parameters of thread *thread* to the values specified in *policy* and *param*.

Returns:

EOK	Success.
EINVAL	Invalid scheduling policy *policy* or parameters *param*.
ENOTSUP	Unsupported scheduling policy *policy* or parameters *param*.
EPERM	Insufficient privilege to modify scheduling policy *policy* or parameters *param*.
ESRCH	Invalid thread ID *thread*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_getschedparam(), **sched_param**

pthread_setspecific()

Set a thread-specific data value

Synopsis:

```
#include <pthread.h>

int pthread_setspecific( pthread_key_t key,
                         const void* value );
```

Arguments:

key The key associated with the data that you want to set. See *pthread_key_create()*.

value The value that you want to store.

Library:

libc

Description:

The *pthread_setspecific()* function binds the thread specific data value *value* with the thread specific data key *key*.

You can call this function from within a thread-specific data destructor function.

You must call this function with a key that you got from *pthread_key_create()*. You can't use a key after destroying it with *pthread_key_delete()*.

Returns:

EOK	Success.
ENOMEM	Insufficient memory to store thread specific data value *value*.
EINVAL	Invalid thread specific data key *key*.

Examples:

See *pthread_key_create()*.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

Calling *pthread_setspecific()* with a non-NULL *value* may result in lost storage or infinite loops unless *value* was returned by *pthread_key_create()*.

See also:

pthread_key_create(), *pthread_getspecific()*

pthread_sigmask()

Examine and change blocked signals

Synopsis:

```
#include <signal.h>

int pthread_sigmask( int how,
                     const sigset_t* set,
                     sigset_t* oset );
```

Arguments:

how How you want to change the signal mask; one of:

- SIG_BLOCK — make the resulting signal mask the union of the current signal mask and the signal set *set*.
- SIG_UNBLOCK — make the resulting signal mask the intersection of the current signal mask and the complement of the signal set *set*.
- SIG_SETMASK — make the resulting signal mask the signal set *set*.

This argument is valid only if *set* is non-NULL.

set A pointer to a **sigset_t** object that specifies the signals that you want to affect in the mask.

oset NULL, or a pointer to a **sigset_t** object where the function can store the thread's old signal mask.

Library:

libc

Description:

The *pthread_sigmask()* function is used to examine and/or change the calling thread's signal mask. If *set* is non-NULL, the thread's signal mask is set to *set*. If *oset* is non-NULL, the thread's old signal mask is returned in *oset*.

You can't block the SIGKILL and SIGSTOP signals.

Returns:

EOK	Success.
EINVAL	Invalid *how* parameter.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sigprocmask()

pthread_sleepon_broadcast()

Unblock waiting threads

Synopsis:

```
#include <pthread.h>

int pthread_sleepon_broadcast( const volatile void * addr );
```

Arguments:

addr The handle that the threads are waiting on. The value of *addr* is typically a data structure that controls a resource.

Library:

libc

Description:

The *pthread_sleepon_broadcast()* function unblocks all threads currently waiting on *addr*. The threads are unblocked in priority order.

Here's a table to help you decide when to use *pthread_sleepon_broadcast()* or *pthread_sleepon_signal()*:

Task	*pthread_sleepon_broadcast()*	*pthread_sleepon_signal()*
Mapping a single predicate to one address.	You must recheck the predicate and reblock if necessary. See *pthread_sleepon_signal()* for a better implementation. The first thread to wake up owns the lock, all others must go back to sleep.	This is the correct and efficient use of *pthread_sleepon_signal()*. You don't have to recheck the predicate. One thread owns the lock at a time.

continued...

Task	*pthread_sleepon_broadcast()*	*pthread_sleepon_signal()*
Mapping multiple predicates to one address.	The *pthread_sleepon_broadcast()* function is necessary to wake up all blocked threads. You must recheck the predicates and reblock if necessary. You should try to map only one predicate to one address.	Don't use *pthread_sleepon_signal()* in this case; it could result in a deadlock.

Returns:

EOK	Success.
EINVAL	Invalid sleepon address.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_broadcast(), *pthread_sleepon_signal()*, *pthread_sleepon_lock()*, *pthread_sleepon_unlock()*, *pthread_sleepon_wait()*

pthread_sleepon_lock()

Lock the pthread_sleepon functions*

Synopsis:

```
#include <pthread.h>

int pthread_sleepon_lock( void );
```

Library:

libc

Description:

The *pthread_sleepon_lock()* function calls *pthread_mutex_lock()* on a mutex associated with the *pthread_sleepon** class of functions. You should call this function before testing conditions that determine whether you need to call *pthread_sleepon_wait()*, *pthread_sleepon_signal()*, or *pthread_sleepon_broadcast()*. This mutex prevents other threads from changing the conditions between the time you examine and act upon them.

This function may be implemented as a simple macro.

Returns:

EOK	Success.
EDEADLK	The calling thread already owns the controlling mutex.
EAGAIN	On the first use of *pthread_sleepon_lock()*, all kernel mutex objects were in use.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_lock(), pthread_sleepon_broadcast(), pthread_sleepon_signal(), pthread_sleepon_unlock(), pthread_sleepon_wait()

pthread_sleepon_signal()

Signal a sleeping thread

Synopsis:

```
#include <pthread.h>

int pthread_sleepon_signal( const volatile void * addr );
```

Arguments:

addr The handle that the threads are waiting on. The value of *addr* is typically a data structure that controls a resource.

Library:

libc

Description:

The *pthread_sleepon_signal()* function unblocks the highest priority thread waiting on *addr*.

Here's a table to help you decide when to use *pthread_sleepon_broadcast()* or *pthread_sleepon_signal()*:

Task	*pthread_sleepon_broadcast()*	*pthread_sleepon_signal()*
Mapping a single predicate to one address.	You must recheck the predicate and reblock if necessary. See *pthread_sleepon_signal()* for a better implementation. The first thread to wake up owns the lock, all others must go back to sleep.	This is the correct and efficient use of *pthread_sleepon_signal()*. You must recheck the predicate. One thread owns the lock at a time.

continued...

Task	*pthread_sleepon_broadcast()*	*pthread_sleepon_signal()*
Mapping multiple predicates to one address.	The *pthread_sleepon_broadcast()* function is necessary to wake up all blocked threads. You must recheck the predicates and reblock if necessary. You should try to map only one predicate to one address.	Don't use *pthread_sleepon_signal()* in this case; it could result in a deadlock.

Returns:

EOK	Success.
EINVAL	Invalid sleepon address.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_signal(), *pthread_sleepon_broadcast()*, *pthread_sleepon_lock()*, *pthread_sleepon_unlock()*, *pthread_sleepon_wait()*

pthread_sleepon_timedwait()

Make a thread sleep while waiting

Synopsis:

```
#include <pthread.h>

int pthread_sleepon_timedwait( const volatile void * addr,
                               uint64_t nsec );
```

Arguments:

addr The handle that you want the thread to wait for. The value of *addr* is typically a data structure that controls a resource.

nsec A limit on the amount of time to wait, in nanoseconds.

Library:

libc

Description:

The *pthread_sleepon_timedwait()* function uses a mutex and a condition variable to sleep on a handle, *addr*.

If *nsec* is nonzero, then *pthread_sleepon_timedwait()* calls *pthread_cond_timedwait()*. If the *pthread_cond_timedwait()* times out, then *pthread_sleepon_timedwait()* returns ETIMEDOUT. If *nsec* is zero, then *pthread_sleepon_timedwait()* calls *pthread_cond_wait()* instead.

The *pthread_sleepon*()* functions provide a simple, uniform way to wait on a variety of resources in a multithreaded application. For example, a multithreaded filesystem may wish to wait on such diverse things as a cache block, a file lock, an operation complete and many others. For example, to wait on a resource:

```
pthread_sleepon_lock();

while((ptr = cachelist->free) == NULL) {
    pthread_sleepon_timedwait(cachelist);
}
cachelist->free = ptr->free;

pthread_sleepon_unlock();
```

To start an operation and wait upon its completion:

```
/* Line up for access to the driver */
pthread_sleepon_lock();
if(driver->busy) {
    pthread_sleepon_timedwait(&driver->busy);
}

/* We now have exclusive use of the driver */
driver->busy = 1;
driver_start(driver);   /* This should be relatively fast */

/* Wait for something to signal driver complete */
pthread_sleepon_timedwait(&driver->complete);
pthread_sleepon_unlock();

/* Get the status/data */
driver_complete(driver);

/* Release control of the driver and signal anyone waiting */
pthread_sleepon_lock();
driver->busy = 0;
pthread_sleepon_signal(&driver->busy);
pthread_sleepon_unlock();
```

The use of a **`while`** loop instead of an **`if`** handles the case where the wait on *addr* is woken up using *pthread_sleepon_broadcast()*.

You must call *pthread_sleepon_lock()*, which acquires the controlling mutex for the condition variable and ensures that another thread won't enter the critical section between the test, block and use of the resource. Since *pthread_sleepon_timedwait()* calls *pthread_cond_timedwait()*, it releases the controlling mutex when it blocks. It reacquires the mutex before waking up.

The wakeup is accomplished by another thread's calling *pthread_sleepon_signal()*, which wakes up a single thread, or *pthread_sleepon_broadcast()*, which wakes up all threads blocked on *addr*. Threads are woken up in priority order. If there's more than one thread with the same highest priority, the one that has been waiting the longest is woken first.

A single mutex and one condition variable for each unique address that's currently being blocked on are used. The total number of

condition variables is therefore equal to the number of unique *addr*s that have a thread waiting on them. This also means that the maximum number of condition variables never exceeds the number of threads. To accomplish this, condition variables are dynamically created as needed and placed upon an internal freelist for reuse when not.

You might find the *pthread_sleepon_*()* functions easier to use and understand than condition variables. They also resemble the traditional *sleepon()* and *wakeup()* functions found in Unix kernels. They can be implemented as follows:

```
int _sleepon(void *addr) {
    int ret;

    if((ret = pthread_sleepon_lock()) == EOK) {
        ret = pthread_sleepon_timedwait(addr);
        pthread_sleepon_unlock();
    }
    return ret;
}

void _wakeup(void *addr) {
    if(pthread_sleepon_lock() == EOK) {
        pthread_sleepon_broadcast(addr);
        pthread_sleepon_unlock();
    }
}
```

Note that in most Unix kernels, a thread runs until it blocks and thus need not worry about protecting the condition it checks with a mutex. Likewise when a Unix *wakeup()* is called, there isn't an immediate thread switch. Therefore, you can use only the above simple routines (*_wakeup()* and *_sleepon()*) if all your threads run with SCHED_FIFO scheduling and at the same priority, thus more closely mimicking Unix kernel scheduling.

Returns:

EDEADLK	The calling thread already owns the controlling mutex.
ETIMEDOUT	The time specified by *nsec* has passed.

EOK Success.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_wait(), pthread_mutex_lock(), pthread_mutex_unlock(), pthread_sleepon_broadcast(), pthread_sleepon_lock(), pthread_sleepon_signal(), pthread_sleepon_unlock(), pthread_sleepon_wait(), sched_setscheduler()

pthread_sleepon_unlock()

Unlock the pthread_sleepon() functions*

Synopsis:

```
#include <pthread.h>

int pthread_sleepon_unlock( void );
```

Library:

libc

Description:

The *pthread_sleepon_unlock()* function calls *pthread_mutex_unlock()* on a mutex associated with the *pthread_sleepon*()* class of functions. You should call it at the end of a critical section entered by *pthread_sleepon_lock()*.

This function may be implemented as a simple macro.

Returns:

EOK	Success.
EPERM	The current thread doesn't own the controlling mutex.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_unlock(), pthread_sleepon_broadcast(), pthread_sleepon_lock(), pthread_sleepon_signal(), pthread_sleepon_wait()

pthread_sleepon_wait()

Make a thread sleep while waiting

Synopsis:

```
#include <pthread.h>

int pthread_sleepon_wait( const volatile void * addr );
```

Arguments:

addr The handle that you want the thread to wait for. The value of *addr* is typically a data structure that controls a resource.

Library:

libc

Description:

The *pthread_sleepon_wait()* function uses a mutex and a condition variable to sleep on a handle, *addr*.

The *pthread_sleepon** functions provide a simple, uniform way to wait on a variety of resources in a multithreaded application. For example, a multithreaded filesystem may wish to wait on such diverse things as a cache block, a file lock, an operation complete and many others. For example, to wait on a resource:

```
pthread_sleepon_lock();

while((ptr = cachelist->free) == NULL) {
    pthread_sleepon_wait(cachelist);
}
cachelist->free = ptr->free;

pthread_sleepon_unlock();
```

To start an operation and wait for its completion:

```
/* Line up for access to the driver */
pthread_sleepon_lock();
if(driver->busy) {
    pthread_sleepon_wait(&driver->busy);
}
```

```
/* We now have exclusive use of the driver */
driver->busy = 1;
driver_start(driver);   /* This should be relatively fast */

/* Wait for something to signal driver complete */
pthread_sleepon_wait(&driver->complete);
pthread_sleepon_unlock();

/* Get the status/data */
driver_complete(driver);

/* Release control of the driver and signal anyone waiting */
pthread_sleepon_lock();
driver->busy = 0;
pthread_sleepon_signal(&driver->busy);
pthread_sleepon_unlock();

pthread_exit(NULL);
```

Choose carefully when you decide whether to use a **`while`** loop

- If the wait on *addr* is woken up using *pthread_sleepon_broadcast()*, you must use a **`while`** loop.
- If threads are woken up using *pthread_sleepon_signal()*, you *may* use the **`if`** conditional if the design of the program guarantees proper synchronization and scheduling among contending threads. This is guaranteed in the above example, assuming that none of the threads attempt to reacquire the driver resource (i.e. *pthread_exit()* call).

If you're in doubt, use a **`while`** loop, because it guarantees access to the desired resource.

You must call *pthread_sleepon_lock()*, which acquires the controlling mutex for the condition variable and ensures that another thread won't enter the critical section between the test, block and use of the resource. Since *pthread_sleepon_wait()* calls *pthread_cond_wait()*, it releases the controlling mutex when it blocks. It reacquires the mutex before waking up.

The wakeup is accomplished by another thread's calling *pthread_sleepon_signal()*, which wakes up a single thread, or

pthread_sleepon_broadcast(), which wakes up all threads blocked on *addr*. Threads are woken up in priority order. If there's more than one thread with the same highest priority, the one that has been waiting the longest is woken first.

A single mutex and one condition variable for each unique address that's currently being blocked on are used. The total number of condition variables is therefore equal to the number of unique *addr*s that have a thread waiting on them. This also means that the maximum number of condition variables never exceeds the number of threads. To accomplish this, condition variables are dynamically created as needed and placed upon an internal freelist for reuse when not.

You might find the *pthread_sleepon_*()* functions easier to use and understand than condition variables. They also resemble the traditional *sleepon()* and *wakeup()* functions found in Unix kernels. They can be implemented as follows:

```
int _sleepon(void *addr) {
    int ret;

    if((ret = pthread_sleepon_lock()) == EOK) {
        ret = pthread_sleepon_wait(addr);
        pthread_sleepon_unlock();
    }
    return ret;
}

void _wakeup(void *addr) {
    if(pthread_sleepon_lock() == EOK) {
        pthread_sleepon_broadcast(addr);
        pthread_sleepon_unlock();
    }
}
```

Note that in most Unix kernels, a thread runs until it blocks, and thus need not worry about protecting the condition it checks with a mutex. Likewise, when a Unix *wakeup()* is called, there isn't an immediate thread switch. Therefore, you can use only the above simple routines (*_wakeup()* and *_sleepon()*) if all your threads run with SCHED_FIFO scheduling and at the same priority, thus more closely mimicking Unix kernel scheduling.

Returns:

EOK	Success.
EDEADLK	The calling thread already owns the controlling mutex.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_wait(), *pthread_mutex_lock()*, *pthread_mutex_unlock()*, *pthread_sleepon_broadcast()*, *pthread_sleepon_lock()*, *pthread_sleepon_signal()*, *pthread_sleepon_unlock()*, *sched_setscheduler()*

pthread_spin_destroy()

Destroy a thread spinlock

Synopsis:

```
#include <pthread.h>

int pthread_spin_destroy(
        pthread_spinlock_t * spinner );
```

Arguments:

spinner A pointer to the **pthread_spinlock_t** object that you want to destroy.

Library:

libc

Description:

The *pthread_spin_destroy()* function destroys the thread spinlock *spinner*, releasing its resources.

Once you've destroyed the spinlock, don't use it again until you've reinitialized it by calling *pthread_spin_init()*.

Calling *pthread_spin_destroy()* gives undefined results when a thread has *spinner* locked or when *spinner* isn't initialized.

Returns:

EOK Success.

EBUSY The thread spinlock *spinner* is in use by another thread and can't be destroyed.

EINVAL Invalid **pthread_spinlock_t** object *spinner*.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_spin_init(), *pthread_spin_lock()*, *pthread_spin_trylock()*, *pthread_spin_unlock()*

pthread_spin_init()

Initialize a thread spinlock

Synopsis:

```
#include <pthread.h>

int pthread_spin_init( pthread_spinlock_t * spinner,
                       int pshared );
```

Arguments:

spinner A pointer to the **pthread_spinlock_t** object that you want to initialize.

pshared The value that you want to use for the process-shared attribute of the spinlock. The possible values are:

- PTHREAD_PROCESS_SHARED — the spinlock may be operated on by any thread that has access to the memory where the spinlock is allocated, even if it's allocated in memory that's shared by multiple processes.
- PTHREAD_PROCESS_PRIVATE — the spinlock can be operated on only by threads created within the same process as the thread that initialized the spinlock. If threads of differing processes attempt to operate on such a spinlock, the behavior is undefined.

Library:

libc

Description:

The *pthread_spin_init()* function allocates the resources required for the thread spinlock *spinner*, and initializes *spinner* to an unlocked state.

Any thread that can access the memory where *spinner* is allocated can operate on the spinlock.

Results are undefined if you call *pthread_spin_init()* on a *spinner* that's already initialized, or if you try to use a spinlock that hasn't been initialized.

Returns:

Zero on success, or an error number to indicate the error.

Errors:

EAGAIN	The system doesn't have the resources required to initialize a new spinlock.
EBUSY	The process spinlock, *spinner*, is in use by another thread and can't be initialized.
EINVAL	Invalid **`pthread_spinlock_t`** object *spinner*.
ENOMEM	The system doesn't have enough free memory to create the new spinlock.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_spin_destroy(), *pthread_spin_lock()*, *pthread_spin_trylock()*, *pthread_spin_unlock()*

pthread_spin_lock()

Lock a thread spinlock

Synopsis:

```
#include <pthread.h>

int pthread_spin_lock( pthread_spinlock_t * spinner );
```

Arguments:

spinner	A pointer to the **pthread_spinlock_t** object that you want to lock.

Library:

libc

Description:

The *pthread_spin_lock()* function locks the thread spinlock specified by *spinner*. If *spinner* isn't immediately available, *pthread_spin_lock()* blocks until *spinner* can be locked.

If a thread attempts to lock a spinlock that's already locked via *pthread_spin_lock()* or *pthread_spin_trylock()*, the thread returns EDEADLK.

Returns:

EOK	Success.
EAGAIN	Insufficient resources available to lock *spinner*.
EDEADLK	The calling thread already holds *spinner*s lock.
EINVAL	Invalid **pthread_spinlock_t** object *spinner*.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

You may not get the desired behavior from this function because the spinlocks are implemented using mutexes. If you really want to use a spinlock, you must use the *_pthread_spin_lock()* function.

See also:

pthread_spin_destroy(), *pthread_spin_init()*, *pthread_spin_trylock()*, *pthread_spin_unlock()*

pthread_spin_trylock()

Try to lock a thread spinlock

Synopsis:

```
#include <pthread.h>

int pthread_spin_trylock(
        pthread_spinlock_t * spinner );
```

Arguments:

spinner	A pointer to the **pthread_spinlock_t** object that you want to try to lock.

Library:

libc

Description:

The *pthread_spin_trylock()* function attempts to lock the thread spinlock specified by *spinner*. It returns immediately if *spinner* can't be locked.

If a thread attempts to lock a spinlock that it's already locked via *pthread_spin_lock()* or *pthread_spin_trylock()*, the thread deadlocks.

Returns:

EOK	Success.
EAGAIN	Insufficient resources available to lock *spinner*.
EBUSY	The thread spinlock *spinner* is already locked by another thread.
EINVAL	Invalid **pthread_spinlock_t** object *spinner*.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_spin_destroy(), *pthread_spin_init()*, *pthread_spin_lock()*, *pthread_spin_unlock()*

pthread_spin_unlock()

Unlock a thread spinlock

Synopsis:

```
#include <pthread.h>

int pthread_spin_unlock( spinlock_t * spinner );
```

Arguments:

spinner	A pointer to the **pthread_spinlock_t** object that you want to unlock.

Library:

libc

Description:

The *pthread_spin_unlock()* function unlocks the thread spinlock specified by *spinner*, which was locked with *pthread_spin_lock()* or *pthread_spin_trylock()*.

If there are threads spinning on *spinner*, the spinlock becomes available, and an unspecified thread acquires the lock.

Returns:

EOK	Success.
EINVAL	Invalid process spinlock *spinner*.
EPERM	The calling thread doesn't hold the lock.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_spin_destroy(), *pthread_spin_init()*, *pthread_spin_lock()*, *pthread_spin_trylock()*

pthread_testcancel()

Test thread cancellation

Synopsis:

```
#include <pthread.h>

void pthread_testcancel( void );
```

Library:

libc

Description:

The *pthread_testcancel()* function creates a cancellation point in the calling thread. This function has no effect if cancellation is disabled.

Classification:

POSIX 1003.1 (Threads)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cancel(), *pthread_setcancelstate()*, *pthread_setcanceltype()*, *ThreadCancel()*

pthread_timedjoin()

Join a thread, with a time limit

Synopsis:

```
#include <pthread.h>

int pthread_timedjoin(
        pthread_t thread,
        void** value_ptr,
        const struct timespec* abstime );
```

Arguments:

thread	The target thread whose termination you're waiting for.
value_ptr	NULL, or a pointer to a location where the function can store the value passed to *pthread_exit()* by the target thread.
abstime	A pointer to a **timespec** structure that specifies the maximum time to wait for the join, expressed as an absolute time.

Library:

libc

Description:

The *pthread_timedjoin()* function is similar to *pthread_join()*, except that an error of ETIMEDOUT is returned if the join doesn't occur before the absolute time specified by *abstime* passes (i.e. the system time is greater than or equal to *abstime*):

> If you are not too long, I will wait here for you all my life.
> — Oscar Wilde, *The Importance of Being Earnest*

The *pthread_timedjoin()* function blocks the calling thread until the target thread *thread* terminates, unless *thread* has already terminated.

If *value_ptr* is non-NULL and *pthread_timedjoin()* returns successfully, then the value passed to *pthread_exit()* by the target thread is placed in *value_ptr*. If the target thread has been canceled then *value_ptr* is set to PTHREAD_CANCELED.

The target thread must be joinable. Multiple *pthread_join()*, *pthread_timedjoin()*, *ThreadJoin()*, and *ThreadJoin_r()* calls on the same target thread aren't allowed. When *pthread_timedjoin()* returns successfully, the target thread has been terminated.

Returns:

EOK	Success.
EBUSY	The thread *thread* is already being joined.
EDEADLK	The thread *thread* is the calling thread.
EFAULT	A fault occurred trying to access the buffers provided.
EINTR	The function call was interrupted.
EINVAL	The thread *thread* isn't joinable.
ESRCH	The thread *thread* doesn't exist.
ETIMEDOUT	The absolute time specified in *abstime* passed before the join occurred.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_create(), *pthread_detach()*, *pthread_exit()*, *pthread_join()*, *ThreadJoin()*, *ThreadJoin_r()*, `timespec`

_pulse

Structure that describes a pulse

Synopsis:

```
#include <sys/neutrino.h>

struct _pulse {
    uint16_t                    type;
    uint16_t                    subtype;
    int8_t                      code;
    uint8_t                     zero[3];
    union sigval                value;
    int32_t                     scoid;
};
```

Description:

The **_pulse** structure describes a *pulse*, a fixed-size, nonblocking message that carries a small payload (four bytes of data plus a single byte code). The members include:

type _PULSE_TYPE (0)

subtype _PULSE_SUBTYPE (0)

code A code that identifies the type of pulse. The QNX Neutrino OS reserves the negative codes, including the following:

- _PULSE_CODE_UNBLOCK
- _PULSE_CODE_DISCONNECT
- _PULSE_CODE_THREADDEATH
- _PULSE_CODE_COIDDEATH
- _PULSE_CODE_NET_ACK, _PULSE_CODE_NET_UNBLOCK, and _PULSE_CODE_NET_DETACH — reserved for the **io_net** resource manager.

You can define your own pulses, with a code in the range from _PULSE_CODE_MINAVAIL through _PULSE_CODE_MAXAVAIL.

value Information that's relevant to the code:

- _PULSE_CODE_UNBLOCK — the receive ID (*rcvid*) associated with the blocking message.
- _PULSE_CODE_DISCONNECT — no value defined.
- _PULSE_CODE_THREADDEATH — the thread ID of the thread that died.
- _PULSE_CODE_COIDDEATH — the connection ID of a connection that was attached to a destroyed channel.

For more details, see *ChannelCreate()*.

If you define your own pulses, you can decide what information you want to store in this field.

scoid Server connection ID.

Classification:

QNX Neutrino

See also:

ChannelCreate(), *MsgReceive()*, *MsgReceivePulse()*, *MsgReceivePulsev()*, *MsgReceivev()*, *MsgSendPulse()*, **sigevent**

pulse_attach()

Attach a handler function to a pulse code

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int pulse_attach( dispatch_t * dpp,
                  int flags,
                  int code,
                  int (* func)
                      ( message_context_t * ctp,
                        int code,
                        unsigned flags,
                        void * handle ),
                  void * handle );
```

Arguments:

dpp The dispatch handle, as returned by *dispatch_create()*.

flags Currently, the following flag is defined in **<sys/dispatch.h>**:

- MSG_FLAG_ALLOC_PULSE — allocate and attach a pulse code that's different than any other code that was either given to *pulse_attach()* through the *code* argument, or allocated by *pulse_attach()*. The allocated code is in the range _PULSE_CODE_MINAVAIL and _PULSE_CODE_MAXAVAIL.

code The pulse code that you want to attach the function to.

func The function that you want to call when a message in the given range is received; see "Handler function," in the documentation for *message_attach()*.

handle An arbitrary handle that you want to associate with data for the defined message range. This handle is passed to *func*.

Library:

libc

Description:

The *pulse_attach()* function attaches a pulse *code* to a user-supplied function *func*. You can use the same function *func* with *message_attach()*.

When the resource manager receives a pulse that matches *code*, it calls *func*. This user-supplied function is responsible for doing any specific work needed to handle the pulse pointed to by *ctp->msg.pulse*. The *handle* passed to the function is the *handle* initially passed to *pulse_attach()*. The *handle* may be a device entry you want associated with the pulse *code*.

You typically use *pulse_attach()* to associate pulses generated by interrupt handlers or timers with a routine in the main program of your resource manager. By examining *ctp->rcvid*, the *func* function can determine whether a pulse or message was received.

Returns:

If MSG_FLAG_ALLOC_PULSE is specified, the function returns the allocated pulse code; otherwise, it returns the *code* that's passed in. On failure, -1 is returned (*errno* is set).

Errors:

EAGAIN	Couldn't allocate a pulse *code*.
EINVAL	The pulse *code* is out of range, or it's already registered.
ENOMEM	Insufficient memory to allocate internal data structures.

Examples:

```
#include <sys/dispatch.h>
#include <time.h>
#include <stdio.h>
#include <stdlib.h>

int my_func( ... ) {

   .
   .
   .

}

int main( int argc, char **argv ) {
   dispatch_t    *dpp;
   int           flag = 0, code, mycode;

   if ( ( dpp = dispatch_create() ) == NULL ) {
      fprintf( stderr, "%s: Unable to allocate \
               dispatch handle.\n",argv[0] );
      return EXIT_FAILURE;
   }

   .
   .
   .

   mycode = ...;

   if ( (code = pulse_attach( dpp, flag, mycode,
                &my_func, NULL)) == -1 ) {
      fprintf ( stderr, "Failed to attach code %d.\n", mycode );
      return 1;
   }
   /* else successfully attached a pulse code */

   .
   .
   .
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

message_attach(), *pulse_detach()*

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

pulse_detach()

Detach a handler function from a pulse code

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int pulse_detach( dispatch_t * dpp,
                  int code,
                  int flags );
```

Arguments:

dpp The dispatch handle, as returned by *dispatch_create()*.

code The pulse code that you want to detach.

flags Reserved; pass 0 for this argument.

Library:

libc

Description:

The *pulse_detach()* function detaches the pulse *code*, for dispatch handle *dpp*, that was attached with *pulse_attach()*.

Returns:

0 Success.

-1 The pulse *code* doesn't match any attached pulse code.

Examples:

```
#include <sys/dispatch.h>
#include <time.h>
#include <stdio.h>
#include <stdlib.h>

int my_func( ... ) {

   ⋮
```

```
}

int main( int argc, char **argv ) {
   dispatch_t    *dpp;
   int           flag=0, code, mycode;

   if ( ( dpp = dispatch_create() ) == NULL ) {
      fprintf( stderr, "%s: Unable to allocate \
               dispatch handle.\n",argv[0] );
      return EXIT_FAILURE;
   }

   .
   .
   .
   if ( (code = pulse_attach( dpp, flag, mycode,
                &my_func, NULL)) == -1 ) {
       fprintf ( stderr, "Failed to attach pulse code %d.\n", \
                 mycode );
       return 1;
   }

   .
   .
   .

   if ( pulse_detach ( dpp, code, flag ) == -1 ) {
      fprintf ( stderr, "Failed to detach code %d.\n", code );
      return 1;
   }
   /* else message was detached */

   .
   .
   .
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

message_detach(), *pulse_attach()*

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

Synopsis:

```
#include <stdio.h>

int putc( int c,
          FILE* fp );
```

Arguments:

c The character that you want to write.

fp The stream you want to write the character on.

Library:

libc

Description:

The *putc()* macro writes the character *c*, cast as **(int)(unsigned char)**, to the output stream designated by *fp*.

Returns:

The character written, cast as **(int)(unsigned char)**, or EOF if an error occurs (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE* fp;
    int c;

    fp = fopen( "file", "r" );
    if( fp != NULL ) {
        while( (c = fgetc( fp )) != EOF ) {
            putc( c, stdout );
        }
        fclose( fp );
    }
```

```
    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

putc() is a macro.

See also:

errno, *ferror()*, *fopen()*, *fputc()*, *fputchar()*, *fputs()*, *getc()*, *getc_unlocked()*, *getchar()*, *getchar_unlocked()*, *putchar()*, *putchar_unlocked()*, *putc_unlocked()*, *puts()*

putc_unlocked()

Write a character to an output stream

Synopsis:

```
#include <stdio.h>

int putc_unlocked( int c,
                   FILE *stream );
```

Arguments:

c	The character that you want to write.
stream	The stream you want to write the character on.

Library:

libc

Description:

The *putc_unlocked()* function is a thread-unsafe version of *putc()*. You can use it safely only when the invoking thread has locked *stream* using *flockfile()* (or *ftrylockfile()*) and *funlockfile()*.

Returns:

The character written, cast as **(int)(unsigned char)**, or EOF if an error occurred (*errno* is set).

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getc(), getchar(), getchar_unlocked(), getc_unlocked(), putc(), putchar(), putchar_unlocked()

putchar()

Write a character to standard output

Synopsis:

```
#include <stdio.h>

int putchar( int c );
```

Arguments:

c The character that you want to write.

Library:

libc

Description:

The *putchar()* function writes the character *c*, cast as **(int)(unsigned char)**, to the *stdout* stream. It's equivalent to:

```
fputc( c, stdout );
```

Returns:

The character written, cast as **(int)(unsigned char)**, or EOF if an error occurs (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    int c;

    fp = fopen( "file", "r" );
    c = fgetc( fp );
    while( c != EOF ) {
        putchar( c );
        c = fgetc( fp );
    }
```

```
    fclose( fp );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fputc(), fputchar(), fputs(), getc(), getc_unlocked(), getchar(), getchar_unlocked(), putc(), putchar_unlocked(), putc_unlocked()

putchar_unlocked()

Write a character to stdout

Synopsis:

```
#include <stdio.h>

int putchar_unlocked( int c );
```

Arguments:

c The character that you want to write.

Library:

libc

Description:

The *putchar_unlocked()* function is a thread-unsafe version of *putchar()*. You can use it safely only when the invoking thread has locked *stdout* using *flockfile()* (or *ftrylockfile()*) and *funlockfile()*.

Returns:

The character written, cast as **(int)(unsigned char)**, or EOF if an error occurred (*errno* is set).

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getc(), getc_unlocked(), getchar(), getchar_unlocked(), putc(), putc_unlocked(), putchar()

putenv()

Add, change or delete an environment variable

Synopsis:

```
#include <stdlib.h>

int putenv( const char *env_name );
```

Arguments:

env_name	The name of the environment, and what you want to do to it; see below.

Library:

libc

Description:

The *putenv()* function uses *env_name*, in the form *name=value*, to set the environment variable *name* to *value*. This function alters *name* if it exists, or creates a new environment variable.

In either case, *env_name* becomes part of the environment; subsequent modifications to the string pointed to by *env_name* affect the environment.

The space for environment names and their values is limited. Consequently, *putenv()* can fail when there's insufficient space remaining to store an additional value.

☞ If *env_name* isn't a literal string, you should duplicate the string, since *putenv()* doesn't copy the value. For example:

```
putenv( strdup( buffer ) );
```

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Errors:

ENOMEM There wasn't enough memory to expand the environment.

Examples:

The following gets the string currently assigned to **INCLUDE** and displays it, assigns a new value to it, gets and displays it, and then removes **INCLUDE** from the environment.

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char *path;
    path = getenv( "INCLUDE" );
    if( path != NULL ) {
        printf( "INCLUDE=%s\n", path );
    }

    if( putenv( "INCLUDE=/src/include" ) != 0 ) {
        printf( "putenv() failed setting INCLUDE\n" );
        return EXIT_FAILURE;
    }

    path = getenv( "INCLUDE" );
    if( path != NULL ) {
        printf( "INCLUDE=%s\n", path );
    }

    unsetenv( "INCLUDE" );

    return EXIT_SUCCESS;
}
```

This program produces the following output:

```
INCLUDE=/usr/nto/include
INCLUDE=/src/include
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

Never use *putenv()* with an automatic variable.

The *putenv()* function manipulates the environment pointed to by the global *environ* variable.

See also:

clearenv(), *environ*, *errno*, *getenv()*, *setenv()*, *unsetenv()*

puts()

Write a string to stdout

Synopsis:

```
#include <stdio.h>

int puts( const char *buf );
```

Arguments:

buf A pointer to the zero-terminated string that you want to write.

Library:

libc

Description:

The *puts()* function writes the character string pointed to by *buf* to the *stdout* stream, and appends a newline character to the output. The terminating NUL character of *buf* isn't written.

Returns:

A nonnegative value for success, or EOF if an error occurs (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;
    char buffer[80];

    fp = freopen( "file", "r", stdin );
    while( gets( buffer ) != NULL ) {
        puts( buffer );
    }
    fclose( fp );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fputs(), gets(), putc()

putspent()

Put an entry into the shadow password database

Synopsis:

```
#include <sys/types.h>
#include <shadow.h>

int putspent( const struct spwd* p,
              FILE* fp );
```

Arguments:

p A pointer to a **spwd** structure that contains the entry that you want to write.

fp The stream that you want to write the entry on.

Library:

libc

Description:

The *putspent()* function writes a shadow password entry into the specified file. This function is the inverse of *getspent()*.

Given a pointer to a **spwd** structure created by the *getspent()* or the *getspnam()* routine, *putspent()* writes a line on the stream *fp*, which matches the format of **</etc/shadow>**. The **spwd** structure contains the following members:

```
char    *sp_namp;     /* name */
char    *sp_pwdp;     /* encrypted password */
long    sp_lstchg;    /* last changed */
long    sp_max;       /* #days (min) to change */
long    sp_min;       /* #days (max) to change */
long    sp_warn;      /* #days to warn */
long    sp_inact;     /* #days of inactivity */
long    sp_expire;    /* date to auto-expire */
long    sp_flag;      /* reserved */
```

If the *sp_min*, *sp_max*, *sp_lstchg*, *sp_warn*, *sp_inact*, or *sp_expire* field of the structure is **-1**, or if *sp_flag* = **0**, the corresponding **</etc/shadow>** field is cleared.

Returns:

Zero.

Errors:

The *putspent()* function uses the following functions, and as a result *errno* can be set to an error for any of these calls:

- *fclose()*
- *fgets()*
- *fopen()*
- *fseek()*
- *rewind()*

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <pwd.h>
#include <shadow.h>

/*
 * This program adds a user and password to
 * a temporary file which can then be used with
 * fgetspent() (of course the password
 * string should be encrypted already etc.)
 */

int main( int argc, char** argv )
{
     FILE* fp;
 struct spwd   sp;
     char              pwbuf[80], nambuf[80];

     memset(&sp, 0, sizeof(sp));
     if (argc < 2) {
           printf("%s filename \n", argv[0]);
           return(EXIT_FAILURE);
     }

     if (!(fp = fopen(argv[1], "w"))) {
           fprintf(stderr, "Can't open file %s \n", argv[1]);
           perror("Problem ");
```

```
            return(1);
        }

        printf("Enter a userid: ");
        if (!gets(nambuf)) {
            fprintf(stderr, "Can't get username  string\n");
        }
        sp.sp_namp = nambuf;

        printf("Enter a password: ");
        if (!gets(pwbuf)) {
            fprintf(stderr, "Can't get username  password\n");
        }
        sp.sp_pwdp = pwbuf;

        putspent(&sp, fp);
        fclose(fp);
    return( EXIT_SUCCESS );
}
```

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

errno, *getgrent()*, *getlogin()*, *getpwnam()*, *getpwuid()*, *getspent()*, *getspnam()*, *setspent()*

pututline()

Write an entry in the user-information file

Synopsis:

```
#include <utmp.h>

void pututline( struct utmp * __utmp );
```

Arguments:

__utmp	A pointer to the **utmp** structure for the entry that you want to add.

Library:

libc

Description:

The *pututline()* function writes out the supplied **utmp** structure into the **utmp** file.

It uses *getutid()* to search forward for the proper place if it finds that it isn't already there. Normally, you should search for the proper entry by calling *getutent()*, *getutid()*, or *getutline()*, If so, *pututline()* doesn't search. If *pututline()* doesn't find a matching slot for the new entry, it adds a new entry to the end of the file.

When called by a non-**root** user, *pututline()* invokes a *setuid()* root program to verify and write the entry, since the file specified in *_PATH_UTMP* is normally writable only by root. In this event, the *ut_name* field must correspond to the actual user name associated with the process; the *ut_type* field must be either USER_PROCESS or DEAD_PROCESS; the *ut_line* field must be a device-special file and be writable by the user.

Returns:

A pointer to the **utmp** structure.

Files:

_PATH_UTMP

Specifies the user information file.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The most current entry is saved in a static structure. Copy it before making further accesses.

On each call to either *getutid()* or *getutline()*, the routine examines the static structure before performing more I/O. If the contents of the static structure match what it's searching for, the function looks no further. For this reason, to use *getutline()* to search for multiple occurrences, zero out the static area after each success, or *getutline()* will return the same structure over and over again.

There's one exception to the rule about emptying the structure before further reads are done: the implicit read done by *pututline()* (if it finds that it isn't already at the correct place in the file) doesn't hurt the contents of the static structure returned by the *getutent()*, *getutid()* or *getutline()* routines, if the user has just modified those contents and passed the pointer back to *pututline()*.

These routines use buffered standard I/O for input, but *pututline()* uses an unbuffered nonstandard write to avoid race conditions between processes trying to modify the **utmp** and **wtmp** files.

See also:

endutent(), *getutent()*, *getutid()*, *getutline()*, *setutent()*, **utmp**, *utmpname()*

login in the *Utilities Reference*

putw()

Put a word on a stream

Synopsis:

```
#include <wchar.h>

int putw( int w,
          FILE *stream );
```

Arguments:

w	The word that you want to write.
stream	The stream that you want to write a word on.

Library:

libc

Description:

The *putw()* function writes the C **int** (word) *w* to the standard I/O output *stream* (at the position of the file pointer, if defined). The size of a word is the size of an integer, and varies from machine to machine. The *putw()* function neither assumes nor causes special alignment in the file.

Returns:

0	Success.
1	An error occurred; *errno* is set.

Errors:

EFBIG	The file is a regular file and an attempt was made to write at or beyond the offset maximum.

Classification:

Legacy Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Because of possible differences in word length and byte ordering, files written using *putw()* are machine-dependent, and might not be read correctly using *getw()* on a different processor.

See also:

errno, *ferror()*, *fopen()*, *fputc()*, *fputchar()*, *fputs()*, *getw()*, *putchar()*, *putchar_unlocked()*, *putc_unlocked()*, *puts()*

putwc()

Write a wide character to a stream

Synopsis:

```
#include <wchar.h>

wint_t putwc( wchar_t wc,
              FILE * fp );
```

Arguments:

wc The wide character that you want to write.

fp The stream that you want to write the wide character on.

Library:

libc

Description:

The *putwc()* functions writes the wide character specified by *wc*, cast as **(wint_t)(wchar_t)**, to the output stream specified by *fp*.

Returns:

The wide character written, cast as **(wint_t)(wchar_t)**, or WEOF if an error occurs (*errno* is set).

If *wc* exceeds the valid wide-character range, the value returned is the wide character written, not *wc*.

Errors:

EAGAIN The O_NONBLOCK flag is set for *fp* and would have been blocked by this operation.

EBADF The file descriptor for *fp* isn't valid for writing.

EFBIG The file exceeds the maximum file size, the process's file size limit, or the function can't write at or beyond the offset maximum.

EINTR	A signal terminated the write operation; no data was transferred.
EIO	A physical I/O error has occurred or all of the following conditions were met: • The process is in the background. • TOSTOP is set. • The process is blocking/ignoring SIGTTOU. • The process group is orphaned.
EPIPE	Can't write to pipe or FIFO because it's closed; a SIGPIPE signal is also sent to the thread.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *getwc()*, *getwchar()*

"Stream I/O functions" and "Wide-character functions" in the summary of functions chapter.

putwchar()

Write a wide character to a stdout

Synopsis:

```
#include <wchar.h>

wint_t putwchar( wchar_t wc );
```

Arguments:

wc The wide character that you want to write.

Library:

libc

Description:

The *putwchar()* function writes the wide character *wc*, cast as **(wint_t)(wchar_t)**, to the *stdout* stream. It's equivalent to:

```
fputwc( wc, stdout );
```

Returns:

The wide character written, cast as **(wint_t)(wchar_t)** or WEOF if an error occurs (*errno* is set).

If *wc* exceeds the valid wide-character range, the value returned is the wide character written, not *wc*.

Errors:

EAGAIN The O_NONBLOCK flag is set for *fp* and would have been blocked by this operation.

EBADF The file descriptor for *fp* isn't valid for writing.

EFBIG The file exceeds the maximum file size, the process's file size limit, or the function can't write at or beyond the offset maximum.

EINTR	A signal terminated the write operation; no data was transferred.
EIO	A physical I/O error has occurred or all of the following conditions were met: • The process is in the background. • TOSTOP is set. • The process is blocking/ignoring SIGTTOU. • The process group is orphaned.
EPIPE	Can't write to pipe or FIFO because it's closed; a SIGPIPE signal is also sent to the thread.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *getwc()*, *getwchar()*

"Stream I/O functions" and "Wide-character functions" in the summary of functions chapter.

pwrite(), pwrite64()

Write into a file without changing the file pointer

Synopsis:

```
#include <unistd.h>

ssize_t pwrite( int filedes,
                const void* buff,
                size_t nbytes,
                off_t offset );

ssize_t pwrite64( int filedes,
                  const void* buff,
                  size_t nbytes,
                  off64_t offset );
```

Arguments:

filedes	The file descriptor for the file you want to write in.
buff	A pointer to a buffer that contains the data you want to write.
nbytes	The number of bytes to write.
offset	The desired position inside the file.

Library:

libc

Description:

The *pwrite()* function performs the same action as *write()*, except that it writes into a given position without changing the file pointer.

The *pwrite64()* function is a 64-bit version of *pwrite()*.

Returns:

The number of bytes actually written, or -1 if an error occurred (*errno* is set).

Errors:

EAGAIN	The O_NONBLOCK flag is set for the file descriptor, and the process would be delayed in the write operation.
EBADF	The file descriptor, *fildes*, isn't a valid file descriptor open for writing.
EFBIG	File is too big.
EINTR	The write operation was interrupted by a signal, and either no data was transferred, or the resource manager responsible for that file doesn't report partial transfers.
EIO	A physical I/O error occurred (for example, a bad block on a disk). The precise meaning is device-dependent.
ENOSPC	There's no free space remaining on the device containing the file.
ENOSYS	The *pwrite()* function isn't implemented for the filesystem specified by *filedes*.
EPIPE	An attempt was made to write to a pipe (or FIFO) that isn't open for reading by any process. A SIGPIPE signal is also sent to the process.

Classification:

pwrite() is standard Unix; *pwrite64()* is for large-file support

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

close(), creat(), dup(), dup2(), errno, fcntl(), lseek(), open(), pipe(), pread(), read(), readv(), select(), write(), writev()

Synopsis:

```
#include <unistd.h>

char* qnx_crypt( const char* key,
                 const char* salt );
```

Arguments:

key A NUL-terminated string (normally a password typed by a user).

salt A two-character string chosen from the set [**a-zA-Z0-9./**]. This function doesn't validate the values for *salt*, and values outside this range may cause undefined behavior. This string is used to perturb the algorithm in one of 4096 different ways.

Library:

libc

Description:

The *qnx_crypt()* function performs password encryption. It's a variant of the standard *crypt()* function that uses an encryption similar to, but not compatible with, the Data Encryption Standard (DES) encryption. This function is provided for compatibility with QNX 4.

The *qnx_crypt()* function checks only the first eight characters of *key*.

Returns:

A pointer to the encrypted value, or NULL on failure.

Examples:

```
#include <unistd.h>

int main(int argc, char **argv) {
        char salt[3];
```

```
        char string[20];
        char *result;

        strcpy(string, "thomasf");
        salt[0] = 'a';
        salt[1] = 'B';
        salt[2] = 0;

        result = qnx_crypt(string, salt);
        printf("Result is [%s] --> [%s] \n", string, result);

        return 0;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The return value points to static data that's overwritten by each call to *qnx_crypt()*.

See also:

crypt(), *encrypt()*, *getpass()*, *setkey()*

login in the *Utilities Reference*

qsort()

Sort an array

Synopsis:

```
#include <stdlib.h>

void qsort( void* base,
            size_t num,
            size_t width,
            int (*compare) (
                const void* ,
                const void* ) );
```

Arguments:

base	A pointer to the array that you want to sort.
num	The number of elements in the array.
width	The size of each element, in bytes.
compare	A pointer to a function that compares two entries. It's called with two arguments that point to elements in the array. The comparison function must return an integer less than, equal to, or greater than zero if the first argument is less than, equal to, or greater than the second argument.

Library:

libc

Description:

The *qsort()* function sorts the *base* array using the comparison function specified by *compare*. The array must have at least *num* elements, each of *width* bytes.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

char* some_strs[] = { "last", "middle", "first" };

int compare( const void* op1, const void* op2 )
{
    const char **p1 = (const char **) op1;
    const char **p2 = (const char **) op2;

    return( strcmp( *p1, *p2 ) );
}

int main( void )
{
    qsort( some_strs,
           sizeof( some_strs ) / sizeof( char * ),
           sizeof(char *),
           compare );

    printf( "%s %s %s\n",
        some_strs[0], some_strs[1], some_strs[2] );

    return EXIT_SUCCESS;
}
```

produces the output:

```
first last middle
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

bsearch()

Raccept()

Accept a connection on a socket (via a SOCKS server)

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

int Raccept( int s,
             struct sockaddr * addr,
             int * addrlen );
```

Arguments:

s	A socket that's been created with *socket()*.
addr	A result parameter that's filled in with the address of the connecting entity, as known to the communications layer. The exact format of the *addr* parameter is determined by the domain in which the connection was made.
addrlen	A value-result parameter. It should initially contain the amount of space pointed to by *addr*; on return it contains the actual length (in bytes) of the address returned. This call is used with connection-based socket types, currently with SOCK_STREAM.

Library:

libsocks

Description:

The *Raccept()* function is a cover function for *accept()* — the difference is that *Raccept()* does its job via a SOCKS server.

For more information about SOCKS and its libraries, see the appendix, SOCKS — A Basic Firewall.

Returns:

A descriptor for the accepted socket, or -1 if an error occurs (*errno* is set).

Classification:

SOCKS

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

accept(), *Rbind()*, *Rconnect()*, *Rgetsockname()*, *Rlisten()*, *Rrcmd()*, *Rselect()*, *SOCKSinit()*

SOCKS — A Basic Firewall

raise()

Generate a signal

Synopsis:

```
#include <signal.h>

int raise( int condition );
```

Arguments:

condition	The signal that you want to raise. For more information, see *signal()*.

Library:

libc

Description:

The *raise()* function generates the signal specified by *condition*. Use *SignalAction()* or *signal()* to specify the actions to take when a signal is received.

Returns:

0 if the specified *condition* is sent, or nonzero if an error occurs (*errno* is set).

The *raise()* function doesn't return if the action for that signal is to terminate the program or to transfer control using the *longjmp()* function.

Errors:

EAGAIN	Insufficient system resources are available to deliver the signal.
EINVAL	The value of *condition* isn't a valid signal number.

Examples:

Wait until a SIGINT signal is received. The signal is automatically raised on iteration 10000, or when you press Ctrl – C:

```
#include <stdio.h>
#include <stdlib.h>
#include <signal.h>

sig_atomic_t signal_count;
sig_atomic_t signal_number;

void alarm_handler( int signum )
{
    ++signal_count;
    signal_number = signum;
}

int main( void )
{
    unsigned long i;

    signal_count = 0;
    signal_number = 0;
    signal( SIGINT, alarm_handler );

    printf("Iteration:      ");
    for( i = 0; i < 100000; ++i ) {
        printf( "\b\b\b\b\b%*d", 5, i );

        if( i == 10000 ) raise( SIGINT );

        if( signal_count > 0 ) break;
    }

    if( i == 100000 ) {
        printf( "\nNo signal was raised.\n" );
    } else if( i == 10000 ) {
        printf( "\nSignal %d was raised by the "
                "raise() function.\n", signal_number );
    } else {
        printf( "\nUser raised signal #%d.\n",
                signal_number );
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

signal(), SignalAction()

rand()

Generate a pseudo-random integer

Synopsis:

```
#include <stdlib.h>

int rand( void );
```

Library:

libc

Description:

The *rand()* function computes a pseudo-random integer in the range 0 to RAND_MAX. You can start the sequence at different values by calling *srand()*.

The *rand_r()* function is a thread-safe version of *rand()*.

Returns:

A pseudo-random integer.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    int i;

    for( i=1; i < 10; ++i ) {
        printf( "%d\n", rand() );
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	No

See also:

lrand48(), *nrand48()*, *rand_r()*, *srand()*

rand_r()

Generate a pseudo-random integer in a thread-safe manner

Synopsis:

```
#include <stdlib.h>

int rand_r( unsigned int* seed );
```

Arguments:

seed A pointer to the seed for the sequence of pseudo-random numbers. If you call *rand_r()* with the same initial value for the *seed*, the same sequence is generated.

Library:

libc

Description:

If _POSIX_THREAD_SAFE_FUNCTIONS is defined, *rand_r()* computes a sequence of pseudo-random integers in the range 0 to RAND_MAX.

Returns:

A pseudo-random integer.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

rand(), srand()

random()

Generate a pseudo-random number from the default state

Synopsis:

```
#include <stdlib.h>

long random( void );
```

Library:

libc

Description:

The *random()* function uses a nonlinear additive feedback random-number generator employing a default state array size of 31 long integers to return successive pseudo-random numbers in the range from 0 to 231-1. The period of this random-number generator is approximately 16 × (231-1). The size of the state array determines the period of the random-number generator. Increasing the state array size increases the period.

Use this function in conjunction with the following:

initstate()	Initialize the state of the pseudo-random number generator.
setstate()	Specify the state of the pseudo-random number generator.
srandom()	Set the seed used by the pseudo-random number generator.

The *random()* and *srandom()* functions have (almost) the same calling sequence and initialization properties as *rand()* and *srand()* The difference is that *rand()* produces a much less random sequence. In fact, the low dozen bits generated by *rand()* go through a cyclic pattern. All the bits generated by *random()* are usable. For example,

```
random()&01
```

produces a random binary value.

Unlike *srand()*, *srandom()* doesn't return the old seed because the amount of state information used is much more than a single word. The *initstate()* and *setstate()* routines are provided to deal with restarting/changing random number generators. With 256 bytes of state information, the period of the random-number generator is greater than 269.

Like *rand()*, *random()* produces by default a sequence of numbers that can be duplicated by calling *srandom()* with 1 as the seed.

If *initstate()* hasn't been called, *random()* behaves as though *initstate()* had been called with *seed*=1 and *size*=128.

If *initstate()* is called with *size* less than 8, *random()* uses a simple linear congruential random number generator.

Returns:

The generated pseudo-random number.

Examples:

See *initstate()*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	No

See also:

drand48(), initstate(), rand(), setstate(), srand(), srandom()

Rbind()

Bind a name to a socket (via a SOCKS server)

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

int Rbind( int s,
           const struct sockaddr * name,
           int namelen );
```

Arguments:

s	The file descriptor to be bound.
name	A pointer to the **sockaddr** structure that holds the address to be bound to the socket. The socket length and format depend upon its address family.
namelen	The length of the **sockaddr** structure pointed to by *name*.

Library:

libsocks

Description:

The *Rbind()* function is a cover function for *bind()* — the difference is that *Rbind()* does its job via a SOCKS server.

For more information about SOCKS and its libraries, see the appendix, SOCKS — A Basic Firewall.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Classification:

SOCKS

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

bind() Raccept(), Rconnect(), Rgetsockname(), Rlisten(), Rrcmd(), Rselect(), SOCKSinit()

SOCKS — A Basic Firewall

rcmd()

Execute a command on a remote host

Synopsis:

```
#include <unistd.h>

int rcmd( char ** ahost,
          unsigned short inport,
          const char * locuser,
          const char * remuser,
          const char * cmd,
          int * fd2p );
```

Arguments:

ahost	The name of the host that you want to execute the command on. If the function can find the host, it sets **ahost* to the standard name of the host.
inport	The well-known Internet port on the host, where the server resides.
locuser	The user ID on the local machine.
remuser	The user ID on the remote machine.
cmd	The command that you want to execute.
fd2p	See below.

Library:

libsocket

Description:

The *rcmd()* function is used by the superuser to execute a command, *cmd*, on a remote machine using an authentication scheme based on reserved port numbers. The **rshd** server (among others) uses the *rcmd()*, *rresvport()*, and *ruserok()* functions.

The *rcmd()* function looks up the host **ahost* by means of *gethostbyname()*, and returns -1 if the host doesn't exist. Otherwise,

**ahost* is set to the standard name of the host and a connection is established to a server residing at the well-known Internet port *inport*.

If the connection succeeds, a SOCK_STREAM socket in the Internet domain is returned to the caller and given to the remote command as standard input and standard output.

If *fd2p* is:	Then:
Nonzero	An auxiliary channel to a control process is set up, and a descriptor for it is placed in **fd2p*. The control process will return diagnostic output from the command (unit 2) on this channel and will accept bytes as signal numbers to be forwarded to the command's process group.
Zero	The standard error (unit 2 of the remote command) is made the same as the standard output and no provision is made for sending arbitrary signals to the remote process (although you may be able to get its attention by using out-of-band data).

The protocol is described in detail in **`rshd`** in the *Utilities Reference*.

Returns:

A valid socket descriptor; or -1 if an error occurs and a message is printed to standard error.

Errors:

The error code EAGAIN is overloaded to mean "All network ports in use."

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

gethostbyname(), *rresvport()*, *ruserok()*

rlogin, **rlogind**, **rsh**, **rshd** in the *Utilities Reference*

Rconnect()

Initiate a connection on a socket (via a SOCKS server)

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

int Rconnect( int s,
              const struct sockaddr * name,
              int namelen);
```

Arguments:

s	The descriptor of the socket on which to initiate the connection.
name	The name of the socket to connect to for a SOCK_STREAM connection.
namelen	The length of the *name*, in bytes.

Library:

libsocks

Description:

The *Rconnect()* function is a cover function for *connect()* — the difference is that *Rconnect()* does its job via a SOCKS server.

For more information about SOCKS and its libraries, see the appendix, SOCKS — A Basic Firewall.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Classification:

SOCKS

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

connect() Raccept(), Rbind(), Rgetsockname(), Rlisten(), Rrcmd(), Rselect(), SOCKSinit()

SOCKS — A Basic Firewall

rdchk()

Check to see if a read is likely to succeed

Synopsis:

```
#include <unix.h>

int rdchk( int fd );
```

Arguments:

fd The file descriptor that you want to check.

Library:

libc

Description:

The *rdchk()* function checks to see if a read from the file descriptor, *fd*, is likely to succeed.

Returns:

The number of characters waiting to be read, or -1 if an error occurred (*errno* is set).

Errors:

ENOTTY The *fd* argument isn't the file descriptor for a character device.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

tcischars()

re_comp()

Compile a regular expression

Synopsis:

```
#include <unix.h>

char *re_comp( char *s );
```

Arguments:

s A string that contains the regular expression that you want to compile. This string must end with a null byte and may include newline characters. If this argument is NULL, the current regular expression remains unchanged.

Library:

libc

Description:

The *re_comp()* function converts a regular expression string (RE) into an internal form suitable for pattern matching. Use this function with *re_exec()*.

The *re_comp()* and *re_exec()* functions support simple regular expressions. The regular expressions of the form **\{m\}**, **\{m,\}**, or **\{m,n\}** aren't supported.

For better portability, use *regcomp()*, *regerror()*, and *regexec()* instead of these functions.

Returns:

NULL if the string pointed to by *s* was successfully converted. Otherwise, a pointer to one of the following error message strings is returned:

- **No previous regular expression**
- **Regular expression too long**

- **unmatched \(**
- **missing]**
- **too many \(\) pairs**
- **unmatched \)**

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

re_exec(), *regcomp()*, *regerror()*, *regexec()*

grep in the *Utilities Reference*

re_exec()

Execute a regular expression

Synopsis:

```
#include <unix.h>

int re_exec( char *s );
```

Arguments:

s A pointer to the string that you want to compare to the current regular expression. This string must end with a null byte and may include newline characters.

Library:

libc

Description:

The *re_exec()* function compares the string pointed to by the string argument with the last regular expression passed to *re_comp()*.

The *re_comp()* and *re_exec()* functions support simple regular expressions. The regular expressions of the form **\{m\}**, **\{m,\}**, or **\{m,n\}** aren't supported.

☞ For better portability, use *regcomp()*, *regerror()*, and *regexec()* instead of these functions.

Returns:

1 The string matches the last compiled regular expression.

0 The string doesn't match the last compiled regular expression.

-1 The compiled regular expression is invalid (indicating an internal error).

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

re_comp(), *regcomp()*, *regerror()*, *regexec()*

grep in the *Utilities Reference*

read()

Read bytes from a file

Synopsis:

```
#include <unistd.h>

ssize_t read( int fildes,
              void* buf,
              size_t nbyte );
```

Arguments:

fildes	The descriptor of the file that you want to read from.
buf	A pointer to a buffer where the function can store the data that it reads.
nbyte	The number of bytes that you want to read.

Library:

libc

Description:

The *read()* function attempts to read *nbyte* bytes from the file associated with the open file descriptor, *fildes*, into the buffer pointed to by *buf*.

If *nbyte* is zero, *read()* returns zero, and has no other effect.

On a regular file or other file capable of seeking, *read()* starts at a position in the file given by the file offset associated with *fildes*. Before successfully returning from *read()*, the file offset is incremented by the number of bytes actually read.

The *read()* call ignores advisory locks that you may have set with *fcntl()*.

On a file not capable of seeking, *read()* starts at the current position.

When *read()* returns successfully, its return value is the number of bytes actually read and placed in the buffer. This number will never

be greater than *nbyte*, although it may be less than *nbyte* for one of the following reasons:

- The number of bytes left in the file is less than *nbyte*.
- The *read()* request was interrupted by a signal.
- The file is a pipe (or FIFO) or a special file, and has fewer than *nbyte* bytes immediately available for reading. For example, reading from a file associated with a terminal may return one typed line of data.

If *read()* is interrupted by a signal before it reads any data, it returns a value of -1 and sets *errno* to EINTR. However, if *read()* is interrupted by a signal after it has successfully read some data, it returns the number of bytes read.

No data is transferred past the current end-of-file. If the starting position is at or after the end-of-file, *read()* returns zero. If the file is a device special file, the result of subsequent calls to *read()* will work, based on the then current state of the device (that is, the end of file is transitory).

If the value of *nbyte* is greater than INT_MAX, *read()* returns -1 and sets *errno* to EINVAL. See **<limits.h>**.

When attempting to read from an empty pipe or FIFO:

1. If no process has the pipe open for writing, *read()* returns 0 to indicate end-of-file.
2. If a process has the pipe open for writing, and O_NONBLOCK is set, *read()* returns -1, and *errno* is set to EAGAIN.
3. If a process has the pipe open for writing, and O_NONBLOCK is clear, *read()* blocks until some data is written, or the pipe is closed by all processes that had opened it for writing.

When attempting to read from a file (other than a pipe or FIFO) that support nonblocking reads and has no data currently available:

1. If O_NONBLOCK is set, *read()* returns -1, and *errno* is set to EAGAIN.

2 If O_NONBLOCK is clear, *read()* blocks until some data is available.

3 The O_NONBLOCK flag has no effect if some data is available.

If you call *read()* on a portion of a file, prior to the end-of-file, that hasn't been written, it returns bytes with the value zero.

If *read()* succeeds, the *st_atime* field of the file is marked for update.

Returns:

The number of bytes actually read, or -1 (*errno* is set).

Errors:

EAGAIN	The O_NONBLOCK flag is set for the file descriptor, and the process would be delayed in the read operation.
EBADF	The file descriptor, *fildes*, isn't a valid file descriptor open for reading.
EINTR	The read operation was interrupted by a signal, and either no data was transferred, or the resource manager responsible for that file doesn't report partial transfers.
EIO	A physical I/O error occurred (for example, a bad block on a disk). The precise meaning is device-dependent.
ENOSYS	The *read()* function isn't implemented for the filesystem specified by *filedes*.
EOVERFLOW	The file is a regular file and an attempt is made to read at or beyond the offset maximum associated with the file.

Examples:

```
#include <sys/types.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>
#include <stdio.h>

int main( void )
{
    int fd;
    int size_read;
    char buffer[80];

    /* Open a file for input */
    fd = open( "myfile.dat", O_RDONLY );

    /* Read the text */
    size_read = read( fd, buffer,
                      sizeof( buffer ) );

    /* Test for error */
    if( size_read == -1 ) {
        perror( "Error reading myfile.dat" );
        return EXIT_FAILURE;
    }

    /* Close the file */
    close( fd );

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

close(), creat(), dup(), dup2(), errno, fcntl(), lseek(), open(), pipe(), readblock(), readv(), select(), write(), writev()

read_main_config_file()

Read the **snmpd.conf** *file*

Synopsis:

```
#include <snmp/snmp_api.h>

int read_main_config_file(
              struct snmpd_conf_data * info );
```

Arguments:

info A pointer to a **snmpd_conf_data** structure that the function can fill with the configuration information. For more information about this structure, see below.

Library:

libsnmp

Description:

The *read_main_config_file()* function fills the *info* structure with data from the **snmpd.conf** file (see the *Utilities Reference*). This information is useful if you wish to know what configuration information the SNMP agent was started with.

The string pointers in this structure, if not NULL, point to strings obtained by using *malloc()*; you can free them by calling *free()*.

If the data for a member of the structure isn't available, the structure member isn't modified. You should use *memset()* to set the structure to 0 before calling *read_main_config_file()*.

To locate the **snmpd.conf** file, this function first checks the **SNMPCONFIGFILE** environment variable. If this isn't found, the default, **snmpd.conf**, is used. If the specified file couldn't be accessed, the structure members aren't updated.

The **snmpd_conf_data** structure is defined in **<snmp_api.h>**, and contains the following members:


```
struct snmpd_conf_data{
  char* main_config_fname;
  char* party_conf_fname;
  char* view_conf_fname;
  char* context_conf_fname;
  char* acl_conf_fname;
  char* sysContact;
  char* sysLocation;
  char* sysName;
  char* private_community;
  char* public_community;
  char* trap_sink;
  char* trap_community;
  int conf_authentraps;
};
```

The members of this structure are:

main_config_fname

snmpd.conf file location.

party_conf_fname

party.conf file location.

view_conf_fname

view.conf file location.

context_conf_fname

context.conf file location.

acl_conf_fname

acl.conf file location.

sysContact *system.sysContact* string.

sysLocation *system.sysLocation* string.

sysName *system.sysName* string.

private_community

Private level community string name to use.

public_community

Public level community string name to use.

trap_sink Destination host to send trap messages.

trap_community

Community name to use for trap messages.

conf_authentraps

Enable authentication traps (1 means enable, 2 means disable).

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

ENOENT The **`snmpd.conf`** file wasn't found.

Files:

`snmpd.conf` Default SNMP configuration file. For more information, see the *Utilities Reference*.

Environment variables:

SNMPCONFIGFILE

Location of the SNMP configuration file.

Classification:

SNMP

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

snmp_close(), *snmp_free_pdu()*, *snmp_open()*, **snmp_pdu**, *snmp_pdu_create()*, *snmp_read()*, *snmp_select_info()*, *snmp_send()*, **snmp_session**, *snmp_timeout()*

snmpd, **snmpd.conf** in the *Utilities Reference*

readblock()

Read blocks of data from a file

Synopsis:

```
#include <unistd.h>

int readblock( int fd,
               size_t blksize,
               unsigned block,
               int numblks,
               void *buff );
```

Arguments:

fd	The file descriptor for the file you want to read from.
blksize	The number of bytes in each block of data.
block	The block number from which to start reading.
numblks	The number of blocks to read.
buff	A pointer to a buffer where the function can store the data that it reads.

Library:

libc

Description:

The *readblock()* function reads *numblks* blocks of data from the file associated with the open file descriptor *fd*, into the buffer pointed to by *buff*, starting at block number *block* (blocks are numbered starting at 0). The *blksize* argument specifies the size of a block, in bytes.

This function is useful for direct access to raw blocks on a block special device (for example, raw disk blocks) but may also be used for high-speed access to database files, for example. (The speed gain is through the combined seek/read implicit in this call, and the ability to transfer more than the *read()* function's limit of INT_MAX bytes at a time.)

If *numblks* is zero, *readblock()* returns zero and has no other results.

On successful completion, *readblock()* returns the number of blocks actually read and placed in the buffer. This number is never greater than *numblks*. The value returned may be less than *numblks* if one of the following occurs:

- The number of blocks left before the end-of-file is less than *numblks*.
- The process requests more blocks than implementation limits allow to be read in a single atomic operation.
- A read error occurred after reading at least one block.

If a read error occurs on the first block, *readblock()* returns -1 and sets *errno* to EIO.

Returns:

The number of blocks actually read. If an error occurs, it returns -1, sets *errno* to indicate the error, and the contents of the buffer pointer to by *buff* are left unchanged.

Errors:

EBADF	The *fd* argument isn't a valid file descriptor open for reading a block-oriented device.
EIO	A physical read error occurred on the first block.
EINVAL	The starting position is invalid (0 or negative) or beyond the end of the disk.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

writeblock()

readcond()

Read data from a terminal device

Synopsis:

```
#include <unistd.h>

int readcond( int fd,
              void * buf,
              int n,
              int min,
              int time,
              int timeout );
```

Arguments:

fd The file descriptor associated with the terminal device that you want to read from.

buf A pointer to a buffer into which *readcond()* can put the data.

n The maximum number of bytes to read.

min, time, timeout

When used in RAW mode, these arguments override the behavior of the *MIN* and *TIME* members of the terminal's **termios** structure. For more information, see below.

Library:

libc

Description:

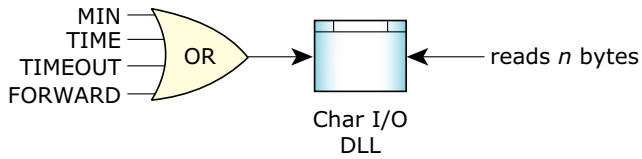
The *readcond()* function reads up to *n* bytes of data from the terminal device indicated by *fd* into the buffer pointed to by *buf*.

This function is an alternative to the *read()* function for terminal devices, providing additional arguments for timed read operations. These additional arguments can be used to minimize overhead when dealing with terminal devices.

The three arguments (*min*, *time*, and *timeout*), when used on terminal devices in RAW mode, override the behavior of the *MIN* and *TIME*

elements of the currently defined **termios** structure (for the duration of this call only). The **termios** structure also defines a forwarding character (in *c_cc[VFWD]*) that can be used to bypass *min*, *time* and *timeout*.

The normal case of a simple read by an application would block until at least one character was available.



MIN	Respond when at least this number of characters arrives.
TIME	Respond if a pause in the character stream occurs.
TIMEOUT	Respond if an overall amount of time passes.
FORWARD	Respond if a framing character arrives.

Conditions that satisfy an input request.

In the case where multiple conditions are specified, the read will be satisfied when any one of them is satisfied.

MIN

The qualifier *MIN* is useful when an application has knowledge of the number of characters it expects to receive.

Any protocol that knows the character count for a frame of data can use *MIN* to wait for the entire frame to arrive. This significantly reduces IPC and process scheduling. *MIN* is often used in conjunction with *TIME* or *TIMEOUT*. *MIN* is part of the POSIX standard.

TIME

The qualifier *TIME* is useful when an application is receiving streaming data and wishes to be notified when the data stops or pauses. The pause time is specified in 1/10 of a second. *TIME* is part of the POSIX standard.

TIMEOUT

The qualifier *TIMEOUT* is useful when an application has knowledge of how long it should wait for data before timing out. The timeout is specified in 1/10 of a second.

Any protocol that knows the character count for a frame of data it expects to receive can use *TIMEOUT*. This in combination with the baud rate allows a reasonable guess to be made when data should be available. It acts as a deadman timer to detect dropped characters. It can also be used in interactive programs with user input to timeout a read if no response is available within a given time.

TIMEOUT is a QNX extension and isn't part of the POSIX standard.

FORWARD

The qualifier *FORWARD* is useful when a protocol is delimited by a special framing character. For example, the PPP protocol used for TCP/IP over a serial link start and end its packets with a framing character. When used in conjunction with *TIMEOUT*, the *FORWARD* character can greatly improve the efficiency of a protocol implementation. The protocol process will receive complete frames, rather than character by character. In the case of a dropped framing character, *TIMEOUT* or *TIME* can be used to quickly recover.

This greatly minimizes the amount of IPC work for the OS and results in a much lower processor utilization for a given TCP/IP data rate. It is interesting to note that PPP doesn't contain a character count for its frames. Without the data-forwarding character, an implementation would be forced to read the data one character at a time.

FORWARD is a QNX extension and isn't part of the POSIX standard.

To enable the *FORWARD* character, you must set the VFWD character in the *c_cc* member of the **termios** structure:

```
/* PPP forwarding character */
const char fwd_char = 0x7e;

#include <termios.h>

⋮
```

```
int fd;
struct termios termio;

⋮

tcgetattr( fd, &termio );
termio.c_cc[VFWD] = fwd_char;
tcsetattr( fd, TCSANOW, &termio );
```

The following table summarizes the interaction of *min*, *time*, and *timeout*:

min	*time*	*timeout*	**Description**
0	0	0	Returns immediately with as many bytes as are currently available (up to *n* bytes).
M	0	0	Return with up to *n* bytes only when at least *M* bytes are available.
0	*T*	0	Return with up to *n* bytes when at least one byte is available, or *T* * .1 sec has expired.
M	*T*	0	Return with up to *n* bytes when either *M* bytes are available, or at least one byte has been received and the inter-byte time between any subsequently received characters exceeds *T* * .1 sec.
0	0	*t*	RESERVED.
M	0	*t*	Return with up to *n* bytes when *t* * .1 sec has expired, or *M* bytes are available.
0	*T*	*t*	RESERVED.

continued...

min	*time*	*timeout*	**Description**
M	*T*	*t*	Return with up to *n* bytes when *M* bytes are available, or *t* * .1 sec has expired and no characters are received, or at least one byte has been received and the inter-byte time between any subsequently received characters exceeds *T* * .1 sec.

Note that when *timeout* is zero, the behavior of *min* and *time* is exactly the same as the behavior of the **`MIN`** and **`TIME`** parameters of the **`termios`** controlling structure. Thus, *readcond()* can be used as a higher speed alternative to consecutive calls of *tcgetattr()*, *tcsetattr()*, and *read()* when dealing with RAW terminal I/O.

The (*M*, 0, *t*) case is useful for communications protocols that cannot afford to block forever waiting for data that may never arrive.

The (*M*, *T*, *t*) case is provided to permit *readcond()* to return when a burst of data ends (as in the (*M*, *T*, 0) case), but also to return if no burst at all is detected within a reasonable amount of time.

Returns:

The number of bytes read, or -1 if an error occurs (*errno* is set).

Errors:

EAGAIN — The O_NONBLOCK flag is set on this *fd*, and the process would have been blocked in trying to perform this operation.

EBADF — The argument *fd* is invalid or file isn't opened for reading.

EINTR — The *readcond()* call was interrupted by the process being signalled.

EIO — This process isn't currently able to read data from this *fd*.

ENOSYS This function isn't supported for this *fd*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *read()*, *tcgetattr()*, *tcsetattr()*, **termios**

readdir()

Read a directory entry

Synopsis:

```
#include <dirent.h>

struct dirent * readdir( DIR * dirp );
```

Arguments:

dirp A pointer to the directory stream to be read.

Library:

libc

Description:

The *readdir()* function reads the next directory entry from the directory specified by *dirp*, which is the value returned by a call to *opendir()*.

You can call *readdir()* repeatedly to list all of the entries contained in the directory specified by the pathname given to *opendir()*. The *closedir()* function must be called to close the directory stream and free the memory allocated by *opendir()*.

The **<dirent.h>** file defines the **struct dirent** and the **DIR** type used by the *readdir()* family of functions.

☞ The result of using a directory stream after one of the *exec*()* or *spawn*()* family of functions is undefined. After a call to *fork()*, either the parent *or* the child (but not both) can continue processing the directory stream, using the *readdir()* and *rewinddir()* functions. If both the parent and child processes use these functions, the result is undefined. Either (or both) processes may use *closedir()*.

The **<dirent.h>** file also defines the following macros for accessing extra data associated with the **dirent** structure:

_DEXTRA_FIRST(*pdirent*)

Get a pointer to the first block of data associated with the structure pointed to by *pdirent*.

_DEXTRA_NEXT(*last*)

Get the block of data that follows the block pointed to by *last*.

_DEXTRA_VALID(*extra*, *pdirent*)

Evaluates to 1 if *extra* is a pointer to a valid block of data associated with the structure pointed to by *pdirent*.

You can use these macros to traverse the data associated with the **dirent** structure like this:

```
for( extra = _DEXTRA_FIRST(dirent);
    _DEXTRA_VALID(extra, dirent);
    extra = _DEXTRA_NEXT(extra)) {
      switch(extra->d_type) {
        /* No data */
         case _DTYPE_NONE  :
            break;
         /* Data includes information as returned by stat() */
         case _DTYPE_STAT  :
            break;
         /* Data includes information as returned by lstat() */
         case _DTYPE_LSTAT :
            break;
         ...
     }
}
```

Returns:

A pointer to a **struct dirent** object for success, or NULL if the end of the directory stream is encountered or an error occurs (*errno* is set).

Errors:

EBADF	The *dirp* argument doesn't refer to an open directory stream.

EOVERFLOW	One of the values in the structure to be returned can't be represented correctly.

Examples:

Get a list of files contained in the directory **/home/fred**:

```
#include <stdio.h>
#include <dirent.h>
#include <stdlib.h>

int main( void )
{
    DIR* dirp;
    struct dirent* direntp;

    dirp = opendir( "/home/fred" );
    if( dirp != NULL ) {
        for(;;) {
            direntp = readdir( dirp );
            if( direntp == NULL ) break;

            printf( "%s\n", direntp->d_name );
        }

        closedir( dirp );

        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	No

See also:

closedir(), errno, lstat(), opendir(), readdir_r(), rewinddir(), seekdir(), telldir(), stat()

readdir_r()

Get information about the next matching filename

Synopsis:

```
#include <sys/types.h>
#include <dirent.h>

int readdir_r( DIR * dirp,
               struct dirent * entry,
               struct direct ** result );
```

Arguments:

dirp	A pointer to the directory stream to be read.
entry	A pointer to a **dirent** structure where the function can store the directory entry.
result	The address of a location where the function can store a pointer to the information found.

Library:

libc

Description:

If _POSIX_THREAD_SAFE_FUNCTIONS is defined, *readdir_r()* initializes the **dirent** structure referenced by *entry* with the directory entry at the current position in the directory stream referred to by *dirp*, and stores a pointer to this structure in *result*.

The storage pointed by *entry* must be large enough for a **dirent** structure with the *s_name* member an array of char containing at least NAME_MAX plus one element.

The **`struct dirent`** structure *doesn't* include space for the pathname. You must provide it:

```
struct dirent *entry;
entry = malloc( sizeof(*entry) + NAME_MAX + 1 );
```

Returns:

EOK Success.

On failure, *errno* is set.

Errors:

EBADF	The *dirp* argument doesn't refer to an open directory stream.
EOVERFLOW	One of the values in the structure to be returned can't be represented correctly.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

closedir(), errno, opendir(), readdir(), seekdir(), telldir(), rewinddir()

Place the contents of a symbolic link into a buffer

Synopsis:

```
#include <unistd.h>

int readlink( const char* path,
              char* buf,
              size_t bufsiz );
```

Arguments:

path	The name of the symbolic link.
buf	A pointer to a buffer where the function can store the contents of the symbolic link (i.e. the path linked to).
bufsiz	The size of the buffer.

Library:

libc

Description:

The *readlink()* function places the contents of the symbolic link named by *path* into the buffer pointed to by *buf*, which has a size of *bufsiz*. The contents of the returned symbolic link doesn't include a NULL terminator. Its length must be determined from the **stat** structure returned by *lstat()*, or by the return value of the *readlink()* call.

If *readlink()* is successful, up to *bufsiz* bytes from the contents of the symbolic link are placed in *buf*.

Returns:

The number of bytes placed in the buffer, or -1 if an error occurs (*errno* is set).

Errors:

EACCES — Search permission is denied for a component of the *path* prefix.

EINVAL — The named file isn't a symbolic link.

ELOOP — A loop exists in the symbolic links encountered during resolution of the path argument, and more than SYMLOOP_MAX symbolic links were encountered.

ENAMETOOLONG — A component of the *path* exceeded NAME_MAX characters, or the entire pathname exceeded PATH_MAX characters.

ENOENT — The named file doesn't exist.

ENOSYS — Links aren't supported by the resource manager associated with path.

ENOTDIR — A component of the *path* prefix named by path isn't a directory.

Examples:

```
/*
 * Read the contents of the named symbolic links
 */
#include <limits.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

char buf[PATH_MAX + 1];

int main( int argc, char** argv )
{
  int n;
  int len;
  int ecode = 0;

  for( n = 1; n < argc; ++n ) {
    if(( len = readlink( argv[n], buf, PATH_MAX )) == -1) {
      perror( argv[n] );
```

```
      ecode++;
    }
    else {
      buf[len] = '\0';
      printf( "%s -> %s\n", argv[n], buf );
    }
  }

  return( ecode );
}
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, lstat(), symlink()

readv()

Read bytes from a file

Synopsis:

```
#include <sys/uio.h>

ssize_t readv( int fildes,
               const iov_t* iov,
               int iovcnt );
```

Arguments:

fildes	The descriptor of the file that you want to read from.
iov	An array of **iov_t** objects where the function can store the data that it reads.
iovcnt	The number of entries in the *iov* array. The maximum number of entries is UIO_MAXIOV.

Library:

libc

Description:

The *readv()* function attempts to read from the file associated with the open file descriptor, *fildes*, placing the data into *iovcnt* buffers specified by the members of the *iov* array: *iov*[0], *iov[1]*, . . . , *iov*[*iovcnt*-1].

On a regular file or other file capable of seeking, *readv()* starts at a position in the file given by the file offset associated with *fildes*. Before successfully returning from *readv()*, the file offset is incremented by the number of bytes actually read.

The *iov_t* structure contains the following members:

iov_base	The base address of a memory area where data should be placed.
iov_len	The length of the memory area.

The *readv()* function always fills one buffer completely before proceeding to the next.

The *readv()* call ignores advisory locks that may have been set by the *fcntl()* function.

On a file not capable of seeking, *readv()* starts at the current position.

When *readv()* returns successfully, its return value is the number of bytes actually read and placed in the buffer. This number will never be greater than the combined sizes of the *iov* buffers, although it may be less for one of the following reasons:

- The number of bytes left in the file is less than the combined size of the *iov* buffers.
- The *readv()* request was interrupted by a signal.
- The file is a pipe (or FIFO) or a special file, and has fewer bytes immediately available for reading. For example, reading from a file associated with a terminal may return one typed line of data.

If *readv()* is interrupted by a signal before it reads any data, it returns a value of -1 and sets *errno* to EINTR. However, if *readv()* is interrupted by a signal after it has successfully read some data, it returns the number of bytes read.

No data is transferred past the current end-of-file. If the starting position is at or after the end-of-file, *readv()* returns zero. If the file is a device special file, the result of subsequent calls to *readv()* will work, based on the then current state of the device (that is, the end of file is transitory).

When attempting to read from an empty pipe or FIFO:

1. If no process has the pipe open for writing, *readv()* returns 0 to indicate end-of-file.
2. If a process has the pipe open for writing, and O_NONBLOCK is set, *readv()* returns -1 and sets *errno* to EAGAIN.

3 If a process has the pipe open for writing, and O_NONBLOCK is clear, *read()* blocks until some data is written, or the pipe is closed by all processes that had opened it for writing.

When attempting to read from a file (other than a pipe or FIFO) that supports nonblocking reads and has no data currently available:

1 If O_NONBLOCK is set, *readv()* returns -1 and sets *errno* to EAGAIN.

2 If O_NONBLOCK is clear, *readv()* blocks until some data is available.

3 The O_NONBLOCK flag has no effect if some data is available.

If you call *readv()* on a portion of a file, prior to the end-of-file, that hasn't been written, it returns bytes with the value zero.

If *readv()* succeeds, the *st_atime* field of the file is marked for update.

Returns:

The number of bytes read, or -1 if an error occurred (*errno* is set).

Errors:

EAGAIN	The O_NONBLOCK flag is set for the file descriptor, and the process would be delayed in the read operation.
EBADF	The file descriptor, *fildes*, isn't a valid file descriptor open for reading.
EINTR	The read operation was interrupted by a signal, and either no data was transferred, or the resource manager responsible for that file doesn't report partial transfers.
EINVAL	The *iovcnt* argument is less than or equal to 0, or greater than UIO_MAXIOV.

EIO	A physical I/O error occurred (for example, a bad block on a disk). The precise meaning is device-dependent.
ENOSYS	The *readv()* function isn't implemented for the filesystem specified by *filedes*.
EOVERFLOW	The file is a regular file and an attempt is made to read at or beyond the offset maximum associated with the file.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

close(), creat(), dup(), dup2(), errno, fcntl(), lseek(), open(), pipe(), read(), readblock(), select(), write(), writev()

realloc()

Allocate, reallocate or free a block of memory

Synopsis:

```
#include <stdlib.h>

void* realloc( void* old_blk,
               size_t size );
```

Arguments:

old_blk	A pointer to the block of memory to be allocated, reallocated, or freed.
size	The new size, in bytes, for the block of memory.

Library:

libc

Description:

The *realloc()* function allocates, reallocates, or frees the block of memory specified by *old_blk* based on the following rules:

- If *old_blk* is NULL, a new block of memory of *size* bytes is allocated.
- If the *size* is zero, the *free()* function is called to release the memory pointed to by *old_blk*.
- Otherwise, *realloc()* reallocates space for an object of *size* bytes by:
  - shrinking the size of the allocated memory block *old_blk* when *size* is smaller than the current size of *old_blk*
  - extending the allocated size of the allocated memory block *old_blk* if there is a large enough block of unallocated memory immediately following *old_blk*
  - allocating a new block with the appropriate *size*, and copying the contents of *old_blk* to this new block

The *realloc()* function allocates memory from the heap.

Because it's possible that a new block will be allocated, any pointers into the old memory could be invalidated. These pointers will point to freed memory, with possible disastrous results, when a new block is allocated.

The *realloc()* function returns NULL when the memory pointed to by *old_blk* can't be reallocated. In this case, the memory pointed to by *old_blk* isn't freed, so be careful to maintain a pointer to the old memory block so it can be freed later.

In the following example, *buffer* is set to NULL if the function fails, and won't point to the old memory block. If *buffer* is your only pointer to the memory block, then you have lost access to this memory.

```
buffer = (char* )realloc( buffer, 100 );
```

Returns:

A pointer to the start of the allocated memory, or NULL if an error occurred (*errno* is set).

Errors:

ENOMEM	Not enough memory.
EOK	No error.

Examples:

```
#include <stdlib.h>
#include <malloc.h>

int main( void )
{
    char* buffer;
    char* new_buffer;

    buffer = (char* )malloc( 80 );
```

```
    new_buffer = (char* )realloc( buffer, 100 );
    if( new_buffer == NULL ) {
        /* not able to allocate larger buffer */

        return EXIT_FAILURE;
    } else {
      buffer = new_buffer;
    }


    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

calloc(), free(), malloc(), sbrk()

realpath()

Resolve a pathname

Synopsis:

```
#include <stdlib.h>

char * realpath( const char * pathname,
                 char * resolved_name );
```

Arguments:

pathname	The path name that you want to resolve.
resolved_name	A pointer to a buffer where the function can store the resolved name.

Library:

libc

Description:

The *realpath()* function resolves all symbolic links, extra slash (**/**) characters and references to **/./** and **/../** in *pathname*, and copies the resulting absolute pathname into the memory referenced by *resolved_name*.

To determine the size of the buffer pointed to by *resolved_name*, call *fpathconf()* or *pathconf()* with an argument of _PC_PATH_MAX.

This function resolves both absolute and relative paths and returns the absolute pathname corresponding to pathname. All but the last component of pathname must exist when *realpath()* is called.

Returns:

A pointer to *resolved_name*, or NULL if an error occurs, in which case *resolved_name* contains the pathname that caused the problem.

Errors:

The *realpath()* function may fail and set the external variable *errno* for any of the errors specified for the library functions *chdir()*, *close()*, *lstat()*, *open()*, *readlink()* and *getcwd()*.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

This implementation of *realpath()* differs slightly from the Solaris implementation. QNX always returns absolute pathnames, whereas the Solaris implementation, under certain circumstances, returns a relative *resolved_name* when given a relative pathname.

See also:

getcwd()

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

ssize_t recv( int s,
              void * buf,
              size_t len,
              int flags );
```

Arguments:

s The descriptor for the socket; see *socket()*.

buf A pointer to a buffer where the function can store the message.

len The size of the buffer.

flags A combination formed by ORing one or more of the values:

- MSG_OOB — process out-of-band data. This flag requests receipt of out-of-band data that wouldn't be received in the normal data stream. You can't use this flag with protocols that place expedited data at the head of the normal data queue.
- MSG_PEEK — peek at the incoming message. This flag causes the receive operation to return data from the beginning of the receive queue without removing that data from the queue. Thus, a subsequent receive call will return the same data.
- MSG_WAITALL — wait for full request or error. This flag requests that the operation block until the full request is satisfied. But the call may still return less data than requested if a signal is caught, if an error or disconnect occurs, or if the next data to be received is of a different type than that returned.

☞ The MSG_WAITALL flag isn't supported by the tiny TCP/IP stack. For more information, see **npm-ttcpip.so** in the *Utilities Reference*.

Library:

libsocket

Description:

The *recv()* function receives a message from a socket. It's normally used only on a *connected* socket — see *connect()* — and is identical to *recvfrom()* with a zero *from* parameter.

This routine returns the length of the message on successful completion. If a message is too long for the supplied buffer, *buf*, then excess bytes might be discarded, depending on the type of socket that the message is received from; see *socket()*.

If no messages are available at the socket, the receive call waits for a message to arrive, unless the socket is nonblocking — see *ioctl()* — in which case -1 is returned and the external variable *errno* is set to EWOULDBLOCK. Normally, the receive calls return any data available, up to the requested amount, rather than wait for the full amount requested; this behavior is affected by the socket-level options SO_RCVLOWAT and SO_RCVTIMEO described in *getsockopt()*.

You can use *select()* to determine when more data is to arrive.

Returns:

The number of bytes received, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	Invalid descriptor *s*.
EFAULT	The receive buffer is outside the process's address space.
EINTR	The receive was interrupted by delivery of a signal before any data was available.

ENOTCONN The socket is associated with a connection-oriented protocol and hasn't been connected; see *connect()* and *accept()*.

EWOULDBLOCK

Either the socket is marked nonblocking and the receive operation would block, or a receive timeout had been set and the timeout expired before data was received.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

connect(), *ioctl()*, *getsockopt()*, *read()*, *recvfrom()*, *recvmsg()*, *select()*, *socket()*

recvfrom()

Receive a message from the socket at a specified address

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

ssize_t recvfrom( int s,
                  void * buff,
                  size_t len,
                  int flags,
                  struct sockaddr * from,
                  socklen_t * fromlen );
```

Arguments:

s The descriptor for the socket; see *socket()*.

buf A pointer to a buffer where the function can store the message.

len The size of the buffer.

flags A combination formed by ORing one or more of the values:

- MSG_OOB — process out-of-band data. This flag requests receipt of out-of-band data that wouldn't be received in the normal data stream. You can't use this flag with protocols that place expedited data at the head of the normal data queue.
- MSG_PEEK — peek at the incoming message. This flag causes the receive operation to return data from the beginning of the receive queue without removing that data from the queue. Thus, a subsequent receive call will return the same data.
- MSG_WAITALL — wait for full request or error. This flag requests that the operation block until the full request is satisfied. But the call may still return less data than requested if a signal is caught, if an error or

disconnect occurs, or if the next data to be received is of a different type than that returned.

☞ The MSG_WAITALL flag isn't supported by the tiny TCP/IP stack. For more information, see **npm-ttcpip.so** in the *Utilities Reference*.

from NULL, or a pointer to a **sockaddr** object where the function can store the source address of the message.

fromlen A pointer to a **socklen_t** object that specifies the size of the *from* buffer. The function stores the actual size of the address in this object.

Library:

libsocket

Description:

The *recvfrom()* routine receives a message from the socket, *s*, whether or not it's connection-oriented.

If *from* is nonzero, and the socket is connectionless, the source address of the message is filled in. The parameter *fromlen* is a value-result parameter, initialized to the size of the buffer associated with *from*, and modified on return to indicate the actual size of the stored address.

This routine returns the length of the message on successful completion. If a message is too long for the supplied buffer, *buf*, excess bytes may be discarded depending on the type of socket that the message is received from — see *socket()*.

If no messages are available at the socket, the receive call waits for a message to arrive, unless the socket is nonblocking — see *ioctl()* — in which case *recvfrom()* returns -1 is returned and sets the external variable *errno* to EWOULDBLOCK. Normally, the receive calls return any data available, up to the requested amount, rather than wait for the full amount requested; this behavior is affected by the socket-level options SO_RCVLOWAT and SO_RCVTIMEO described in *getsockopt()*.

You can use *select()* to determine when more data is to arrive.

Returns:

The number of bytes received, or -1 if an error occurs (*errno* is set).

Errors:

EBADF — Invalid descriptor *s*.

EFAULT — The receive buffer pointer(s) point outside the process's address space.

EINTR — The receive was interrupted by delivery of a signal before any data was available.

ENOTCONN — The socket is associated with a connection-oriented protocol and hasn't been connected; see *connect()* and *accept()*.

EWOULDBLOCK — Either the socket is marked nonblocking and the receive operation would block, or a receive timeout had been set and the timeout expired before data was received.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

recv(), recvmsg(), select()

recvmsg()

Receive a message and its header from a socket

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

ssize_t recvmsg( int s,
                 struct msghdr * msg,
                 int flags );
```

Arguments:

s The descriptor for the socket; see *socket()*.

msg A pointer to a **msghdr** structure where the function can store the message header; see below.

len The size of the buffer.

flags A combination formed by ORing one or more of the values:

- MSG_OOB — process out-of-band data. This flag requests receipt of out-of-band data that wouldn't be received in the normal data stream. You can't use this flag with protocols that place expedited data at the head of the normal data queue.
- MSG_PEEK — peek at the incoming message. This flag causes the receive operation to return data from the beginning of the receive queue without removing that data from the queue. Thus, a subsequent receive call will return the same data.
- MSG_WAITALL — wait for full request or error. This flag requests that the operation block until the full request is satisfied. But the call may still return less data than requested if a signal is caught, if an error or disconnect occurs, or if the next data to be received is of a different type than that returned.

☞ The MSG_WAITALL flag isn't supported by the tiny TCP/IP stack. For more information, see **npm-ttcpip.so** in the *Utilities Reference*.

Library:

libsocket

Description:

The *recvmsg()* routine receives a message from a socket, *s*, whether or not it's connection-oriented.

The *recvmsg()* call uses a **msghdr** structure to minimize the number of directly supplied parameters. This structure, defined in **<sys/socket.h>**, has the following form:

```
struct msghdr {
     caddr_t msg_name;       /* optional address */
     u_int   msg_namelen;    /* size of address */
     struct  iovec *msg_iov; /* scatter/gather array */
     u_int   msg_iovlen;     /* # elements in msg_iov */
     caddr_t msg_control;    /* ancillary data, see below */
     u_int   msg_controllen; /* ancillary data buffer len */
     int     msg_flags;      /* flags on received message */
};
```

The *msg_name* and *msg_namelen* parameters specify the address (source address for *recvmsg()*; destination address for *sendmsg()*) if the socket is unconnected; the *msg_name* parameter may be given as a null pointer if no names are desired or required.

The *msg_iov* and *msg_iovlen* parameters describe scatter-gather locations, as discussed in *read()*.

The *msg_control* parameter, whose length is determined by *msg_controllen*, points to a buffer for other protocol-control related messages or for other miscellaneous ancillary data. The messages are of the form:

```
struct cmsghdr {
     u_int cmsg_len;    /* data byte count, including hdr */
     int cmsg_level;    /* originating protocol */
```

```
    int cmsg_type;      /* protocol-specific type */
                        /* followed by u_char cmsg_data[]; */
};
```

Currently, the tiny TCP/IP stack doesn't support ancillary data. The **msg_controllen** member of **struct msghdr** must be 0.

The *msg_flags* field is set on return according to the message received:

MSG_CTRUNC	Indicates that some control data was discarded due to lack of space in the buffer for ancillary data.
MSG_EOR	Indicates end-of-record; the data returned completed a record.
MSG_OOB	Indicates that expedited or out-of-band data was received.
MSG_TRUNC	Indicates that the trailing portion of a datagram was discarded because the datagram was larger than the buffer supplied.

Returns:

The number of bytes received, or -1 if an error occurs (*errno* is set).

Errors:

ENOMEM	Not enough memory.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

recv(), recvfrom(), sendmsg()

regcomp()

Compile a regular expression

Synopsis:

```
#include <regex.h>

int regcomp( regex_t * preg,
             const char * pattern,
             int cflags );
```

Arguments:

preg A pointer to a **regex_t** object where the function can store the compiled regular expression.

pattern The regular expression that you want to compile; see below.

cflags A bitwise inclusive OR of zero or more of the following flags:

- REG_EXTENDED — use Extended Regular Expressions.
- REG_ICASE — ignore differences in case.
- REG_NEWLINE — treat **<**newline**>** as a regular character.
- REG_NOSUB — report only success/failure in *regexec()*.

Library:

libc

Description:

The *regcomp()* function prepares the regular expression, *preg*, for use by the function *regexec()*, from the specification *pattern* and *cflags*. The member *re_nsub* of *preg* is set to the number of subexpressions in *pattern*.

The functions that deal with regular expressions (*regcomp()*, *regerror()*, *regexec()*, and *regfree()*) support two classes of regular

expressions, the *Basic* and *Extended Regular* Expressions. These classes are rigorously defined in IEEE P1003.2, *Regular Expression Notation*.

Basic Regular Expressions

The Basic Regular Expressions are composed of these terms:

x$	*x* at end of line ($ must be the last term).
^*x*	*x* at beginning of line (^ must be first the term).
*x**	Zero or more occurrences of *x*.
.	Any single character (except newline).
c	The character *c*.
xc	*x* followed by the character *c*.
cx	Character *c* followed by *x*.
[*cd*]	The characters *c* or *d*.
[*c*-*d*]	All characters between *c* and *d*, inclusive.
[^*c*]	Any character but *c*.

[[:*classname*:]]

Any of the following classes:

- **alnum**
- **alpha**
- **cntrl**
- **digit**
- **graph**
- **lower**
- **print**
- **punct**

- **space**
- **upper**
- **xdigit**

[[=*c*=]]	All character in the equivalence class with *c*.
[[=.=]]	All collating elements.
x{*m*,*n*}	*m* through *n* occurrences of *x*.
c	Character *c*, even if *c* is an operator.
\(*x*\)	A labeled subexpression, *x*.
m	The *m*th subexpression encountered.
xy	Expression *x* followed by *y*.

Extended Regular Expressions

The Extended Regular Expressions also include:

x+	One or more occurrences of *x*.
x?	Zero or one occurrences of *x*.
(*x*)	Subexpression *x* (for precedence handling).
x | *y*	Expression *x* OR *y*.

Returns:

0	Success.
<>0	An error occurred (use *regerror()* to get an explanation).

Examples:

```
/*
    The following example prints out all lines
    from FILE "f" that match "pattern".
*/
#include <stdio.h>
#include <regex.h>
#include <limits.h>

#define BUFFER_SIZE   512

void grep( char* pattern, FILE* f )
  {
    int t;
    regex_t re;
    char    buffer[BUFFER_SIZE];

    if ((t=regcomp( &re, pattern, REG_NOSUB )) != 0) {
      regerror(t, &re, buffer, sizeof buffer);
      fprintf(stderr,"grep: %s (%s)\n",buffer,pattern);
      return;
    }
    while( fgets( buffer, BUFFER_SIZE, f ) != NULL ) {
      if( regexec( &re, buffer, 0, NULL, 0 ) == 0 ) {
        fputs( buffer, stdout );
      }
    }
    regfree( &re );
  }
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Contributing author:

Henry Spencer. For copyright information, see Third-Party Copyright Notices in this reference.

See also:

regerror(), *regexec()*, *regfree()*

regerror()

Explain a regular expression error code

Synopsis:

```
#include <regex.h>

size_t regerror( int err,
                 const regex_t * reg,
                 char * buf,
                 size_t len );
```

Arguments:

err The value returned by a previous call to *regcomp()* or *regexec()*.

reg A pointer to the **regex_t** object for the regular expression that you provided to the failed call to *regcomp()* or *regexec()*.

buf A pointer to a buffer where the function can store the explanation.

len The length of the buffer, in characters.

Library:

libc

Description:

The *regerror()* function provides a string explaining an error code returned by *regcomp()* or *regexec()*. The string is copied into *buf* for up to *len* characters.

Returns:

The number of characters copied into the buffer.

Examples:

See *regcomp()*.

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Contributing author:

Henry Spencer. For copyright information, see Third-Party Copyright Notices in this reference.

See also:

regcomp(), *regexec()*, *regfree()*

regexec()

Compare a string with a compiled regular expression

Synopsis:

```
#include <regex.h>

int regexec( const regex_t * preg,
             const char * string,
             size_t nmatch,
             regmatch_t * pmatch,
             int eflags );
```

Arguments:

preg A pointer to the **regex_t** object for the regular expression that you want to execute. You must have compiled the expression by calling *regcomp()*.

string The string that you want to match against the regular expression.

nmatch The maximum number of matches to record in *pmatch*.

pmatch An array of **regmatch_t** objects where the function can record the matches; see below.

eflags Execution parameters to *regexec()*. For example, you may need to call *regexec()* multiple times if the line you're processing is too large to fit into *string*. The *eflags* argument is the bitwise inclusive OR of zero or more of the following flags:

- REG_NOTBOL — the *string* argument doesn't point to the beginning of a line.
- REG_NOTEOL — the end of *string* isn't the end of a line.

Library:

libc

Description:

The *regexec()* function compares *string* against the compiled regular expression *preg*. If *regexec()* finds a match it returns zero; otherwise, it returns nonzero.

The *preg* argument represents a compiled form of either a Basic Regular Expression or Extended Regular Expression. These classes are rigorously defined in IEEE P1003.2, *Regular Expression Notation*, and are summarized in the documentation for *regcomp()*.

The *regexec()* function records the matches in the *pmatch* array, with *nmatch* specifying the maximum number of matches to record. The **regmatch_t** structure contains the pointer members *rm_sp* and *rm_ep*, which are updated to identify the start and end of each matched substring. The pointers in *pmatch[0]* identify the substring corresponding to the entire expression, while those in *pmatch[1...nmatch]* identify up to the first *nmatch* subexpressions. Unused elements of the *pmatch* array are set to NULL.

You can disable the recording of substrings by either specifying REG_NOSUB in *regcomp()*, or by setting *nmatch* to zero.

Returns:

0	The *string* argument matches *preg*.
<>0	A match wasn't found, or an error occurred (use *regerror()* to get an explanation).

Examples:

See *regcomp()*.

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Contributing author:

Henry Spencer. For copyright information, see Third-Party Copyright Notices in this reference.

See also:

regcomp(), *regerror()*, *regfree()*

regfree()

Release memory allocated for a regular expression

Synopsis:

```
#include <regex.h>

void regfree( regex_t * preg );
```

Arguments:

preg A pointer to the **regex_t** object for the regular expression that you want to free; see *regcomp()*.

Library:

libc

Description:

The *regfree()* function releases all memory allocated by *regcomp()* associated with *preg*.

Examples:

See *regcomp()*.

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Contributing author:

Henry Spencer. For copyright information, see Third-Party Copyright Notices in this reference.

See also:

regcomp(), regerror(), regexec()

remainder(), *remainderf()*

Compute the floating point remainder

Synopsis:

```
#include <math.h>

double remainder( double x,
                  double y );


float remainderf( float x,
                  float y );
```

Arguments:

x The numerator of the division.

y The denominator.

Library:

libm

Description:

The *remainder()* and *remainderf()* functions return the floating point remainder $r = x - ny$, where y is nonzero. The value n is the integral value nearest the exact value x/y. When $|n - x/y| = \frac{1}{2}$, the value n is chosen to be even.

The behavior of *remainder()* is independent of the rounding mode.

Returns:

The floating point remainder $r = x - ny$, where y is nonzero.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

drem(), modf()

remove()

Remove a link to a file

Synopsis:

```
#include <stdio.h>

int remove( const char * filename );
```

Arguments:

filename The path to the file that you want to delete.

Library:

libc

Description:

The *remove()* function removes a link to a file:

- If the *filename* names a symbolic link, *remove()* removes the link, but doesn't affect the file or directory that the link goes to.
- If the *filename* isn't a symbolic link, *remove()* removes the link and decrements the link count of the file that the link refers to.

  If the link count of the file becomes zero, and no process has the file open, then the space that the file occupies is freed, and no one can access the file anymore.

  If one or more processes have the file open when the last link is removed, the link is removed, but the removal of the file is delayed until all references to it have been closed.

This function is equivalent to *unlink()*.

To remove a directory, call *rmdir()*.

Returns:

0	The operation was successful.
Nonzero	The operation failed (*errno* is set).

Errors:

EACCES	Search permission is denied for a component of *filename*, or write permission is denied on the directory containing the link to be removed.
EBUSY	The directory named by *filename* can't be unlinked because it's being used by the system or another process, and the target filesystem or resource manager considers this to be an error.
ENAMETOOLONG	The *filename* argument exceeds PATH_MAX in length, or a pathname component is longer than NAME_MAX.
ENOENT	The named file doesn't exist, or *filename* is an empty string.
ENOSYS	The *remove()* function isn't implemented for the filesystem specified by *filename*.
ENOTDIR	A component of *filename* isn't a directory.
EPERM	The file named by *filename* is a directory, and either the calling process doesn't have the appropriate privileges, or the target filesystem or resource manager prohibits using *remove()* on directories.
EROFS	The directory entry to be unlinked resides on a read-only filesystem.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    if( remove( "vm.tmp" ) ) {
        puts( "Error removing vm.tmp!" );
        return EXIT_FAILURE;
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *rmdir()*, *unlink()*

rename()

Rename a file

Synopsis:

```
#include <stdio.h>

int rename( const char* old,
            const char* new );
```

Arguments:

old	The path to the file that you want to rename.
new	The new name for the file.

Library:

libc

Description:

The *rename()* function renames the file indicated *old* to the name specified in *new*.

If a file (or empty directory) named *new* exists, it's overwritten.

Returns:

0	Success.
Nonzero	An error occurred (*errno* is set).

Errors:

EACCESS	The calling program doesn't have permission to search one of the components of either path prefix, or one of the directories containing *old* or *new* denies write permission.
EBUSY	The directory named by *old* or *new* can't be renamed because it is in use by another process.

EEXIST	The file specified by *new* is directory that contains files.
EINVAL	The *new* directory pathname contains the *old* directory.
EISDIR	The file specified by *new* is a directory and *old* is a file.
ELOOP	Too many levels of symbolic links.
EMLINK	The file named by *old* is a directory, and the link count of the parent directory of *new* would exceed LINK_MAX.
ENAMETOOLONG	The length of *old* or *new* exceeds PATH_MAX.
ENOENT	The *old* file doesn't exist, or *old* or *new* is an empty string.
ENOSPC	The directory that would contain *new* can't be extended.
ENOSYS	The *rename()* function isn't implemented for the filesystem specified in *old* or *new*.
ENOTDIR	A component of either path prefix isn't a directory, or *old* is a directory and *new* isn't.
ENOTEMPTY	The file specified by *new* is a directory that contains files.
EROFS	The *rename()* would affect files on a read-only filesystem.
EXDEV	The files or directories named by *old* and *new* are on different filesystems.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    if( rename( "old.dat", "new.dat" ) ) {
        puts( "Error renaming old.dat to new.dat." );

        return EXIT_FAILURE;
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno

res_init()

Initialize the Internet domain name resolver routines

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <arpa/nameser.h>
#include <resolv.h>

int res_init( void );
```

Library:

libsocket

Description:

The resolver routines are used for making, sending, and interpreting query and reply messages with Internet domain name servers.

The *res_init()* routine reads the resolver configuration file (if one is present; see **/etc/resolv.conf** in the *Utilities Reference*) to get the default domain name, search list, and Internet address of the local name servers. If no server is configured, the host running the resolver is tried. If not specified in the configuration file, the current domain name is defined by the hostname; the domain name can be overridden by the environment variable **LOCALDOMAIN**. Initialization normally occurs on the first call to one of the resolver routines.

Resolver configuration

Global configuration and state information used by these routines is kept in the **__res_state** structure **_res**, which is defined in **<resolv.h>**. Since most of the values have reasonable defaults, you can generally ignore them.

The *_res.options* member is a simple bit mask that contains the bitwise OR of the enabled options. The following options are defined in **<resolv.h>**:

RES_DEBUG Print debugging messages.

RES_DEFNAMES

If this option is set, *res_search()* appends the default domain name to single-component names (those that don't contain a dot). This option is enabled by default.

RES_DNSRCH — If this option is set, *res_search()* searches for hostnames in the current domain and in parent domains. This is used by the standard host lookup routine, *gethostbyname()*. This option is enabled by default.

RES_INIT — True if the initial name server address and default domain name are initialized (i.e. *res_init()* has been called).

RES_RECURSE — Set the recursion-desired bit in queries. This is the default. Note that *res_send()* doesn't do iterative queries — it expects the name server to handle recursion.

RES_STAYOPEN

Used with RES_USEVC to keep the TCP connection open between queries. This is useful only in programs that regularly do many queries. UDP should be the mode you normally use.

RES_USEVC — Instead of UDP datagrams, use TCP connections for queries.

Returns:

0	Success.
Nonzero	An error occurred.

Errors:

See *herror()*.

Files:

`/etc/resolv.conf`

Resolver configuration file.

Environment variables:

LOCALDOMAIN

When set, **LOCALDOMAIN** contains a domain name that overrides the current domain name.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

dn_comp(), *dn_expand()*, *gethostbyname()*, *res_mkquery()*, *res_query()*, *res_querydomain()*, *res_search()*, *res_send()*

`hostname`, **`/etc/resolv.conf`** in the *Utilities Reference*

RFC 974, *RFC 1032*, *RFC 1033*, *RFC 1034*, *RFC 1035*

res_mkquery()

Construct an Internet domain name query

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <arpa/nameser.h>
#include <resolv.h>

int res_mkquery( int op,
                 const char * dname,
                 int class,
                 int type,
                 const u_char * data,
                 int datalen,
                 const u_char * newrr,
                 u_char * buf,
                 int buflen );
```

Arguments:

op Usually QUERY, but it can be also IQUERY or NS_NOTIFY_OP. Note that not all of the query types defined in **<arpa/nameser.h>** are supported.

dname The domain name for the query.

class The class of information that you want; one of:

- C_IN — ARPA Internet.
- C_CHAOS — Chaos net (MIT).
- C_HS — Hesiod name server (MIT).
- C_ANY — any class.

You typically use C_IN.

type The type of information that you want. You typically use T_PTR, but you can use any of the T_* constants defined in **<arpa/nameser.h>**.

data NULL, or a pointer to resource record data.

datalen The length of the data.

newrr Currently unused. This argument is intended for making update messages.

buf A pointer to a buffer where the function can build the query.

buflen The length of the buffer.

Library:

libsocket

Description:

The *res_mkquery()* function is a low-level routine that's used by *res_query()* to construct an Internet domain name query. This routine constructs a standard query message and places it in *buf*. It returns the size of the query, or -1 if the query is larger than *buflen*.

The resolver routines are used for making, sending, and interpreting query and reply messages with Internet domain name servers. Global configuration and state information used by the resolver routines is kept in the structure **_res**. For more information on the options, see *res_init()*.

Returns:

The size of the prepared query, in bytes, or -1 if an error occurs.

Files:

/etc/resolv.conf

Resolver configuration file.

Environment variables:

LOCALDOMAIN

When set, **LOCALDOMAIN** contains a domain name that overrides the current domain name.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

dn_comp(), *dn_expand()*, *gethostbyname()*, *res_init()*, *res_query()*, *res_querydomain()*, *res_search()*, *res_send()*

`hostname`, **`/etc/resolv.conf`** in the *Utilities Reference*

RFC 974, *RFC 1032*, *RFC 1033*, *RFC 1034*, *RFC 1035*

res_query()

Query the local Internet domain name server

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <arpa/nameser.h>
#include <resolv.h>

int res_query( const char  * dname,
               int class,
               int type,
               u_char  * answer,
               int anslen );
```

Arguments:

dname The fully qualified domain name that you want to query.

class The class of information that you want; one of:

- C_IN — ARPA Internet.
- C_CHAOS — Chaos net (MIT).
- C_HS — Hesiod name server (MIT).
- C_ANY — any class.

You typically use C_IN.

type The type of information that you want. You typically use T_PTR, but you can use any of the T_* constants defined in **<arpa/nameser.h>**.

answer A pointer to a buffer where the function can store the answer to the query.

anslen The length of the buffer.

Library:

libsocket

Description:

The *res_query()* function provides an interface to the server query mechanism. It constructs a query, sends it to the local server, waits for a response, and makes preliminary checks on the reply. The query requests information of the specified *type* and *class* for the specified fully qualified domain name *dname*. The reply message is left in the *answer* buffer with length *anslen* supplied by the caller.

The resolver routines are used for making, sending, and interpreting query and reply messages with Internet domain name servers. Global configuration and state information used by the resolver routines is kept in the structure *_res*. For more information on the options, see *res_init()*.

The *res_query()* function uses the following lower-level routines:

- *res_mkquery()* constructs a standard query message.
- *res_send()* sends the preformatted query and returns an answer.
- *dn_comp()* compresses a domain name.
- *dn_expand()* expands the compressed domain name to a full domain name.

Returns:

The length of a reply message, in bytes, or -1 if an error occurs (*h_errno* is set).

Errors:

See *herror()*.

Files:

`/etc/resolv.conf`

Resolver configuration file.

Environment variables:

LOCALDOMAIN

When set, **LOCALDOMAIN** contains a domain name that overrides the current domain name.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

dn_comp(), *dn_expand()*, *gethostbyname()*, *herror()*, *res_init()*, *res_mkquery()*, *res_querydomain()*, *res_search()*, *res_send()*

`hostname`, **`/etc/resolv.conf`** in the *Utilities Reference*

RFC 974, *RFC 1032*, *RFC 1033*, *RFC 1034*, *RFC 1035*

res_querydomain()

Query the local Internet domain name server

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <arpa/nameser.h>
#include <resolv.h>

int res_querydomain( const char * name,
                     const char * domain,
                     int class,
                     int type,
                     u_char * answer,
                     int anslen );
```

Arguments:

name The host name that you want to query.

domain The domain name that you want to query.

class The class of information that you want; one of:

- C_IN — ARPA Internet.
- C_CHAOS — Chaos net (MIT).
- C_HS — Hesiod name server (MIT).
- C_ANY — any class.

You typically use C_IN.

type The type of information that you want. You typically use T_PTR, but you can use any of the T_* constants defined in **<arpa/nameser.h>**.

answer A pointer to a buffer where the function can store the answer to the query.

anslen The length of the buffer.

Library:

libsocket

Description:

The *res_querydomain()* function provides an interface to the server query mechanism. It constructs a query, sends it to the local server, waits for a response, and makes preliminary checks on the reply. The query requests information of the specified *type* and *class* for the host specified by concatenating *name* and *domain*. The trailing dot is removed from *name* if *domain* is 0.

The reply message is left in the *answer* buffer with length *anslen* supplied by the caller.

Returns:

0 Success.

-1 An error occurred.

Files:

/etc/resolv.conf

Resolver configuration file.

Environment variables:

LOCALDOMAIN

When set, **LOCALDOMAIN** contains a domain name that overrides the current domain name.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

res_init(), *res_query()*

res_search()

Query a local server, using search options

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <arpa/nameser.h>
#include <resolv.h>

int res_search( const char * dname,
                int class,
                int type,
                u_char * answer,
                int anslen );
```

Arguments:

dname The fully qualified domain name that you want to query.

class The class of information that you want; one of:

- C_IN — ARPA Internet.
- C_CHAOS — Chaos net (MIT).
- C_HS — Hesiod name server (MIT).
- C_ANY — any class.

You typically use C_IN.

type The type of information that you want. You typically use T_PTR, but you can use any of the T_* constants defined in **<arpa/nameser.h>**.

answer A pointer to a buffer where the function can store the answer to the query.

anslen The length of the buffer.

Library:

libsocket

Description:

The *res_search()* routine makes an Internet domain name search. Like *res_query()*, *res_search()* makes a query and waits for a response. But it also implements the default and search rules controlled by the RES_DEFNAMES and RES_DNSRCH options. It returns the first successful reply.

The resolver routines are used for making, sending, and interpreting query and reply messages with Internet domain name servers.

Global configuration and state information used by the resolver routines is kept in the structure *_res*. For more information on the options, see *res_init()*.

Returns:

The length of a reply message, in bytes, or -1 if an error occurs (*h_errno* is set).

Errors:

See *herror*.

Files:

`/etc/resolv.conf`

Resolver configuration file.

Environment variables:

LOCALDOMAIN

When set, **LOCALDOMAIN** contains a domain name that overrides the current domain name.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

dn_comp(), *dn_expand()*, *gethostbyname()*, *herror()*, *res_init()*, *res_mkquery()*, *res_query()*, *res_querydomain()*, *res_send()*

`hostname`, **`/etc/resolv.conf`** in the *Utilities Reference*

RFC 974, *RFC 1032*, *RFC 1033*, *RFC 1034*, *RFC 1035*

res_send()

Send a preformatted Internet domain name query

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <arpa/nameser.h>
#include <resolv.h>

int res_send( const u_char * msg,
              int msglen,
              u_char * answer,
              int anslen );
```

Arguments:

msg	The preformatted Internet domain name query that you want to send.
msglen	The length of the message.
answer	A pointer to a buffer where the function can store the answer to the query.
anslen	The length of the buffer.

Library:

libsocket

Description:

The *res_send()* function is a low-level routine that's used by *res_query()* to send a preformatted Internet domain name query and return an answer. It calls *res_init()* if RES_INIT isn't set, sends the query to the local name server, and handles timeouts and retries.

The resolver routines are used for making, sending, and interpreting query and reply messages with Internet domain name servers.

Global configuration and state information used by the resolver routines is kept in the structure *_res*. For more information on the options, see *res_init()*.

Returns:

The length of a reply message, in bytes; or -1 if an error occurs.

Errors:

ECONNREFUSED
: No name servers found.

ETIMEDOUT
: No answer obtained.

Files:

`/etc/resolv.conf`

Resolver configuration file.

Environment variables:

LOCALDOMAIN

When set, **LOCALDOMAIN** contains a domain name that overrides the current domain name.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

dn_comp(), *dn_expand()*, *gethostbyname()*, *res_init()*, *res_mkquery()*, *res_query()*, *res_querydomain()*, *res_search()*

hostname, **/etc/resolv.conf** in the *Utilities Reference*

RFC 974, *RFC 1032*, *RFC 1033*, *RFC 1034*, *RFC 1035*

resmgr_attach()

Attach a path to the pathname space

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int resmgr_attach (
        dispatch_t *dpp,
        resmgr_attr_t *attr,
        const char *path,
        enum _file_type file_type,
        unsigned flags,
        const resmgr_connect_funcs_t *connect_funcs,
        const resmgr_io_funcs_t *io_funcs,
        RESMGR_HANDLE_T *handle );
```

Arguments:

dpp — A dispatch handle created by *dispatch_create()*.

attr — A pointer to a **resmgr_attr_t** structure that defines attributes for the resource manager; see below.

path — NULL, or the path that you want to attach the resource manager to; see below.

file_type — The file type; one of the following (defined in **<sys/ftype.h>**):

- _FTYPE_ANY — the path name can be anything.
- _FTYPE_LINK — reserved for the Process Manager.
- _FTYPE_MOUNT — receive mount requests on the path (*path* must be NULL).
- _FTYPE_MQUEUE — reserved for a mqueue manager.
- _FTYPE_PIPE — reserved for a pipe manager.

- _FTYPE_SEM — reserved for a semaphore manager.
- _FTYPE_SHMEM — reserved for a shared memory object.
- _FTYPE_SOCKET — reserved for a socket manager.
- _FTYPE_SYMLINK — reserved for the Process Manager.

flags Flags that control the pathname resolution:

- _RESMGR_FLAG_AFTER
- _RESMGR_FLAG_BEFORE
- _RESMGR_FLAG_OPAQUE
- _RESMGR_FLAG_DIR
- _RESMGR_FLAG_FTYPEONLY
- _RESMGR_FLAG_MASK
- _RESMGR_FLAG_SELF

For more information, see "Flags," below.

connect_funcs A pointer to the **resmgr_connect_funcs_t** structure that defines the POSIX-level connect functions.

io_funcs A pointer to the **resmgr_io_funcs_t** structure that defines the POSIX-level I/O functions.

handle A pointer to an arbitrary structure that you want to associate with the pathname you're attaching. For most resource managers, this is an **iofunc_attr_t** structure.

Library:

libc

Description:

The *resmgr_attach()* function puts the *path* into the general pathname space and binds requests on this path to the dispatch handle *dpp*.

Most of the above file types are used for special services that have their own open function associated with them. For example, the mqueue manager specifies *file_type* as _FTYPE_MQUEUE and *mq_open()* requests a pathname match of the same type.

Specify _FTYPE_ANY for normal filesystems and simple devices, such as serial ports, that don't have their own special open type. Also if you can handle the type of service or a redirection node to a manager that does. Most resource managers are of this type.

Your resource manager won't receive messages from an open of an inappropriate type. The following table shows the different open function types and the types of pathnames they'll match.

Function:	***file_type*:**	**Matches pathname of type:**
mq_open()	_FTYPE_MQUEUE	_FTYPE_ANY _FTYPE_MQUEUE
open()	_FTYPE_ANY	all types
pipe()	_FTYPE_PIPE	_FTYPE_ANY or _FTYPE_PIPE
sem_open()	_FTYPE_SEM	_FTYPE_ANY or _FTYPE_SEM
shm_open()	_FTYPE_SHMEM	_FTYPE_ANY or _FTYPE_SHMEM
socket()	_FTYPE_SOCKET	_FTYPE_ANY or _FTYPE_SOCKET

The generic *open()* can be used to open a pathname of any type.

If you want to use the POSIX functions, we've provided you with the POSIX layer; to fill your connect and I/O functions tables with the default handler functions supplied by the POSIX layer library, call *iofunc_func_init()*. You can then override the defaults placed in the structures with your own handlers.

In the most general case, the last argument, *handle* is an arbitrary structure that you wish to have associated with the pathname you're attaching. Practically, however, we recommend that it contain the POSIX layer's well defined attributes structure, **iofunc_attr_t**, because this lets you use the POSIX layer default library. You can extend the data that's contained in the attributes structure to contain any device-specific data that you may require. This is commonly done, and is described in the "Extending Data Control Structures (DCS)" section in the Writing a Resource Manager chapter of the *Programmer's Guide*.

In order to use the POSIX layer default library, the attributes structure must be bound into the Open Control Block, and you must use the POSIX layer's **iofunc_ocb_t** OCB. This is described in the documentation for *resmgr_open_bind()*, as well as in the above reference.

resmgr_attr_t structure

You can specify attributes such as the maximum message size, number of parts (number of IOVs in context), and flags in the *attr* structure. The **resmgr_attr_t** structure looks like this:

```
typedef struct _resmgr_attr {
   unsigned      flags;
   unsigned      nparts_max;
   unsigned      msg_max_size;
   int           (*other_func)
                 ( resmgr_context_t *, void *msg );
} resmgr_attr_t;
```

The members include:

nparts_max — The number of components to allocate for the IOV array. If you specify 0, the resource manager library bumps the value to the minimum usable by the library itself.

msg_max_size — The minimum amount of room to reserve for receiving a message that's allocated in *resmgr_context_alloc()*. If the value is too low, or you specify it as 0, *resmgr_attach()* picks a value that's usable.

other_func — A pointer to a function that's called if the resource manager receives an I/O message that it didn't successfully handle. This function is attached only if the RESMGR_FLAG_ATTACH_OTHERFUNC flag (defined in **<sys/dispatch.h>**) is set.

Flags

The *flags* argument specifies additional information to control the pathname resolution. The flags (defined in **<sys/resmgr.h>**) include at least the following bits:

_RESMGR_FLAG_AFTER

Force the path to be resolved after others with the same pathname at the same mountpoint.

_RESMGR_FLAG_BEFORE

Force the path to be resolved before others with the same pathname at the same mountpoint.

_RESMGR_FLAG_DIR

Treat the pathname as a directory and allow the resolving of longer pathnames. The _IO_CONNECT message contains the pathname passed to the client *open()* with the matching prefix stripped off. Without this flag, the pathname is treated as a simple file requiring an exact match.

Attached path	Opened path	_RESMGR_FLAG_DIR set	_RESMGR_FLAG_DIR clear
`/a/b`	`/a/b`	match `""`	match `""`
`/a/b`	`/a/b/c`	match `c`	no match
`/a/b`	`/a/b/c/d`	match `c/d`	no match
`/a/b`	`/a/bc`	no match	no match

You can't attach a directory pathname that contains, as a subset, an existing file pathname. Likewise, you can't attach a file pathname that's a subset of an existing directory pathname.

Existing path	New path	New path allowed?
dir `/a/b`	dir `/a`	yes
dir `/a/b`	dir `/a/b/c`	yes
file `/a/b`	dir `/a`	yes
file `/a/b`	dir `/a/b/c`	no, dir beneath a file
dir `/a/b`	file `/a`	no, dir beneath a file
dir `/a/b`	file `/a/b/c`	yes
file `/a/b`	file `/a`	yes
file `/a/b`	file `/a/b/c`	yes

_RESMGR_FLAG_FTYPEONLY

Handle only requests for the specific filetype indicated. The pathname must be NULL.

_RESMGR_FLAG_OPAQUE

Don't resolve paths to mountpoints on a path shorter than this (i.e. find the longest match against all pathnames attached).

_RESMGR_FLAG_SELF

Allow requests to resolve back to this server (a deadlock is possible).

Returns:

A unique link ID associated with this attach, or -1 on failure (*errno* is set).

The returned ID is needed to detach the pathname at a later time using *resmgr_detach()*. The ID is also passed back in the *resmgr_handler()* function in *ctp->id*.

Errors:

ENOMEM	There isn't enough free memory to complete the operation.
ENOTDIR	A component of the pathname wasn't a directory entry.

Examples:

Here's an example of a simple single-threaded resource manager:

```
#include <stdio.h>
#include <stddef.h>
#include <stdlib.h>
#include <sys/iofunc.h>
#include <sys/dispatch.h>

static resmgr_connect_funcs_t    connect_funcs;
static resmgr_io_funcs_t         io_funcs;
static iofunc_attr_t             attr;

int main(int argc, char **argv)
{
    dispatch_t           *dpp;
    resmgr_attr_t        resmgr_attr;
    resmgr_context_t     *ctp;
    int                  id;

    /* initialize dispatch interface */
    if ( (dpp = dispatch_create()) == NULL ) {
       fprintf( stderr, "%s: Unable to allocate \
                dispatch handle.\n", argv[0] );
       return EXIT_FAILURE;
    }

    /* initialize resource manager attributes */
    memset( &resmgr_attr, 0, sizeof resmgr_attr );
    resmgr_attr.nparts_max = 1;
```

```
    resmgr_attr.msg_max_size = 2048;

    /* initialize functions for handling messages */
    iofunc_func_init( _RESMGR_CONNECT_NFUNCS, &connect_funcs,
                      _RESMGR_IO_NFUNCS, &io_funcs );

    /* initialize attribute structure */
    iofunc_attr_init( &attr, S_IFNAM | 0666, 0, 0 );

    /* attach our device name (passing in the POSIX defaults
       from the iofunc_func_init and iofunc_attr_init functions)
     */
    if ( (id = resmgr_attach
          ( dpp, &resmgr_attr, "/dev/mynull", _FTYPE_ANY, 0,
          &connect_funcs, &io_funcs, &attr)) == -1 ) {
        fprintf( stderr, "%s: Unable to attach name.\n", \
                 argv[0] );
        return EXIT_FAILURE;
    }

    /* allocate a context structure */
    ctp = resmgr_context_alloc( dpp );

    /* start the resource manager message loop */
    while (1) {
        if ( (ctp = resmgr_block( ctp )) == NULL ) {
           fprintf(stderr, "block error\n");
           return EXIT_FAILURE;
        }
        resmgr_handler(ctp);
    }
}
```

For more examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, and *thread_pool_create()*. For more information on writing a resource manager, see the "Writing a Resource Manager" chapter in the *Programmer's Guide*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If your application calls this function, it must run as **root**.

See also:

dispatch_create(), *iofunc_attr_init()*, **iofunc_attr_t**, *iofunc_func_init()*, **iofunc_ocb_t**, *resmgr_block()*, **resmgr_connect_funcs_t**, *resmgr_context_alloc()*, *resmgr_context_free()*, *resmgr_detach()*, *resmgr_handler()*, **resmgr_io_funcs_t**

"Writing a Resource Manager" chapter of the *Programmer's Guide*.

resmgr_block()

Block while waiting for a message

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

resmgr_context_t * resmgr_block
                   ( resmgr_context_t * ctp );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

Library:

libc

Description:

The *resmgr_block()* function waits for a message (created by a call to *resmgr_context_alloc()*) for context *ctp*.

☞ This function is a special case of *dispatch_block()* that you should use only with a simple resource manager. If you need to attach pulses or other messages, then you should use *dispatch_block()*.

Returns:

The same pointer as *ctp*, or NULL if an error occurs (*errno* is set).

Errors:

EFAULT A fault occurred when the kernel tried to access the buffers provided. Because the OS accesses the sender's buffers only when *MsgReceive()* is called, a fault could occur *in the sender* if the sender's buffers are invalid. If a fault occurs when accessing

	the sender buffers (only) they'll receive an EFAULT and the *MsgReceive()* won't unblock.
EINTR	The call was interrupted by a signal.
ETIMEDOUT	A kernel timeout (that was set with *dispatch_timeout()*) unblocked the call.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   dispatch_t          *dpp;
   resmgr_context_t    *ctp;

   if ((dpp = dispatch_create()) == NULL) {
      fprintf( stderr, "%s: Unable to allocate \
               dispatch handle.\n",argv[0] );
      return EXIT_FAILURE;
   }

   .
   .
   .

   ctp = resmgr_context_alloc( dpp );

   while (1) {
     if ( ( ctp = resmgr_block( ctp )) == NULL ) {
        fprintf( stderr, "block error\n" );
        return EXIT_FAILURE;
     }
     resmgr_handler( ctp );
   }
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

Use *resmgr_block()* only in a simple resource manager and when you don't use *message_attach()*, *pulse_attach()*, or *select_attach()*.

See also:

dispatch_block(), *resmgr_attach()*, *resmgr_context_alloc()*, *resmgr_handler()*

"Components of a Resource Manager" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

resmgr_connect_funcs_t

Table of POSIX-level connect functions

Synopsis:

```
#include <sys/resmgr.h>

typedef struct _resmgr_connect_funcs {

    unsigned nfuncs;

    int (*open)       (resmgr_context_t *ctp, io_open_t *msg,
                       RESMGR_HANDLE_T *handle, void *extra);

    int (*unlink)     (resmgr_context_t *ctp, io_unlink_t *msg,
                       RESMGR_HANDLE_T *handle, void *reserved);

    int (*rename)     (resmgr_context_t *ctp, io_rename_t *msg,
                       RESMGR_HANDLE_T *handle,
                       io_rename_extra_t *extra);

    int (*mknod)      (resmgr_context_t *ctp, io_mknod_t *msg,
                       RESMGR_HANDLE_T *handle, void *reserved);

    int (*readlink)   (resmgr_context_t *ctp, io_readlink_t *msg,
                       RESMGR_HANDLE_T *handle, void *reserved);

    int (*link)       (resmgr_context_t *ctp, io_link_t *msg,
                       RESMGR_HANDLE_T *handle,
                       io_link_extra_t *extra);

    int (*unblock)    (resmgr_context_t *ctp, io_pulse_t *msg,
                       RESMGR_HANDLE_T *handle, void *reserved);

    int (*mount)      (resmgr_context_t *ctp, io_mount_t *msg,
                       RESMGR_HANDLE_T *handle,
                       io_mount_extra_t *extra);
} resmgr_connect_funcs_t;
```

Description:

The **resmgr_connect_funcs_t** structure is a table of the POSIX-level connect functions that are used by a resource manager.

You can initialize this table by calling *iofunc_func_init()* and then overriding the defaults with your own functions.

This structure includes *nfuncs*, which indicates how many functions are in the table (in case the structure grows in the future), along with these functions:

Member:	Used to:	Default:
open	Handle _IO_CONNECT messages	*iofunc_open_default()*
unlink	Unlink the resource	None
rename	Rename the resource	None
mknod	Create a filesystem entry point	None
readlink	Read a symbolic link	None
link	Create a symbolic link	None
unblock	Unblock the resource if an operation is aborted	None
mount	Mount a filesystem	None

Classification:

QNX Neutrino

See also:

iofunc_func_init(), *iofunc_open_default()*, **resmgr_io_funcs_t**

Writing a Resource Manager chapter of the QNX Neutrino *Programmer's Guide*

resmgr_context_alloc()

Allocate a resource-manager context

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

resmgr_context_t * resmgr_context_alloc
                   ( dispatch_t * dpp );
```

Arguments:

dpp A dispatch handle created by *dispatch_create()*.

Library:

libc

Description:

The *resmgr_context_alloc()* function returns a context that's used for blocking and receiving messages.

This function is a special case of *dispatch_context_alloc()*. You should use it only when writing a simple resource manager.

Returns:

A pointer to a **resmgr_context_t** structure, or NULL if an error occurs (*errno* is set).

Errors:

EINVAL No resource manager events were attached to *dpp*.

ENOMEM Insufficient memory to allocate the context *ctp*.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   dispatch_t          *dpp;
   resmgr_context_t    *ctp;

   if ( (dpp = dispatch_create()) == NULL ) {
      fprintf( stderr, "%s: Unable to allocate \
               dispatch handle.\n",argv[0] );
      return EXIT_FAILURE;
   }

   .
   .
   .

   if ( ( ctp = resmgr_context_alloc ( dpp )) == NULL ) {
      fprintf( stderr, "Context wasn't allocated.\n" );
      return EXIT_FAILURE;
   }
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

dispatch_context_alloc(), dispatch_create(), resmgr_attach(), resmgr_context_free(), **`resmgr_context_t`**

"Components of a Resource Manager" in the Writing a Resource Manager chapter of the *Programmer's Guide*

resmgr_context_free()

Free a resource-manager context

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

void resmgr_context_free( resmgr_context_t * ctp );
```

Arguments:

ctp A pointer to the **resmgr_context_t** structure that you want to free.

Library:

libc

Description:

The *resmgr_context_free()* function frees a context allocated by *resmgr_context_alloc()*.

This function is a special case of *dispatch_context_free()*. You should use it only when writing a simple resource manager.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   dispatch_t          *dpp;
   resmgr_context_t    *ctp;

   if ( (dpp = dispatch_create()) == NULL ) {
      fprintf( stderr, "%s: Unable to allocate \
               dispatch handle.\n",argv[0] );
      return EXIT_FAILURE;
   }

   .
   .
   .
```

```
    if ( ( ctp = resmgr_context_alloc ( dpp )) == NULL ) {
        fprintf( stderr, "Context wasn't allocated.\n" );
        return EXIT_FAILURE;
    }

    .
    .
    .

    resmgr_context_free ( ctp );
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

resmgr_context_alloc(), **resmgr_context_t**

"Components of a Resource Manager" in the Writing a Resource Manager chapter of the *Programmer's Guide*

Synopsis:

```
#include <sys/resmgr.h>

typedef struct _resmgr_context {
    int                         rcvid;
    struct _msg_info            info;
    resmgr_iomsgs_t             *msg;
    dispatch_t                  *dpp;
    int                         id;
    unsigned                    tid;
    unsigned                    msg_max_size;
    int                         status;
    int                         offset;
    int                         size;
    iov_t                       iov[1];
} resmgr_context_t;
```

Description:

The **resmgr_context_t** structure defines context information that's passed to resource-manager functions.

The members include:

rcvid	The receive ID to use for messages to and from the client.
info	A pointer to a **_msg_info** structure that contains information about the message received by the resource manager.
msg	A pointer to the message received by the resource manager, expressed as a union of all the possible message types.
dpp	The dispatch handle, created by *dispatch_create()*.
id	The link Id, returned by *resmgr_attach()*.
tid	Not used; always zero.

msg_max_size	The minimum amount of space reserved for receiving a message.
status	A place to store the status of the current operation. Always use *_RESMGR_STATUS()* to set this member.
offset	The offset, in bytes, into the client's message. You'll use this when working with combine messages.
size	The number of valid bytes in the message area.
iov	An I/O vector where you can place the data that you're returning to the client.

Classification:

QNX Neutrino

See also:

dispatch_create(), **_msg_info**, *MsgInfo()*, *resmgr_attach()*, *resmgr_context_alloc()*, *resmgr_context_free()*, *_RESMGR_STATUS()*

resmgr_detach()

Remove a pathname from the pathname space

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int resmgr_detach( dispatch_t * dpp,
                   int id,
                   unsigned flags );
```

Arguments:

dpp A dispatch handle created by *dispatch_create()*.

id The link ID that *resmgr_attach()* returned.

flags Flags that affect the operation. The possible *flags* (defined in **<sys/dispatch.h>** and **<sys/resmgr.h>**) are:

- _RESMGR_DETACH_ALL — detach the name from the namespace and invalidate all open bindings.
- _RESMGR_DETACH_PATHNAME — detach only the name from the namespace, leaving existing bindings intact. This option is useful when you're unlinking a file or device, and you want to remove the name, but you want processes with open files to continue to use it until they close.

Library:

libc

Description:

The *resmgr_detach()* function removes pathname *id* from the pathname space of context *dpp*.

Blocking states

The *resmgr_detach()* function blocks until the **RESMGR_HANDLE_T**, that's passed to the corresponding *resmgr_attach()*, isn't being used in any connection function.

The effect that this has on servers is generally minimal. You should follow the following precautions to prevent potential deadlock situations:

- If you're using the **RESMGR_HANDLE_T** as an attribute, and that attribute is locked in any of the connection callouts (i.e. open, unlink, mount, etc.), then should unlock it before calling *resmgr_detach()*. This allows any pending connection requests to complete before they're consequently invalidated.

If you call *resmgr_detach()* from within a connection function, then the internal reference counting takes this into account and the server doesn't deadlock.

- If two or more *resmgr_detach()* requests come in simultaneously, only one of the requests is served. The superfluous request will return with an error of -1 and *errno* set to ENOENT to indicate that the detachment process has already begun, and the entry is now invalid. If dynamically allocated, you should release **RESMGR_HANDLE_T** only after a successful return from *resmgr_detach()*.
- If *resmgr_detach()* is called and an existing client connection is established, then the I/O callout table is redirected for that client connection. The client will receive an error of EBADF when it uses the *fd* associated with that connection.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL	The *id* was never attached with *resmgr_attach()*.
ENOENT	A previous detachment request is in progress, or the *id* has already been detached.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   dispatch_t  *dpp;
   int         id;

   if ( (dpp = dispatch_create()) == NULL ) {
      fprintf( stderr, "%s: Unable to allocate \
               dispatch handle.\n",argv[0] );
      return EXIT_FAILURE;
   }

   id = resmgr_attach ( ... );

   .
   .
   .

   if ( resmgr_detach( dpp, id, 0) == -1 ) {
      fprintf( stderr, "Failed to remove pathname \
               from the pathname space.\n" );
      return EXIT_FAILURE;
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

dispatch_create(), resmgr_attach()

"Writing a Resource Manager" chapter of the *Programmer's Guide*.

resmgr_devino()

Get the device and inode number

Synopsis:

```
#include <sys/resmgr.h>

int resmgr_devino( int id,
                   dev_t *pdevno,
                   ino64_t *pino );
```

Arguments:

id	The link ID that *resmgr_attach()* returned.
pdevno	A pointer to a **dev_t** object where the function can store the device number.
pino	A pointer to a **ino64_t** object where the function can store the inode number.

Library:

libc

Description:

The function *resmgr_devino()* fills in the structures pointed to by *pdevno* and *pino* with the device number and inode number extracted from *id*.

This function is typically used to fill in:

- *iofunc_mount_t->dev*
- *iofunc_attr_t->inode*

You can use the *major()*, *minor()*, and *makedev()* macros to work with device IDs. They're defined in **<sys/types.h>** and are described in the documentation for *stat()*.

Returns:

-1 on error (*errno* is set); any other value on success.

Errors:

EINVAL The *id* argument is invalid.

Examples:

```
#include <sys/resmgr.h>
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
  iofunc_mount_t   mount;
  iofunc_attr_t    attr;

  ...
  attr.mount = &mount;
  ...
  id = resmgr_attach( ... )
  ...
  resmgr_devino(id, &mount.dev, &attr.inode);
  ...
  return EXIT_SUCCESS;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

resmgr_attach(), SETIOV(), stat()

resmgr_handle_tune()

Tune aspects of client fd-to-OCB mapping

Synopsis:

```
int resmgr_handle_tune(int min_handles,
                       int min_clients,
                       int max_client_handles,
                       int *min_handles_old,
                       int *min_clients_old,
                       int *max_client_handles_old);
```

Arguments:

min_handles To perform the described mapping, the resource manager framework makes use of **_resmgr_handle_entry** structures. This value describes the minimum number of these structures to keep around. If more than this number are in use, they may be returned to the heap via *free()* as they're released.

min_clients, max_client_handles

To perform the described mapping, the resource manager framework makes use of hash buckets, one per client. The *min_clients* describes the minimum number of these buckets to keep around. If more than this number of clients are in communication with your resource manager, these buckets may be released back to the heap via *free()* as particular clients close all their *fd*s to your manager.

The *max_client_handles* describes the size of each of these hash buckets. The maximum number of lookups to find a particular *fd*-to-OCB mapping is the client's max *fd* divided by *max_client_handles* rounded to the nearest integer, i.e. in pseudocode:

ceil(max *fd*/*max_client_handles*).

If this value changes, the new value takes effect for newly connected clients. Existing clients are unaffected.

If negative values are specified to any of the above three parameters, their current values are left unchanged.

**_old* — If any of these are non-NULL, the corresponding value in use by the resource manager layer at the time of the call is returned.

Library:

libc

Description:

One of the functions of the resource manager framework is to perform the mapping of client file descriptors to structures local to the resource manager that describe these descriptors. These structures are often Open Control Blocks (OCBs). For details on OCBs, see *resmgr_open_bind()*. The *resmgr_handle_tune()* function can be used to tune certain aspects of this mapping and subsequent lookups of a client's OCBs.

Returns:

0.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

resmgr_open_bind()

Writing a Resource Manager chapter of the *Programmer's Guide*

_resmgr_handle_grow()

Expand the capacity of the device manager database

Synopsis:

```
#include <resmgr.h>

int _resmgr_handle_grow ( unsigned min );
```

Arguments:

min The number of requests that you want to accommodate.

Library:

libc

Description:

The *_resmgr_handle_grow()* function pre-grows or allocates the resource manager database table entries to support a given number of connections to improve runtime performance by reducing the number of dynamic memory allocations.

The function pre-allocates database space for *min* requests.

Returns:

The number of free entries in the table, or -1 if the resource manager table can't be locked.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

resmgr_handler()

Handle resource manager messages

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int resmgr_handler( resmgr_context_t * ctp );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

Library:

libc

Description:

The *resmgr_handler()* function handles the message received in *ctp*. This function handles different I/O messages through the resource manager framework.

☞ The *resmgr_handler()* function is a special case of *dispatch_handler()*. You should use it only when writing a simple resource manager i.e. where there's no need to attach pulses or messages.

Returns:

0 Success.

-1 An error occurred.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
```

```
    dispatch_t          *dpp;
    resmgr_context_t    *ctp;

    if ((dpp = dispatch_create()) == NULL) {
       fprintf( stderr, "%s: Unable to allocate \
                dispatch handle.\n",argv[0] );
       return EXIT_FAILURE;
    }

    .
    .
    .

    ctp = resmgr_context_alloc( dpp );

    while (1) {
      if ( ( ctp = resmgr_block( ctp )) == NULL ) {
         fprintf( stderr, "block error\n" );
         return EXIT_FAILURE;
      }
      resmgr_handler( ctp );
    }
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If you attach messages or pulses to *dpp* by calling *message_attach()*, *pulse_attach()*, or *select_attach()*, those events aren't dispatched by *resmgr_handler()*. Instead, you should call *dispatch_handler()*.

See also:

dispatch_handler(), *resmgr_attach()*, *resmgr_block()*

"Components of a Resource Manager" in the Writing a Resource Manager chapter of the *Programmer's Guide*

_resmgr_io_func()

Retrieve an I/O function from an I/O function table

Synopsis:

```
#include <sys/resmgr.h>

_resmgr_func_t *_resmgr_io_func(
   const resmgr_io_funcs_t * funcs,
   unsigned type);
```

Arguments:

funcs A pointer to the **resmgr_io_funcs_t** structure for the table of I/O functions.

type The type of I/O function that you want to get from the table. This argument should be one of the values defined in **<sys/iomsg.h>**, such as _IO_READ or _IO_WRITE.

Library:

libc

Description:

The *_resmgr_io_func()* function retrieves the I/O function associated with *type* from the function table defined by *funcs*.

Returns:

A pointer to the function responsible for servicing *type*, or NULL if the function can't be found.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

resmgr_io_funcs_t, *resmgr_iofuncs()*

resmgr_io_funcs_t

Table of POSIX-level I/O functions

Synopsis:

```
#include <sys/resmgr.h>

typedef struct _resmgr_io_funcs {
   unsigned nfuncs;
   int (*read)      (resmgr_context_t *ctp, io_read_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*write)     (resmgr_context_t *ctp, io_write_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*close_ocb) (resmgr_context_t *ctp, void *reserved,
                     RESMGR_OCB_T *ocb);
   int (*stat)      (resmgr_context_t *ctp, io_stat_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*notify)    (resmgr_context_t *ctp, io_notify_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*devctl)    (resmgr_context_t *ctp, io_devctl_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*unblock)   (resmgr_context_t *ctp, io_pulse_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*pathconf)  (resmgr_context_t *ctp, io_pathconf_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*lseek)     (resmgr_context_t *ctp, io_lseek_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*chmod)     (resmgr_context_t *ctp, io_chmod_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*chown)     (resmgr_context_t *ctp, io_chown_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*utime)     (resmgr_context_t *ctp, io_utime_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*fdopen)    (resmgr_context_t *ctp, io_fdopen_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*fdinfo)    (resmgr_context_t *ctp, io_fdinfo_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*lock)      (resmgr_context_t *ctp, io_lock_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*space)     (resmgr_context_t *ctp, io_space_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*shutdown)  (resmgr_context_t *ctp, io_shutdown_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*mmap)      (resmgr_context_t *ctp, io_mmap_t *msg,
                     RESMGR_OCB_T *ocb);
   int (*msg)       (resmgr_context_t *ctp, io_msg_t *msg,
```

```
                        RESMGR_OCB_T *ocb);
    int (*reserved)   (resmgr_context_t *ctp, void *msg,
                        RESMGR_OCB_T *ocb);
    int (*dup)        (resmgr_context_t *ctp, io_dup_t *msg,
                        RESMGR_OCB_T *ocb);
    int (*close_dup)  (resmgr_context_t *ctp, io_close_t *msg,
                        RESMGR_OCB_T *ocb);
    int (*lock_ocb)   (resmgr_context_t *ctp, void *reserved,
                        RESMGR_OCB_T *ocb);
    int (*unlock_ocb) (resmgr_context_t *ctp, void *reserved,
                        RESMGR_OCB_T *ocb);
    int (*sync)       (resmgr_context_t *ctp, io_sync_t *msg,
                        RESMGR_OCB_T *ocb);
} resmgr_io_funcs_t;
```

Description:

The **resmgr_connect_funcs_t** structure is a table of the POSIX-level I/O functions that are used by a resource manager. You can initialize this table by calling *iofunc_func_init()* and then overriding the defaults with your own functions.

This structure includes *nfuncs*, which indicates how many functions are in the table (in case the structure grows in the future), along with these functions:

Member:	Used to:	Default:
read	Handle _IO_READ messages	*iofunc_read_default()*
write	Handle _IO_WRITE messages	*iofunc_write_default()*

continued…

Member:	Used to:	Default:
close_ocb	Return the memory allocated for an OCB	*iofunc_close_ocb_default()*
stat	Handle _IO_STAT messages	*iofunc_stat_default()*
notify	Handle _IO_NOTIFY messages	None
devctl	Handle _IO_DEVCTL messages	*iofunc_devctl_default()*
unblock	Unblock the resource if an operation is aborted	*iofunc_unblock_default()*
pathconf	Handle _IO_PATHCONF messages	*iofunc_pathconf_default()*
lseek	Handle _IO_LSEEK messages	*iofunc_lseek_default()*
chmod	Handle _IO_CHMOD messages	*iofunc_chmod_default()*
chown	Handle _IO_CHOWN messages	*iofunc_chown_default()*

continued...

Member:	Used to:	Default:
utime	Handle _IO_UTIME messages	*iofunc_utime_default()*
fdopen	Handle _IO_OPENFD messages	*iofunc_openfd_default()*
fdinfo	Handle _IO_FDINFO messages	*iofunc_fdinfo_default()*
lock	Handle _IO_LOCK messages	*iofunc_lock_default()*
space	Allocate or free memory for the resource.	None
shutdown	Reserved	None
mmap	Handle _IO_MMAP messages	*iofunc_mmap_default()*
msg	Handle a more general messaging scheme to control the device	None
reserved	Not applicable	None
dup	Handle _IO_DUP messages	None — handled by the base layer

continued…

Member:	Used to:	Default:
close_dup	Handle _IO_CLOSE messages	*iofunc_close_dup_default()*
lock_ocb	Lock the attributes for a group of messages	*iofunc_lock_ocb_default()*
unlock_ocb	Unlock the attributes for a group of messages	*iofunc_unlock_ocb_default()*
sync	Handle _IO_SYNC messages	*iofunc_sync_default()*

If you use *iofunc_lock_default()*, you must also use *iofunc_close_dup_default()* and *iofunc_unblock_default()*.

Classification:

QNX Neutrino

See also:

iofunc_chmod_default(), *iofunc_chown_default()*, *iofunc_close_dup_default()*, *iofunc_close_ocb_default()*, *iofunc_devctl_default()*, *iofunc_fdinfo_default()*, *iofunc_func_init()*, *iofunc_lock_default()*, *iofunc_lock_ocb_default()*, *iofunc_lseek_default()*, *iofunc_mmap_default()*, *iofunc_openfd_default()*, *iofunc_pathconf_default()*, *iofunc_read_default()*, *iofunc_stat_default()*, *iofunc_sync_default()*, *iofunc_unblock_default()*, *iofunc_unlock_ocb_default()*, *iofunc_utime_default()*, *iofunc_write_default()*, **resmgr_connect_funcs_t**

Writing a Resource Manager chapter of the QNX Neutrino *Programmer's Guide*

resmgr_iofuncs()

Extract the I/O function pointers associated with client connections

Synopsis:

```
#include <resmgr.h>

const resmgr_io_funcs_t * resmgr_iofuncs(
   resmgr_context_t * ctp;
   struct _msg_info * info);
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

info A pointer to the **_msg_info** structure that describes the binding to the client. You should fill this structure by calling *MsgInfo()*.

Library:

libc

Description:

The *resmgr_iofuncs()* function retrieves the I/O function callout table associated with the client connections described by binding specified by *info*.

Note that context information pointed to by *ctp* actually contains *info*.

Returns:

A pointer to the **resmgr_io_funcs_t** I/O function callout table, or NULL if the binding can't be found or an error occurs.

Errors:

ESRCH The connection can't be located in the resource manager's table.

ENOMEM There is no memory available for the operation.

EINVAL Invalid arguments were used.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

_msg_info, *MsgInfo()*, **resmgr_io_funcs_t**, *_resmgr_ocb()*, *resmgr_open_bind()*, *resmgr_unbind()*

resmgr_msgread()

Read a message from a client

Synopsis:

```
#include <sys/resmgr.h>

int resmgr_msgread( resmgr_context_t * ctp,
                    void * msg,
                    int size,
                    int offset );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions. This function extracts the rcvid from this structure.

msg A pointer to a buffer where the function can store the data.

bytes The number of bytes that you want to read. These functions don't let you read past the end of the thread's message; they return the number of bytes actually read.

offset An offset into the thread's send message that indicates where you want to start reading the data.

Library:

libc

Description:

The *resmgr_msgread()* function is a convenience function that you should in a resource manager instead of *MsgRead()*.

You'll use *resmgr_msgread()* when you handle *combine messages*, where the offset of the rest of the message that's to be read is additionally offset by previous combine message elements. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

Returns:

The same values as *MsgRead()*: the number of bytes read, or -1 if an error occurs (*errno* is set).

Errors:

EFAULT	A fault occurred in a server's address space when it tried to access the caller's message buffers.
ESRCH	The thread indicated by *ctp* **->** *rcvid* doesn't exist or its connection is detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgRead(), **resmgr_context_t**, *resmgr_msgreadv()*, *resmgr_msgwrite()*, *resmgr_msgwritev()*

"Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*

resmgr_msgreadv()

Read a message from a client

Synopsis:

```
#include <sys/resmgr.h>

int resmgr_msgreadv( resmgr_context_t * ctp,
                     iov_t * rmsg,
                     int rparts,
                     int offset );
```

Arguments:

ctp	A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions. This function extracts the rcvid from this structure.
riov	An array of buffers where the functions can store the data.
rparts	The number of elements in the *riov* array.
offset	An offset into the thread's send message that indicates where you want to start reading the data.

Library:

libc

Description:

This *resmgr_msgreadv()* function is a convenience function that you should use in a resource manager instead of *MsgReadv()*.

You'll use *resmgr_msgreadv()* when handling combine messages, where the offset of the rest of the message that is to be read is additionally offset by previous combine message elements. For more information, see "Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*.

Returns:

The same values as *MsgReadv()*: the number of bytes read, or -1 if an error occurs (*errno* is set).

Errors:

EFAULT	A fault occurred in a server's address space when it tried to access the caller's message buffers.
ESRCH	The thread indicated by *ctp* `->` *rcvid* doesn't exist or has had its connection detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgReadv(), **`resmgr_context_t`**, *resmgr_msgread()*, *resmgr_msgwrite()*, *resmgr_msgwritev()*

"Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*

resmgr_msgwrite()

Write a message to a client

Synopsis:

```
#include <sys/resmgr.h>

int resmgr_msgwrite( resmgr_context_t *ctp,
                     const void *msg,
                     int size,
                     int offset );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions. This function extracts the rcvid from this structure.

msg A pointer to a buffer that contains the data you want to write.

size The number of bytes that you want to write. These functions don't let you write past the end of the sender's buffer; they return the number of bytes actually written.

offset An offset into the sender's buffer that indicates where you want to start writing the data.

Library:

libc

Description:

The function *resmgr_msgwrite()* is a cover for *MsgWrite()* and performs the exact same functionality.

Returns:

The same values as *MsgWrite()*; the number of bytes written, or -1 if an error occurs (*errno* is set).

Errors:

EFAULT	A fault occurred in the sender's address space when a server tried to access the sender's return message buffer.
ESRCH	The thread indicated by *ctp* `->` *rcvid* does not exist or has had its connection detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgWrite(), **`resmgr_context_t`**, *resmgr_msgread()*, *resmgr_msgreadv()*, *resmgr_msgwritev()*

"Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*

resmgr_msgwritev()

Write a message to a client

Synopsis:

```
#include <sys/resmgr.h>

int resmgr_msgwritev( resmgr_context_t *ctp,
                      const iov_t *smsg,
                      int sparts,
                      int offset );
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions. This function extracts the rcvid from this structure.

iov An array of buffers that contains the data you want to write.

parts The number of elements in the array. These functions don't let you write past the end of the sender's buffer; they return the number of bytes actually written.

offset An offset into the sender's buffer that indicates where you want to start writing the data.

Library:

libc

Description:

The *resmgr_msgwritev()* function is a cover function for *MsgWritev()*, and performs the exact same functionality. It's provided for consistency with *resmgr_msgwrite()*.

Returns:

The number of bytes written, or -1 if an error occurred (*errno* is set).

Errors:

EFAULT	A fault occurred in the sender's address space when a server tried to access the sender's return message buffer.
ESRCH	The thread indicated by *ctp* `->` *rcvid* does not exist or has had its connection detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

MsgWritev(), **`resmgr_context_t`**, *resmgr_msgread()*, *resmgr_msgreadv()*, *resmgr_msgwrite()*

"Combine messages" in the Writing a Resource Manager chapter of the *Programmer's Guide*

_RESMGR_NPARTS()

Get a given number of parts from the ctp->iov structure

Synopsis:

```
#include <sys/resmgr.h>

_RESMGR_NPARTS( int num )
```

Arguments:

num The number of parts that you want to get.

Library:

libc

Description:

The macro *_RESMGR_NPARTS()* indicates to the caller to get *num* parts from the *ctp->iov* structure (see **resmgr_context_t**). The macro is similar to:

MsgReply(*ctp->rcvid, ctp->status, ctp->iov, num*).

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

The *resmgr_attach()* function should set *attr->nparts_max* to be the maximum value for *num*.

See also:

MsgReply(), *resmgr_attach()*, **resmgr_context_t**, *_RESMGR_PTR()*, *_RESMGR_STATUS()*

_resmgr_ocb()

Retrieve an Open Control Block

Synopsis:

```
#include <sys/resmgr.h>

void * _resmgr_ocb( resmgr_context_t * ctp,
                    struct _msg_info * info);
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

Note that *ctp* actually contains *info*.

info A pointer to a **_msg_info** structure that indicates which client mapping you want to retrieve information about. To fill in the structure, call *MsgInfo()*.

Library:

libc

Description:

The *_resmgr_ocb()* function queries the internal resource manager database, which maps client connections to the server Open Control Block (OCB), to retrieve the OCB pointer that was previously bound using *resmgr_open_bind()*.

Returns:

A pointer to the OCB for the matching binding, or NULL if the binding can't be found or an error occurred.

The OCB can be a structure that you define. By default, it's of type **iofunc_ocb_t**.

Errors:

ESRCH	The connection can't be located in the resource manager table.
ENOMEM	There isn't enough memory available for the operation.
EINVAL	Invalid arguments were used.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

iofunc_ocb_t, **_msg_info**, *MsgInfo()*, *resmgr_iofuncs()*, *resmgr_open_bind()*, *resmgr_unbind()*

resmgr_open_bind()

Associate an OCB with an open request

Synopsis:

```
#include <sys/resmgr.h>

int resmgr_open_bind(
        resmgr_context_t* ctp,
        void* ocb,
        const resmgr_io_funcs_t* iofuncs );
```

Arguments:

ctp	A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.
ocb	A pointer to the Open Control Block that you want to bind to the open request. An OCB is usually a structure of type **iofunc_ocb_t**, but you can define your own.
iofuncs	A pointer to the **resmgr_io_funcs_t** structure that defines the I/O functions for the resource manager.

Library:

libc

Description:

The *resmgr_open_bind()* function is the lowest-level call in the resource manager library used for handling open messages. It associates the Open Control Block (OCB) with a process identified by the *id* and *info* members of *ctp*.

You must use this function as part of the handling of an _IO_OPEN message. In practice, you don't call this function directly; you typically use either *iofunc_open_default()* or *iofunc_ocb_attach()*. (The *iofunc_open_default()* function calls *iofunc_ocb_attach()*, which in turn calls *resmgr_open_bind()*).

An internal data structure is allocated that maintains the number of links to the OCB. On a file descriptor *dup()*, the link count is incremented and on a *close()* it's decremented. When the count reaches zero, the *close_ocb()* callout specified in *io_funcs* is called.

In the most general case, the OCB is an arbitrary structure that *you* define that can hold information describing an open file, or just a simple **`int`** to hold the open mode for checking in the *read()* and *write()* callouts.

In the typical case, however, the OCB is a structure that contains at least the members as defined by the typedef **`iofunc_ocb_t`**. This typedef defines a common OCB structure that can then be used by the POSIX layer helper functions (all functions beginning with the name *iofunc_**). The advantage of this approach is that your resource manager gets POSIX behavior for free, without any additional work on your part.

The *attr* argument to the *open()* callout is also typically saved in the OCB. The well defined **`iofunc_ocb_t`** has a member called *attr* to which you must assign the value of the *attr* argument. This lets the POSIX helper functions access information about the current open session (as stored in the OCB) as well as information about the device itself (as stored in the attributes structure, *ocb* **`->`** *attr*).

For a detailed discussion, including several examples, see the Writing a Resource Manager chapter of the *Programmer's Guide*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL	The *id* and/or *info* members of *ctp* aren't valid.
ENOMEM	Insufficient memory to allocate an internal data structure.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

iofunc_ocb_attach(), **iofunc_ocb_t**, *iofunc_open_default()*, **resmgr_context_t**, **resmgr_io_funcs_t**, *resmgr_unbind()*

Writing a Resource Manager chapter of the *Programmer's Guide*

resmgr_pathname()

Return the pathname associated with an ID

Synopsis:

```
#include <sys/resmgr.h>

int resmgr_pathname( int id,
                     unsigned flags,
                     char* path,
                     int maxbuf );
```

Arguments:

id The link ID that *resmgr_attach()* returned.

flags Flags that affect the operation:

- _RESMGR_PATHNAME_LOCALPATH — get a shortened pathname that's usable only on the local machine. By default, this function gets a globally unique pathname.

path A pointer to a buffer where the function can store the path name.

maxbuf The size of the buffer.

Library:

libc

Description:

The *resmgr_pathname()* function returns the pathname associated with an *id* that's returned from *resmgr_attach()*, it's also the *ctp->id* value of all the resmgr callout functions.

If the *id* was obtained from calling *resmgr_attach()* with _RESMGR_FLAG_DIR specified, then the path name includes a trailing slash.

By default, this function calls:

```
netmgr_ndtostr(ND2S_DIR_SHOW, nd, buf, sizeofbuf)
```

If you specify _RESMGR_PATHNAME_LOCALPATH, it calls

```
netmgr_ndtostr(ND2S_DIR_SHOW|ND2S_LOCAL_STR, nd, buf, sizeofbuf)
```

to return a shortened path that's usable on your local node only. This is useful for display.

Returns:

The length of the path, including the terminating NULL character, or -1 if an error occurs (*errno* is set).

Errors:

EFAULT	A fault occurred in a server's address space when it tried to access the caller's message buffers.
ESRCH	The thread indicated by *ctp -> rcvid* doesn't exist or its connection is detached.
ESRVRFAULT	A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

netmgr_ndtostr(), resmgr_attach()

_RESMGR_PTR()

Get one part from the ctp->iov structure and fill in its fields

Synopsis:

```
#include <sys/resmgr.h>

_RESMGR_PTR( resmgr_context_t ctp,
             void msg,
             size_t nbytes )
```

Arguments:

ctp	A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.
msg	The value you want to use for the structure's *iov_base* member.
nbytes	The value you want to use for the structure's *iov_len* member.

Library:

libc

Description:

The *_RESMGR_PTR()* macro gets one part from the *ctp->iov* structure (see **resmgr_context_t**) and fills in its fields. The macro is equivalent to:

SETIOV (*ctp->iov*, *msg*, *nbytes*)

returning *_RESMGR_NPARTS* (1).

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

resmgr_context_t, *_RESMGR_NPARTS()*, *_RESMGR_STATUS()*, *SETIOV()*

_RESMGR_STATUS()

Set the status member of a resource-manager context

Synopsis:

```
#include <sys/resmgr.h>

_RESMGR_STATUS( resmgr_context_t *ctp,
                int status )
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

status The status that you want to set.

Library:

libc

Description:

The *_RESMGR_STATUS()* macro sets the *status* member in the **resmgr_context_t** structure.

The resource manager library uses this status when it returns the value from *_RESMGR_NPARTS()* for an I/O or connect function, such as:

MsgReply (*ctp->rcvid*, *ctp->status*, *ctp->iov*, *num*).

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

resmgr_connect_funcs_t, **resmgr_io_funcs_t**, *_RESMGR_NPARTS()*, *_RESMGR_PTR()*

resmgr_unbind()

Disassociate an OCB from an open request

Synopsis:

```
#include <sys/resmgr.h>

int resmgr_unbind( resmgr_context_t * ctp);
```

Arguments:

ctp A pointer to a **resmgr_context_t** structure that the resource-manager library uses to pass context information between functions.

Library:

libc

Description:

The *resmgr_unbind()* function removes a binding in the internal resources manager database (which maps client connections to server OCB pointers). The binding must previously have been bound by *resmgr_open_bind()*

The binding is reference counted; if multiple connections are established with the same binding, the binding is freed only when the last connection is removed.

You should use *MsgInfo()* to fill the **info** structure in *ctp* with information about which client mapping to retrieve.

Returns:

-1 Failure.

0 Success.

Errors:

EINVAL	The binding can't be located in the resource manager table.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

MsgInfo(), **`resmgr_context_t`**, *resmgr_open_bind()*

Writing a Resource Manager chapter of the *Programmer's Guide*

rewind()

Rewind a file stream to the beginning of the file

Synopsis:

```
#include <stdio.h>

void rewind( FILE *fp );
```

Arguments:

fp The file stream that you want to rewind.

Library:

libc

Description:

The *rewind()* function rewinds the file stream specified by *fp* to the beginning of the file. It's equivalent to calling *fseek()* like this:

```
fseek( fp, 0L, SEEK_SET );
```

except that the error indicator for the stream is cleared.

Examples:

This example shows how you might implement a two-pass assembler:

```
#include <stdio.h>
#include <stdlib.h>

void assemble_pass( FILE *fp, int passno )
{
    printf( "Pass %d\n", passno );

    /* Do more work on the fp */
    switch( passno ) {
    case 1:
        /* do the first-pass work */
        break;

    case 2:
        /* do the second-pass work */
        break;
```

```
    default:
        break;
    }
}

int main( void )
{
    FILE *fp;

    fp = fopen( "program.s", "r" );
    if( fp != NULL ) {
        assemble_pass( fp, 1 );
        rewind( fp );

        assemble_pass( fp, 2 );
        fclose( fp );

        return EXIT_SUCCESS;
    }

    puts( "Error opening program.s" );

    return EXIT_FAILURE;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

clearerr(), fopen(), fseek()

rewinddir()

Rewind a directory stream to the start of the directory

Synopsis:

```
#include <sys/types.h>
#include <dirent.h>

void rewinddir( DIR * dirp );
```

Arguments:

dirp A pointer to the directory stream of the directory to rewind.

Library:

libc

Description:

The *rewinddir()* function rewinds the directory stream specified by *dirp* to the start of the directory. The directory stream will now refer to the current state of the directory, as if the calling thread had called *opendir()* again.

☞ The result of using a directory stream after one of the *exec*()* or *spawn*()* family of functions is undefined. After a call to *fork()*, either the parent *or* the child (but not both) can continue processing the directory stream, using the *readdir()* and *rewinddir()* functions. If both the parent and child processes use these functions, the result is undefined. Either (or both) processes may use *closedir()*.

Examples:

List all the files in a directory, create a new file, and then list the directory contents again:

```
#include <stdio.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <dirent.h>
#include <stdlib.h>
```

```
int main( void )
{
    DIR *dirp;
    struct dirent *direntp;
    int filedes;

    dirp = opendir( "/home/fred" );
    if( dirp != NULL ) {
        printf( "Old directory listing\n" );
        for(;;) {
            direntp = readdir( dirp );
            if( direntp == NULL ) break;
            printf( "%s\n", direntp->d_name );
        }

        filedes = creat( "/home/fred/file.new",
            S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP );
        close( filedes );

        rewinddir( dirp );
        printf( "New directory listing\n" );
        for(;;) {
            direntp = readdir( dirp );
            if( direntp == NULL ) break;
            printf( "%s\n", direntp->d_name );
        }
        closedir( dirp );
    }

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes

continued...

Safety	
Thread	Yes

See also:

closedir(), opendir(), readdir(), readdir_r(), seekdir()

Rgetsockname()

Get the name of a socket (via a SOCKS server)

Synopsis:

```
#include <sys/socket.h>

int Rgetsockname( int s,
                  struct sockaddr * name,
                  int * namelen );
```

Arguments:

s	The file descriptor of the socket whose name you want to get.
name	A pointer to a **sockaddr** object where the function can store the socket's name.
namelen	A pointer to a **socklen_t** object that initially indicates the amount of space pointed to by *name*. The function updates *namelen* to contain the actual size of the name (in bytes).

Library:

libsocks

Description:

The *Rgetsockname()* function is a cover function for *getsockname()* — the difference is that *Rgetsockname()* does its job via a SOCKS server.

For more information about SOCKS and its libraries, see the appendix, SOCKS — A Basic Firewall.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Classification:

SOCKS

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getsockname() Raccept(), Rbind(), Rconnect(), Rlisten(), Rrcmd(), Rselect(), SOCKSinit()

SOCKS — A Basic Firewall

rindex()

Find the last occurrence of a character in a string

Synopsis:

```
#include <strings.h>

char *rindex( const char *s,
              int c );
```

Arguments:

s The string you want to search. This string must end with a null (`\0`) character. The null character is considered to be part of the string.

c The character you're looking for.

Library:

libc

Description:

The *rindex()* function returns a pointer to the last occurrence of the character *c* in the string *s*.

Returns:

A pointer to the character, or NULL if the character doesn't occur in the string.

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes

continued...

Safety	
Thread	Yes

See also:

index(), strchr(), strrchr()

rint(), *rintf()*

Round to the nearest integral value

Synopsis:

```
#include <math.h>

double rint ( double x );

float rintf ( float x );
```

Arguments:

x The number that you want to round.

Library:

libm

Description:

The *rint()* and *rintf()* functions return the integral value nearest *x* in the direction of the current rounding mode.

If the current rounding mode rounds toward negative infinity, then *rint()* is identical to *floor()*. If the current rounding mode rounds toward positive infinity, then *rint()* is identical to *ceil()*.

Returns:

An integer (represented as a double precision number) nearest *x* in the direction of the current rounding mode (*IEEE754*).

If *x* is:	***rint()* returns:**
±Infinity	*x*
NAN	NAN

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv)
{
    double a, b;

    a = 0.7 ;
    b = rint(a);
    printf("Round Native mode %f -> %f \n", a, b);

    return(0);
}
```

Classification:

rint() is standard Unix; *rintf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ceil(), floor()

Rlisten()

Listen for connections on a socket (via a SOCKS server)

Synopsis:

```
#include <sys/socket.h>

int Rlisten( int s,
             int backlog );
```

Arguments:

s	The descriptor for the socket that you want to listen on. You can create a socket by calling *socket()*.
backlog	The maximum length that the queue of pending connections may grow to.

Library:

libsocks

Description:

The *Rlisten()* function is a cover function for *listen()* — the difference is that *Rlisten()* does its job via a SOCKS server.

For more information about SOCKS and its libraries, see the appendix, SOCKS — A Basic Firewall.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Classification:

SOCKS

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

listen() Raccept(), Rbind(), Rconnect(), Rgetsockname(), Rrcmd(), Rselect(), SOCKSinit()

SOCKS — A Basic Firewall

rmdir()

Delete an empty directory

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

int rmdir( const char* path );
```

Arguments:

path The path of the directory that you want to delete. This path can be relative to the current working directory, or an absolute path.

Library:

libc

Description:

The *rmdir()* function removes (deletes) the specified directory. The directory must not contain any files or directories.

☞ If the directory is the current working directory of any process, *rmdir()* returns **-1** and sets *errno* to EINVAL. If the directory is the root directory, the effect of this function depends on the filesystem.

The space occupied by the directory is freed, making it inaccessible, if its link count becomes zero and no process has the directory open (*opendir()*). If a process has the directory open when the last link is removed, the **.** and **..** entries are removed and no new entries can be created in the directory. In this case, the directory will be removed when all references to it have been closed (*closedir()*).

When successful, *rmdir()* marks *st_ctime* and *st_mtime* for update in the parent directory.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES	Search permission is denied for a component of *path*, or write permission is denied on the parent directory of the directory to be removed.
EBUSY	The directory named by *path* can't be removed because it's being used by another process, and the implementation considers this to be an error.
EEXIST	The *path* argument names a directory that isn't empty.
ELOOP	Too many levels of symbolic links.
ENAMETOOLONG	The argument *path* exceeds PATH_MAX in length, or a pathname component is longer than NAME_MAX.
ENOENT	The specified *path* doesn't exist, or *path* is an empty string.
ENOSYS	The *rmdir()* function isn't implemented for the filesystem specified in *path*.
ENOTDIR	A component of *path* isn't a directory.
ENOTEMPTY	The *path* argument names a directory that isn't empty.
EROFS	The directory entry to be removed resides on a read-only filesystem.

Examples:

To remove the directory called **/home/terry**:

```
#include <stdlib.h>
#include <sys/types.h>
#include <sys/stat.h>

int main( void )
{
    (void)rmdir( "/home/terry" );

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chdir(), chmod(), errno, getcwd(), mkdir(), stat()

ROUTE

System packet forwarding database

Synopsis:

```
#include <sys/socket.h>
#include <net/if.h>
#include <net/route.h>

int socket( PF_ROUTE,
            SOCK_RAW,
            int family );
```

Description:

QNX TCP/IP provides some packet routing facilities.

The following information applies only to the full TCP/IP stack. For information on how the tiny TCP/IP stack can change the routing table, see **npm-ttcpip.so**.

The socket manager maintains a routing information database that's used in selecting the appropriate network interface when transmitting packets.

A user process (or possibly multiple cooperating processes) maintains this database by sending messages over a special kind of socket. This supplants fixed-size *ioctl()*s used in earlier releases. Routing table changes may be carried out only by the superuser.

This interface may spontaneously emit routing messages in response to external events, such as receipt of a redirect or of a failure to locate a suitable route for a request. The message types are described in greater detail below.

Routing database entries

Routing database entries come in two flavors: for a specific host or for all hosts on a generic subnetwork (as specified by a bit mask and value under the mask). The effect of wildcard or default routing may be achieved by using a mask of all zeros. There may be hierarchical routes.

When the system is booted and addresses are assigned to the network interfaces, each protocol family installs a routing table entry for each interface when it's ready for traffic. Normally the protocol specifies the route through each interface as a "direct" connection to the destination host or network. If the route is direct, the transport layer of a protocol family usually requests the packet be sent to the same host specified in the packet. Otherwise, the interface is requested to address the packet to the gateway listed in the routing entry (i.e. the packet is forwarded).

Routing packets

When routing a packet, the kernel attempts to find the most specific route matching the destination. (If there are two different mask and value-under-the-mask pairs that match, the more specific is the one with more bits in the mask. A route to a host is regarded as being supplied with a mask of as many ones as there are bits in the destination). If no entry is found, the destination is declared to be unreachable, and a routing-miss message is generated if there are any listeners on the routing control socket described below.

A wildcard routing entry is specified with a zero destination address value and a mask of all zeroes. Wildcard routes are used when the system fails to find other routes matching the destination. The combination of wildcard routes and routing redirects can provide an economical mechanism for routing traffic.

Routing control messages

To open the channel for passing routing control messages, use the socket call shown in the synopsis above.

The family parameter may be AF_UNSPEC, which provides routing information for all address families, or it can be restricted to a specific address family. There can be more than one routing socket open per system.

Messages are formed by a header followed by a small number of **`sockaddr`**s (with variable length) interpreted by position and delimited by the new length entry in the **`sockaddr`**. An example of a

message with four addresses might be a redirect: Destination, Netmask, Gateway, and Author of the redirect. The interpretation of which addresses are present is given by a bit mask within the header; the sequence is least-significant to most-significant bit within the vector.

Any messages sent to the socket manager are returned, and copies are sent to all interested listeners. The interface provides the process ID for the sender. To distinguish between outstanding messages, the sender may use an additional sequence field. However, message replies may be lost when socket manager buffers are exhausted.

The interface may reject certain messages, as indicated in the *rtm_errno* field.

This error occurs:	**If:**
EEXIST	Requested to duplicate an existing entry.
ESRCH	Requested to delete a nonexistent entry.
ENOBUFS	Insufficient resources were available to install a new route.

In the current implementation, all routing processes run locally, and the values for *rtm_errno* are available through the normal *errno* mechanism, even if the routing reply message is lost.

A process may avoid the expense of reading replies to its own messages by calling *setsockopt()*, to turn off the SO_USELOOPBACK option at the SOL_SOCKET level. A process may ignore all messages from the routing socket by doing a *shutdown()* system call for further input.

If a route is in use when it's deleted, the routing entry is marked down and removed from the routing table, but the resources associated with it won't be reclaimed until all references to it are released. User processes can obtain information about the routing entry to a specific destination by using a RTM_GET message or by calling *sysctl()*.

The messages are:

```
#define RTM_ADD       0x1  /* Add Route */
#define RTM_DELETE    0x2  /* Delete Route */
#define RTM_CHANGE    0x3  /* Change Metrics, Flags, or Gateway */
#define RTM_GET       0x4  /* Report Information */
#define RTM_LOSING    0x5  /* Kernel Suspects Partitioning */
#define RTM_REDIRECT  0x6  /* Told to use different route */
#define RTM_MISS      0x7  /* Lookup failed on this address */
#define RTM_RESOLVE   0xb  /* request to resolve dst to LL addr */
#define RTM_NEWADDR   0xc  /* address being added to iface */
#define RTM_DELADDR   0xd  /* address being removed from iface */
#define RTM_IFINFO    0xe  /* iface going up/down etc. */
```

A message header consists of one of the following:

```
struct rt_msghdr {
    u_short rtm_msglen;    /* skip over non-understood msgs */
    u_char  rtm_version;   /* future binary compatibility */
    u_char  rtm_type;      /* message type */
    u_short rtm_index;     /* index for associated ifp */
    int     rtm_flags;     /* flags, incl kern & message, e.g. DONE */
    int     rtm_addrs;     /* bitmask identifying sockaddrs in msg */
    pid_t   rtm_pid;       /* identify sender */
    int     rtm_seq;       /* for sender to identify action */
    int     rtm_errno;     /* why failed */
    int     rtm_use;       /* from rtentry */
    u_long  rtm_inits;     /* which metrics we're initializing */
    struct  rt_metrics rtm_rmx; /* metrics themselves */
};

struct if_msghdr {
    u_short ifm_msglen;    /* to skip over non-understood msgs */
    u_char  ifm_version;   /* future binary compatibility */
    u_char  ifm_type;      /* message type */
    int     ifm_addrs;     /* like rtm_addrs */
    int     ifm_flags;     /* value of if_flags */
    u_short ifm_index;     /* index for associated ifp */
    struct  if_data ifm_dat /* statistics and other data about if */
};

struct ifa_msghdr {
    u_short ifam_msglen;   /* to skip over non-understood msgs */
    u_char  ifam_version;  /* future binary compatibility */
    u_char  ifam_type;     /* message type */
    int     ifam_addrs;    /* like rtm_addrs */
    int     ifam_flags;    /* value of ifa_flags */
    u_short ifam_index;    /* index for associated ifp */
    int     ifam_metric;   /* value of ifa_metric */
};
```

The RTM_IFINFO message uses an **`if_msghdr`** header. The RTM_NEWADDR and RTM_DELADDR messages use an **`ifa_msghdr`** header. All other messages use the **`rt_msghdr`** header.

The metrics structure is:

```
struct rt_metrics {
    u_long rmx_locks;      /* Kernel must leave these values alone */
    u_long rmx_mtu;        /* MTU for this path */
    u_long rmx_hopcount;   /* max hops expected */
    u_long rmx_expire;     /* lifetime for route, e.g. redirect */
    u_long rmx_recvpipe;   /* inbound delay-bandwidth product */
    u_long rmx_sendpipe;   /* outbound delay-bandwidth product */
    u_long rmx_ssthresh;   /* outbound gateway buffer limit */
    u_long rmx_rtt;        /* estimated round trip time */
    u_long rmx_rttvar;     /* estimated rtt variance */
    u_long rmx_pksent;     /* packets sent using this route */
};
```

Flags include the values:

```
#define RTF_UP         0x1    /* route usable */
#define RTF_GATEWAY    0x2    /* destination is a gateway */
#define RTF_HOST       0x4    /* host entry (net otherwise) */
#define RTF_REJECT     0x8    /* host or net unreachable */
#define RTF_DYNAMIC    0x10   /* created dynamically (by redirect) */
#define RTF_MODIFIED   0x20   /* modified dynamically (by redirect) */
#define RTF_DONE       0x40   /* message confirmed */
#define RTF_MASK       0x80   /* subnet mask present */
#define RTF_CLONING    0x100  /* generate new routes on use */
#define RTF_XRESOLVE   0x200  /* external daemon resolves name */
#define RTF_LLINFO     0x400  /* generated by ARP or ESIS */
#define RTF_STATIC     0x800  /* manually added */
#define RTF_BLACKHOLE 0x1000 /* just discard pkts (during updates) */
#define RTF_PROTO2     0x4000 /* protocol specific routing flag */
#define RTF_PROTO1     0x8000 /* protocol specific routing flag */
```

Specifiers for metric values in *rmx_locks* and *rtm_inits* are:

```
#define RTV_MTU        0x1   /* init or lock _mtu */
#define RTV_HOPCOUNT   0x2   /* init or lock _hopcount */
#define RTV_EXPIRE     0x4   /* init or lock _expire */
#define RTV_RPIPE      0x8   /* init or lock _recvpipe */
#define RTV_SPIPE      0x10  /* init or lock _sendpipe */
#define RTV_SSTHRESH   0x20  /* init or lock _ssthresh */
#define RTV_RTT        0x40  /* init or lock _rtt */
#define RTV_RTTVAR     0x80  /* init or lock _rttvar */
```

Specifiers for which addresses are present in the messages are:

```
#define RTA_DST       0x1  /* destination sockaddr present */
#define RTA_GATEWAY   0x2  /* gateway sockaddr present */
#define RTA_NETMASK   0x4  /* netmask sockaddr present */
```

```
#define RTA_GENMASK  0x8  /* cloning mask sockaddr present */
#define RTA_IFP      0x10 /* interface name sockaddr present */
#define RTA_IFA      0x20 /* interface addr sockaddr present */
#define RTA_AUTHOR   0x40 /* sockaddr for author of redirect */
#define RTA_BRD      0x80 /* for NEWADDR, */
                          /*      broadcast or p-p dest addr */
```

Examples:

Use the following code to set the default route:

```
#include <sys/socket.h>
#include <sys/uio.h>
#include <unistd.h>
#include <net/route.h>
#include <netinet/in.h>
#include <stdio.h>
#include <libgen.h>
#include <arpa/inet.h>
#include <process.h>
#include <errno.h>

struct my_rt
{
      struct rt_msghdr rt;
      struct sockaddr_in dst;
      struct sockaddr_in gate;
      struct sockaddr_in mask;
};

int main(int argc, char **argv)
{
      int s;
      struct rt_msghdr *rtm;
      struct sockaddr_in *dst, *gate, *mask;
      struct my_rt my_rt;

      if(argc < 2)
      {
              fprintf(stderr, "Usage: %s: <ip_addr_of_default_gateway>\n",
                      basename(argv[0]));
              return 1;
      }

      if((s = socket(AF_ROUTE, SOCK_RAW, 0)) == -1)
      {
              perror("socket");
```

```
                return 1;
        }

        memset(&my_rt, 0x00, sizeof(my_rt));

        rtm  = &my_rt.rt;

        dst  = &my_rt.dst;
        gate = &my_rt.gate;
        mask = &my_rt.mask;

        rtm->rtm_type = RTM_ADD;
        rtm->rtm_flags = RTF_UP | RTF_GATEWAY | RTF_STATIC;
        rtm->rtm_msglen = sizeof(my_rt);
        rtm->rtm_version = RTM_VERSION;
        rtm->rtm_seq = 1234;
        rtm->rtm_addrs = RTA_DST | RTA_GATEWAY | RTA_NETMASK;
        rtm->rtm_pid = getpid();

        dst->sin_len    = sizeof(*dst);
        dst->sin_family = AF_INET;

        mask->sin_len    = sizeof(*mask);
        mask->sin_family = AF_INET;

        gate->sin_len    = sizeof(*gate);
        gate->sin_family = AF_INET;
        inet_aton(argv[1], &gate->sin_addr);

AGAIN:
        if(write(s, rtm, rtm->rtm_msglen) < 0)
        {
                if(errno == EEXIST && rtm->rtm_type == RTM_ADD)
                {
                        rtm->rtm_type = RTM_CHANGE;
                        goto AGAIN;
                }
                        perror("write");
                        return 1;
        }
        return 0;
}
```

See also:

setsockopt(), socket(), sysctl()

npm-tcpip.so in the *Utilities Reference*

Rrcmd()

Execute a command on a remote host (via a SOCKS server)

Synopsis:

```
int Rrcmd( char ** ahost,
           int inport,
           const char * locuser,
           const char * remuser,
           const char * cmd,
           int * fd2p );
```

Arguments:

ahost	The name of the host that you want to execute the command on. If the function can find the host, it sets **ahost* to the standard name of the host.
inport	The well-known Internet port on the host, where the server resides.
locuser	The user ID on the local machine.
remuser	The user ID on the remote machine.
cmd	The command that you want to execute.
fd2p	See *rcmd()*.

Library:

libsocks

Description:

The *Rrcmd()* function is a cover function for *rcmd()* — the difference is that *Rrcmd()* does its job via a SOCKS server.

For more information about SOCKS and its libraries, see the appendix, SOCKS — A Basic Firewall.

Returns:

A valid socket descriptor; or -1 if an error occurs and a message is printed to standard error.

Classification:

SOCKS

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

Raccept(), Rbind(), rcmd() Rconnect(), Rgetsockname(), Rlisten(), Rselect(), SOCKSinit()

SOCKS — A Basic Firewall

rresvport()

Obtain a socket with a privileged address

Synopsis:

```
#include <unistd.h>

int rresvport( int * port );
```

Arguments:

port An address in the privileged port space. Privileged Internet ports are those in the range 0 to 1023. Only the superuser may bind this type of address to a socket.

Library:

libsocket

Description:

The *rresvport()* function returns a descriptor to a socket with an address in the privileged port space. The *ruserok()* function is used by servers to authenticate clients requesting service with *rcmd()*. All three functions are present in the same file and are used by the **rshd** server (see the *Utilities Reference*), among others.

The *rresvport()* function obtains a socket with a privileged address bound to it. This socket can be used by *rcmd()* and several other functions.

Returns:

A valid, bound socket descriptor, or -1 if an error occurs (*errno* is set).

Errors:

The error code EAGAIN is overloaded to mean “All network ports in use.”

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

rcmd(), ruserok()

rshd in the *Utilities Reference*

Rselect()

Check for descriptors that are ready for reading or writing (via a SOCKS server)

Synopsis:

```
int Rselect( int width,
             fd_set * readfds,
             fd_set * writefds,
             fd_set * exceptionfds,
             struct timeval * timeout );
```

Arguments:

width	The number of descriptors to check in the given sets. Only the descriptors from 0 through (*width*-1) in the descriptor sets are examined. Therefore, the value of *width* must be at least as large as: (*highest valued file descriptor in the sets*) +1
readfds	NULL, or a pointer to a **fd_set** object that specifies the descriptors to check for files that are ready for reading. The function replaces the set with the file descriptors that are actually ready for reading.
writefds	NULL, or a pointer to a **fd_set** object that specifies the descriptors to check for files that are ready for writing. The function replaces the set with the file descriptors that are actually ready for writing.
exceptionfds	NULL, or a pointer to a **fd_set** object that specifies the descriptors to check for files that have an exceptional condition pending. The function replaces the set with the file descriptors that actually have an exceptional condition pending.
timeout	NULL, or a pointer to a **timeval** that specifies how long to wait for the selection to complete.

Library:

libsocks

Description:

The *Rselect()* function is a cover function for *select()* — the difference is that *Rselect()* does its job via a SOCKS server.

For more information about SOCKS and its libraries, see the appendix, SOCKS — A Basic Firewall.

Returns:

The number of ready descriptors in the descriptor sets, 0 if the *timeout* expired, or -1 if an error occurs (*errno* is set).

Classification:

SOCKS

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

select()

SOCKS — A Basic Firewall

rsrcdbmgr_attach()

Reserve a system resource for a process

Synopsis:

```
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int rsrcdbmgr_attach( rsrc_request_t * list,
                      int count );
```

Arguments:

list An array of **rsrc_request_t** structures that describe the resources that you want to reserve; see below.

count The number of entries in the array.

Library:

libc

Description:

The resource database manager allocates and keeps track of system resources i.e. it manages these resources. The system resources currently tracked are:

- memory
- IRQs
- DMA channels
- I/O ports.

Major and minor device numbers are handled with separate *rsrcdbmgr_devno_attach()* and *rsrcdbmgr_devno_detach()* functions.

There are two main functions that drivers can use to communicate with the resource database:

- *rsrcdbmgr_attach()*
- *rsrcdbmgr_detach()*

The *rsrcdbmgr_attach()* function reserves a resource range(s) from the database of available resources for a process. Other processes can't reserve this resource range until the resource is returned to the system (usually with the *rsrcdbmgr_detach()* call). The requested resources are returned in a *list* of **_rsrc_request** structures with the *start* and *end* fields filled in. The number of resources requested is specified in *count*.

Reserving the resources doesn't give you access to them; you still have to use *mmap()*, *InterruptAttach()*, or another means.

When you're finished with the resource, you must return it to the system. The easiest way to return the resource is to call *rsrcdbmgr_detach()* with the same *start*, *end*, and type (via the *flags* field) that were issued for the resource.

rsrc_request_t structure

The resource requests structure looks like this:

```
typedef struct _rsrc_request {
   uint64_t   length;
   uint64_t   align;
   uint64_t   start;
   uint64_t   end;
   uint32_t   flags;
   uint32_t   zero[3];   /* Reserved */
} rsrc_request_t;
```

The members include:

length — The length of the resource that you want to reserve. You must set this member.

align — The alignment of the resource.

start, *end* — The range of resource that you want to reserve.

flags — The type of the resource, as well as flags that affect the request. You must set this member to be one of the following resource types (defined in **<sys/rsrcdbmgr.h>**):

- RSRCDBMGR_DMA_CHANNEL — DMA channel
- RSRCDBMGR_IO_PORT — I/O port address
- RSRCDBMGR_IRQ — Interrupt address
- RSRCDBMGR_MEMORY — Memory address
- RSRCDBMGR_PCI_MEMORY — PCI memory address

You can OR in the following flags (also defined in **<sys/rsrcdbmgr.h>**):

- RSRCDBMGR_FLAG_ALIGN — the contents of the *align* field are valid, and the requested resource starts with the given alignment.
- RSRCDBMGR_FLAG_RANGE — the contents of the *start* and *end* fields are valid, and the requested resource is in the range *start* to *end*, inclusive.
- RSRCDBMGR_FLAG_SHARE — other processes can have access to an allocated resource.
- RSRCDBMGR_FLAG_TOPDOWN — start the search for a free resource block from *end*. If you also set RSRCDBMGR_FLAG_RANGE, this flag makes the search start from the *end* of the available range.

Returns:

EOK, or -1 if an error occurred (*errno* is set).

Errors:

EAGAIN	The resource request can't be filled.
EINVAL	Invalid argument.
ENOMEM	Insufficient memory to allocate internal data structures.

Examples:

When you start the system, the startup code and special programs that know how to probe the hardware call *rsrcdbmgr_create()* to register the hardware in the resource database. The following examples don't do this seeding, so they'll fail with an error code of EINVAL.

Example 1

```
/*
 * Request one DMA Channel, with length 1, from the
 * entire range of available DMA channel resources.
 */
#include <stdio.h>
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int main(int argc, char **argv) {
    int count;
    rsrc_request_t req;

    memset(&req, 0, sizeof(req));
    req.length = 1;
    req.flags = RSRCDBMGR_DMA_CHANNEL;
    count = 1;

    if (rsrcdbmgr_attach( &req, count) == -1) {
        perror("Problem attaching to resource ");
        exit(1);
    }

    printf("You can use DMA channel 0x%llx \n",
            req.start);

    ...
    /* Do something with the acquired resource */
    ...

    /* To return the resource to the database: */
    if (rsrcdbmgr_detach( &req, count) == -1) {
        perror("Problem detaching resource \n");
        exit(1);
    }

    return(0);
}
```

Example 2

```
/*
 * Request memory that's 4-byte aligned
 * and has a length of 50.
 */

#include <stdio.h>
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int main(int argc, char **argv) {
    int count;
    rsrc_request_t req;

    memset(&req, 0, sizeof(req));
    req.align = 4;
    req.length = 50;
    req.flags = RSRCDBMGR_FLAG_ALIGN | RSRCDBMGR_MEMORY;
    count = 1;

    if (rsrcdbmgr_attach(&req, count) == -1) {
        perror("Problem attaching to resource ");
        exit(1);
    }

    printf("You can use memory from 0x%llx 0x%llx inclusive. \n",
            req.start, req.end );

    ...
    /* Do something with the acquired resource */
    ...

    /* To return the resource to the database: */
    if (rsrcdbmgr_detach( &req, count) == -1) {
        perror("Problem detaching resource \n");
        exit(1);
    }

    return(0);
}
```

Example 3

```
/*
 * Request two resources:
 * I/O port 0 and an IRQ in the range 10-12
 * from the available resources.
```

```
 */
#include <stdio.h>
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int main(int argc, char **argv) {
    int count;
    rsrc_request_t req[2];

    memset(req, 0, 2*sizeof(*req));
    req[0].start = 0;
    req[0].end = 0;
    req[0].length = 1;
    req[0].flags = RSRCDBMGR_FLAG_RANGE | RSRCDBMGR_IO_PORT;

    req[1].start = 10;
    req[1].end = 12;
    req[1].length = 1;
    req[1].flags = RSRCDBMGR_FLAG_RANGE | RSRCDBMGR_IRQ;
    count = 2;

    if (rsrcdbmgr_attach(req, count) == -1) {
        perror("Problem attaching to resource ");
        exit(1);
    }

    printf("You can use io-port 0x%llx \n",
            req[0].start);
    printf("You can use irq 0x%llx \n",
            req[1].start);

    ...
    /* Do something with the acquired resource */
    ...

    /* To return the resource to the database: */
    if (rsrcdbmgr_detach(req, count) == -1) {
        perror("Problem detaching resource \n");
        exit(1);
    }

    return(0);
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

rsrcdbmgr_create(), *rsrcdbmgr_detach()*, *rsrcdbmgr_destroy()*, *rsrcdbmgr_devno_attach()*, *rsrcdbmgr_devno_detach()*, *rsrcdbmgr_query()*

rsrcdbmgr_create()

Create a system resource

Synopsis:

```
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int rsrcdbmgr_create( rsrc_alloc_t *item,
                      int count );
```

Arguments:

item An array of **rsrc_alloc_t** structures that describe the resources that you want to create; see below.

count The number of entries in the array.

Library:

libc

Description:

The *rsrcdbmgr_create()* function creates one or more system resources. If the function completes successfully, *count* resources are returned in *item*.

rsrc_alloc_t structure

The structure of a basic resource request looks like this:

```
typedef struct _rsrc_alloc {
   uint64_t   start;   /* Start of resource range */
   uint64_t   end;     /* End of resource range */
   uint32_t   flags;   /* Resource type | Resource flags */
} rsrc_alloc_t;
```

The members include:

start, *end* The resource range.

flags The type of the resource, as well as flags that affect the request. You must set this member to be one of the following resource types (defined in **<sys/rsrcdbmgr.h>**):

- RSRCDBMGR_DMA_CHANNEL — DMA channel
- RSRCDBMGR_IO_PORT — I/O port address
- RSRCDBMGR_IRQ or RSRCMGR_IRQ — interrupt address
- RSRCDBMGR_MEMORY — Memory address
- RSRCDBMGR_PCI_MEMORY — PCI memory address

You can OR in the following flag (also defined in **<sys/rsrcdbmgr.h>**):

- RSRCDBMGR_FLAG_RSVP — create and reserve a resource with a higher priority than other resources. The resource is given out only when there are no other valid ranges available.

You must set all the members.

Returns:

EOK, or -1 if an error occurred (*errno* is set).

Errors:

EAGAIN	The resource request can't be created.
EINVAL	Invalid argument.
ENOMEM	Insufficient memory to allocate internal data structures.

Examples:

```
/*
 * Create two resources:
 * 0-4K memory allocation and 5 DMA channels.
 */
#include <stdio.h>
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int main(int argc, char **argv) {
    rsrc_alloc_t alloc[2];

    memset(alloc, 0, 2* sizeof(*alloc));
    alloc[0].start = 0;
    alloc[0].end = 4*1024;
    alloc[0].flags = RSRCDBMGR_MEMORY;

    alloc[1].start = 1;
    alloc[1].end = 5;
    alloc[1].flags = RSRCDBMGR_DMA_CHANNEL;

    /* Allocate resources to the system. */
    if (rsrcdbmgr_create( alloc, 2 ) == -1) {
        perror("Problem creating resources \n");
        exit(1);
    }

    ...
    /* Do something with the created resource */
    ...

    /* Remove the allocated resources. */
    rsrcdbmgr_destroy ( alloc, 2 );

    return(0);
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

rsrcdbmgr_attach(), rsrcdbmgr_destroy()

rsrcdbmgr_destroy()

Destroy a system resource

Synopsis:

```
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int rsrcdbmgr_destroy( rsrc_alloc_t *item,
                       int count );
```

Arguments:

item An array of **rsrc_alloc_t** structures that describe the resources that you want to destroy. For more information about this structure, see the documentation for *rsrcdbmgr_create()*.

count The number of entries in the array.

Library:

libc

Description:

The *rsrcdbmgr_destroy()* function removes *count* system resources that are defined in the array *item*.

Returns:

EOK Success.

-1 An error occurred; *errno* is set.

Errors:

EINVAL Invalid argument, or the resource is in use.

ENOMEM Insufficient memory to allocate internal data structures.

Examples:

See the example in *rsrcdbmgr_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

rsrcdbmgr_attach(), *rsrcdbmgr_create()*, *rsrcdbmgr_detach()*

rsrcdbmgr_detach()

Return a system resource to the resource database

Synopsis:

```
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int rsrcdbmgr_detach( rsrc_request_t *list,
                      int count );
```

Arguments:

list An array of **rsrc_request_t** structures that describe the resources that you want to return. For information about this structure, see the documentation for *rsrcdbmgr_attach()*.

count The number of entries in the array.

Library:

libc

Description:

The *rsrcdbmgr_detach()* function returns *count* resources in *list* to the database of available system resources. You must return the resource with the same *start*, *end*, and *flags* (type) that were issued for the resource when it was allocated with *rsrcdbmgr_attach()*.

Returns:

EOK Success.

-1 An error occurred; *errno* is set.

Errors:

EINVAL Invalid argument, or the resource is in use by a process, isn't found in the database, or can't be returned to the system.

ENOMEM Insufficient memory to allocate internal data structures.

Examples:

See the examples in *rsrcdbmgr_attach()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

rsrcdbmgr_attach(), *rsrcdbmgr_destroy()*

rsrcdbmgr_devno_attach()

Get major and minor device numbers

Synopsis:

```
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

dev_t rsrcdbmgr_devno_attach( const char * name,
                              int minor_request,
                              int flags );
```

Arguments:

name The name of the class of devices that you want to get the major number for. This string can be anything, but the following class names are defined in **<sys/ftype.h>**:

Constant	Value	Class
_MAJOR_PATHMGR	**"pathmgr"**	Used only by the path manager
_MAJOR_DEV	**"dev"**	Devices in **/dev** with only one instance (e.g. **/dev/tty**)
_MAJOR_BLK_PREFIX	**"blk-"**	All block devices (e.g. **/dev/hd[0-9]*** would be **"blk-hd"**)

continued...

Constant	Value	Class
_MAJOR_CHAR_PREFIX	`"char-"`	All character devices (e.g. `/dev/ser[0-9]*` would be `"char-ser"`)
_MAJOR_FSYS	`"fsys"`	All filesystems

minor_request The minor device number that you want to reserve, or -1 to let the system assign the next available minor number.

flags Presently, there are no flags; pass zero for this argument.

Library:

`libc`

Description:

The function *rsrcdbmgr_devno_attach()* reserves a device number that consists of:

- a major number that corresponds to the given device class. If there isn't already a major number associated with the class, a new major number is assigned to it.
- a minor number that's based on *minor_request*. If *minor_request* is -1, the function returns the first free minor number in the specified class.

There's a maximum of 64 major numbers (0 through 63) on the system, and a maximum of 1024 minor numbers (0 through 1023) per major number.

Major and minor numbers are used only by resource managers and are exposed through the *rdev* member of the **iofunc_attr_t** structure , and correspondingly the *st_rdev* member of the **stat** structure. They aren't required for proper operation; on simple devices, an entry will be simulated for you.

Returns:

A **dev_t** object that contains the major and minor numbers, or -1 if an error occurs (*errno* is set).

You can extract the major and minor number values from the **dev_t** object by using the *major()* and *minor()* macros defined in **<sys/types.h>**. For more information, see the documentation for *stat()*.

Errors:

EINVAL Invalid argument.

Examples:

```
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

char      *dev_name;
int       myminor_request, flags=0;
dev_t     major_minor;

major_minor = rsrcdbmgr_devno_attach
              ( dev_name, myminor_request, flags );

⋮

rsrcdbmgr_devno_detach( major_minor, flags );
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

iofunc_attr_t, *rsrcdbmgr_attach()*, *rsrcdbmgr_devno_detach()*, *stat()*

rsrcdbmgr_devno_detach()

Detach a major and minor number

Synopsis:

```
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int rsrcdbmgr_devno_detach( dev_t devno,
                            int flags );
```

Arguments:

devno A **dev_t** object that was returned by *rsrcdbmgr_devno_attach()*.

flags Presently, there are no flags; pass zero for this argument.

Library:

libc

Description:

The function *rsrcdbmgr_devno_detach()* detaches device number that was attached with *rsrcdbmgr_devno_attach()*.

Returns:

EOK Success.

-1 An error occurred.

Examples:

```
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

dev_t   dev_num;
int     flags=0;

⋮

rsrcdbmgr_devno_detach( dev_num, flags );
```


Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

rsrcdbmgr_attach(), *rsrcdbmgr_devno_attach()*

rsrcdbmgr_query()

Query the resource database

Synopsis:

```
#include <sys/rsrcdbmgr.h>
#include <sys/rsrcdbmsg.h>

int rsrcdbmgr_query( rsrc_alloc_t *list,
                     int listcnt,
                     int start,
                     uint32_t type );
```

Arguments:

item NULL, or an array of **rsrc_alloc_t** structures that the function can fill with information about the resources that it finds. For more information about this structure, see the documentation for *rsrcdbmgr_create()*.

listcnt The number of entries in the array.

start The index that you want to start searching at.

type The type of resource that you want to query; one of the following (defined in **<sys/rsrcdbmgr.h>**):

- RSRCDBMGR_DMA_CHANNEL — DMA channel
- RSRCDBMGR_IO_PORT — I/O port address
- RSRCDBMGR_IRQ or RSRCMGR_IRQ — interrupt address
- RSRCDBMGR_MEMORY — Memory address
- RSRCDBMGR_PCI_MEMORY — PCI memory address

Library:

libc

Description:

The *rsrcdbmgr_query()* function queries the database for *listcnt* count of *type* resources in use, beginning at the index *start*. If you make the query with a non-NULL *list*, then the function stores a maximum of found *listcnt* resources in the array.

Returns:

If *list* is NULL or *listcnt* is `0`, then the function returns the number of resources of *type* in the database.

If *list* is non-NULL, then the function returns the number of *type* resources available in the system.

If an error occurs, the function returns `-1` and sets *errno*.

Errors:

EINVAL	Invalid argument
ENOMEM	Insufficient memory to allocate internal data structures.

Examples:

List all of the memory resource blocks available in the system:

```
rsrc_alloc_t  list[20];
int           size, count = 0, start = 0;

while (1) {
   count = rsrcdbmgr_query( &list, 20, start, RSRCDBMGR_MEMORY );
   if (count == -1)
   break;

   size = min( count-start, 20 );  /* In case more than 20 blocks
                                      were returned. */
   printf( "Retrieved %d of a possible %d resource blocks", \
            size, count);

   for (count=0; count<size; count++) {
       printf( "RSRC[%d] Start %d End %d \n",  \
                start+count, list[count].start, list[count].end);
   }
   start += size;  /* Loop again, in case there are more than
```

```
                                    20 blocks. */
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

rsrcdbmgr_attach()

ruserok()

Check the identity of a remote host

Synopsis:

```
#include <unistd.h>

int ruserok( char * rhost,
             int superuser,
             char * ruser,
             char * luser );
```

Arguments:

rhost	The name of the remote host, as returned by *gethostbyaddr()*.
superuser	Nonzero if the local user is the superuser, zero otherwise.
ruser	The name of the remote user.
luser	The name of the local user.

Library:

libsocket

Description:

The *ruserok()* routine checks the identity of a remote host. It's used by servers to authenticate clients requesting service with *rcmd()*.

The *rcmd()*, *rresvport()*, and *ruserok()* functions are used by the **rshd** server (see the *Utilities Reference*), among others.

The *ruserok()* function takes a remote host's name (as returned by the *gethostbyaddr()* routine), two user names, and a flag indicating whether the local user's name is that of the superuser. Then, if the user is *not* the superuser, it checks the file **/etc/hosts.equiv** (described in the *Utilities Reference*).

If that lookup isn't done, or is unsuccessful, the **.rhosts** file in the local user's home directory is checked to see if the request for service

is allowed. If this file is owned by anyone other than the user or the superuser, or if it's writable by anyone other than the owner, the check automatically fails.

If the local domain obtained from *gethostname()* is the same as the remote domain, only the machine name need be specified.

Returns:

0 The machine name is listed in the **`hosts.equiv`** file, or the host and remote username were found in the **`.rhosts`** file.

-1 An error occurred (*errno* is set).

Errors:

The error code EAGAIN is overloaded to mean "All network ports in use."

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

gethostbyaddr(), *gethostname()*, *rcmd()*, *rresvport()*

`/etc/hosts.equiv`, **`rshd`** in the *Utilities Reference*

sbrk()

Set the allocation break value

Synopsis:

```
#include <unistd.h>

void* sbrk( int increment );
```

Arguments:

increment	The amount by which to increase the current break value. This increment may be positive or negative.

Library:

libc

Description:

The *break* value is the address of the first byte of unallocated memory. When a program starts execution, the break value is placed following the code and constant data for the program. As memory is allocated, this pointer advances when there is no free block large enough to satisfy an allocation request. The *sbrk()* function sets a new break value for the program by adding the value of *increment* to the current break value.

The variable *_amblksiz* (defined in **<stdlib.h>**) contains the default increment. This value may be changed by a program at any time.

Returns:

A pointer to the start of the new block of memory for success, or **-1** if an error occurs (*errno* is set).

Errors:

EAGAIN	The total amount of system memory available for allocation to this process is temporarily insufficient. This may occur although the space requested is less than the maximum data segment size.

ENOMEM	The requested change allocated more space than allowed, is impossible since there's insufficient swap space available, or it caused a memory allocation conflict.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

#define alloc( x, y ) y = sbrk( x );

int main( void )
{
    void* brk;

    brk = sbrk( 0x3100 );
    printf( "New break value after sbrk( 0x3100 ) \t%p\n",
            brk );

    brk = sbrk( 0x0200 );
    printf( "New break value after sbrk( 0x0200 ) \t%p\n",
            brk );

    return EXIT_SUCCESS;
}
```

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

_amblksiz, *_btext*, *_edata*, *_end*, *_etext*, *brk()*, *calloc()*, *errno*, *free()*, *malloc()*, *realloc()*

scalb(), scalbf()

Load the exponent of a radix-independent floating point number

Synopsis:

```
#include <math.h>

double scalb( double x,
              double n );

float scalbf( float x,
              float n );
```

Arguments:

x The floating point number that you want to multiply by the exponent.

n The exponent to apply to the radix of the machine's floating-point arithmetic.

Library:

libm

Description:

☞ We recommend that you use *scalbn()* since it computes by exponent manipulation rather than mock multiplications or additions.

These functions compute $x \times r^n$, where *r* is the radix of the machine's floating point arithmetic and *n* is a finite number. When *r* is 2, *scalb()* is equivalent to *ldexp()*.

Returns:

$x \times r^n$

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv)
{
    double a, b, c, d;

    a = 10;
    b = 2;
    c = scalb(a, b);
    d = sqrt(c/a);
    printf("Radix of machines fp arithmetic is %f \n", d);
    printf("So %f = %f * (%f ^ %f) \n", c, a, d, b);

    return(0);
}
```

produces the output:

```
Radix of machines fp arithmetic is 2.000000
So 40.000000 = 10.000000 * (2.000000 ^ 2.000000)
```

Classification:

scalb() is standard Unix; *scalbf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

ldexp(), *scalbn()*

scalbn(), *scalbnf()*

Load the exponent of a radix-independent floating point number

Synopsis:

```
#include <math.h>

double scalbn ( double x,
                int n );

float scalbnf ( float x,
                int n );
```

Arguments:

x The floating point number that you want to multiply by the exponent.

n The exponent to apply to the radix of the machine's floating-point arithmetic.

Library:

libm

Description:

The *scalbn()* and *scalbnf()* functions compute $x \times r^n$, where *r* is the radix of the machine's floating point arithmetic.

Returns:

$x \times r^n$

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv)
{
    double a, b, c, d;

    a = 10;
    b = 2;
    c = scalbn(a, b);
    d = sqrt(c/a);
    printf("Radix of machines fp arithmetic is %f \n", d);
    printf("So %f = %f * (%f ^ %f) \n", c, a, d, b);

    return(0);
}
```

produces the output:

```
Radix of machines fp arithmetic is 2.000000
So 40.000000 = 10.000000 * (2.000000 ^ 2.000000)
```

Classification:

scalbn() is standard Unix; *scalbnf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

scalb()

_scalloc()

Allocate space for an array

Synopsis:

```
#include <malloc.h>

void* _scalloc( size_t size );
```

Arguments:

size The number of bytes to allocate.

Library:

libc

Description:

The *_scalloc()* functions allocate space for an array of length *size* bytes. Each element is initialized to 0.

You must use *_sfree()* to deallocate the memory allocated by *_scalloc()*.

Returns:

A pointer to the start of the allocated memory, or NULL if there's insufficient memory available or if the *size* is zero.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

calloc(), free(), realloc(), _sfree(), _smalloc(), _srealloc()

scandir()

Scan a directory

Synopsis:

```
#include <sys/types.h>
#include <sys/dir.h>

int scandir( char * dirname,
             struct direct * (* namelist[]),
             int (*select)(struct dirent *),
             int (*compar)(const void *,const void *) );
```

Arguments:

dirname The name of the directory that you want to scan.

namelist A pointer to a location where *scandir()* can store a pointer to the array of directory entries that it builds.

select A pointer to a user-supplied subroutine that *scandir()* calls to select which entries to included in the array. The *select* routine is passed a pointer to a directory entry and should return a nonzero value if the directory entry is to be included in the array.

If *select* is NULL, all the directory entries are included.

compar A pointer to a user-supplied subroutine that's passed to *qsort()* to sort the completed array. If this pointer is NULL, the array isn't sorted.

You can use *alphasort()* as the *compar* parameter to sort the array alphabetically.

Library:

libc

Description:

The *scandir()* function reads the directory *dirname* and builds an array of pointers to directory entries, using *malloc()* to allocate the space.

The *scandir()* function returns the number of entries in the array, and stores a pointer to the array in the location referenced by *namelist*.

You can deallocate the memory allocated for the array by calling *free()*. Free each pointer in the array, and then free the array itself.

Returns:

The number of entries in the array, or -1 if the directory can't be opened for reading, or *malloc()* can't allocate enough memory to hold all the data structures.

Classification:

Legacy Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

alphasort(), closedir(), free(), malloc(), opendir(), qsort(), readdir(), rewinddir(), seekdir(), telldir()

Synopsis:

```
#include <stdio.h>

int scanf( const char* format,
           ... );
```

Arguments:

format A string that controls the format of the input, as described below. The formatting string determines what additional arguments you need to provide.

Library:

libc

Description:

The *scanf()* function scans input from *stdin* under control of the *format* argument, assigning values to the remaining arguments.

Format control string

The format control string consists of zero or more *format directives* that specify what you consider to be acceptable input data. Subsequent arguments are pointers to various types of objects that the function assigns values to as it processes the format string.

A format directive can be a sequence of one or more whitespace characters or:

multibyte characters

Any character in the *format* string, other than a whitespace character or the percent character (`%`), that isn't part of a conversion specifier.

conversion specifiers

A sequence of characters in the *format* string that begins with a percent character (`%`) and is followed by:

- an optional *assignment suppression indicator*: the asterisk character (**`*`**)
- an optional decimal integer that specifies the *maximum field width* to be scanned for the conversion
- an optional *type length* specification; one of **`h`**, **`L`**, or **`l`**
- a character that specifies the type of conversion to be performed; one of the characters: **`c`**, **`d`**, **`e`**, **`f`**, **`g`**, **`i`**, **`n`**, **`o`**, **`p`**, **`s`**, **`u`**, **`X`**, **`x`**, **`[`**

As each format directive in the format string is processed, the directive may successfully complete, fail because of a lack of input data, or fail because of a matching error as defined by the directive.

If end-of-file is encountered on the input data before any characters that match the current directive have been processed (other than leading whitespace, where permitted), the directive fails for lack of data.

If end-of-file occurs after a matching character has been processed, the directive is completed (unless a matching error occurs), and the function returns without processing the next directive.

If a directive fails because of an input character mismatch, the character is left unread in the input stream.

Trailing whitespace characters, including newline characters, aren't read unless matched by a directive. When a format directive fails, or the end of the format string is encountered, the scanning is completed, and the function returns.

When one or more whitespace characters (space, horizontal tab **`\t`**, vertical tab **`\v`**, form feed **`\f`**, carriage return **`\r`**, newline or linefeed **`\n`**) occur in the format string, input data up to the first non-whitespace character is read, or until no more data remains. If no whitespace characters are found in the input data, the scanning is complete, and the function returns.

An ordinary character in the format string is expected to match the same character in the input stream.

Conversion specifiers

A conversion specifier in the format string is processed as follows:

- For conversion types other than **[**, **c** and **n**, leading whitespace characters are skipped.
- For conversion types other than **n**, all input characters, up to any specified maximum field length, that can be matched by the conversion type are read and converted to the appropriate type of value; the character immediately following the last character to be matched is left unread; if no characters are matched, the format directive fails.
- Unless you specify the assignment suppression indicator (*****), the result of the conversion is assigned to the object pointed to by the next unused argument (if assignment suppression was specified, no argument is skipped); the arguments must correspond in number, type and order to the conversion specifiers in the format string.

Type length specifiers

A type length specifier affects the conversion as follows:

- **hh** causes a **d**, **i**, **o**, **u**, **x**, **X** or **n** format conversion to assign the converted value to an object of type **signed char** or **unsigned char**.
- **h** causes a **d**, **i**, **o**, **u**, **x**, **X** or **n** (integer) format conversion to assign the converted value to an object of type **short** or **unsigned short**.
- **j** causes a **d**, **i**, **o**, **u**, **x**, **X** or **n** conversion to assign the converted value to an object of type **intmax_t** or **uintmax_t**.
- **l** (“el”) causes a **d**, **i**, **o**, **u**, **x**, **X** or **n** (integer) conversion to assign the converted value to an object of type **long** or **unsigned long**.
- **l** (“el”) causes an **a**, **A**, **e**, **E**, **f**, **F**, **g** or **G** conversion to assign the converted value to an object of type **double**.

- **l** ("el") causes a **c**, **s** or **[** conversion to assign the converted value to an object of type **wchar_t**.
- **ll** (double "el") causes a **d**, **i**, **o**, **u**, **x**, **X** or **n** format conversion to assign the converted value to an object of type **long long** or **unsigned long long**.
- **L** causes an **a**, **A**, **e**, **E**, **f**, **F**, **g** or **G** conversion to assign the converted value to an object of type **long double**.
- **t** causes a **d**, **i**, **o**, **u**, **x**, **X** or **n** conversion to assign the converted value to an object of type **ptrdiff_t** or to the corresponding **unsigned** type.
- **z** causes a **d**, **i**, **o**, **u**, **x**, **X** or **n** conversion to assign the converted value to an object of type **size_t** or to the corresponding signed integer type.

Conversion type specifiers

The valid conversion type specifiers are:

a, **A**, **e**, **E**, **f**, **F**, **g** or **G**

A floating-point number, infinity, or NaN, all of which have a format as expected by *strtod()*. The argument is assumed to point to an object of type **float**.

c

Any sequence of characters in the input stream of the length specified by the field width, or a single character if you don't specify a field width. The argument is assumed to point to the first element of a character array of sufficient size to contain the sequence, *without* a terminating NUL character (**'\0'**). For a single character assignment, a pointer to a single object of type **char** is sufficient.

When an **l** ("el") qualifier is present, a sequence of characters are converted from the initial shift state to **wchar_t** wide characters as if by a call to *mbrtowc()*. The conversion state is described by a **mbstate_t** object.

d A decimal integer with a format as expected by *strtol()* and a *base* of **10**. The argument is assumed to point to an object of type **int**.

i An optionally signed integer with a format as expected by *strtol()* and a *base* of **0**. The argument is assumed to point to an object of type **int**.

n No input data is processed. Instead, the number of characters that have already been read is assigned to the object of type **int** that's pointed to by the argument. The number of items that have been scanned and assigned (the return value) isn't affected by the **n** conversion type specifier.

o An optionally signed octal integer with a format as expected by *strtoul()* and a *base* of **8**.The argument is assumed to point to an object of type **int**.

p A hexadecimal integer, as described for **x** conversions below. The converted value is taken as a **void *** and then assigned to the object pointed to by the argument.

s A sequence of non-whitespace characters. The argument is assumed to point to the first element of a character array of sufficient size to contain the sequence of **char**, **signed char** or **unsigned char** and a terminating NUL character, which by the conversion operation adds.

When an **l** ("el") qualifier is present, a sequence of characters are converted from the initial shift state to **wchar_t** wide characters as if by a call to *mbrtowc()*. The conversion state is described by a **mbstate_t** object.

u An unsigned decimal integer, consisting of one or more decimal digits. The argument is assumed to point to an object of type **unsigned int**.

x, **X** A hexadecimal integer, with a format as expected by *strtoul()* when *base* is **16**. The argument is assumed to point to an object of type **unsigned**.

`[` Matches the *scanset*, a nonempty sequence of characters. The argument is assumed to point to the first element of a character array of sufficient size to contain the sequence and a terminating NUL character, which by the conversion operation adds.

When an `l` ("el") qualifier is present, a sequence of characters are converted from the initial shift state to **`wchar_t`** wide characters as if by a call to *mbrtowc()* with *mbstate* set to `0`. The argument is assumed to point to the first element of a **`wchar_t`** array of sufficient size to contain the sequence and a terminating NUL character, which the conversion operation adds.

The conversion specification includes all characters in the scanlist between the beginning `[` and the terminating `]`. If the conversion specification starts with `[^`, the scanlist matches all the characters that *aren't* in the scanlist. If the conversion specification starts with `[]` or `[^]`, the `]` is included in the scanlist. (To scan for `]` only, specify `%[]]`.)

`%` A `%` character (The entire specification is `%%`).

A conversion type specifier of `%` is treated as a single ordinary character that matches a single `%` character in the input data. A conversion type specifier other than those listed above causes scanning to terminate, and the function to returns with an error.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF if the scanning stopped by reaching the end of the input stream before storing any values.

Examples:

The line:

```
scanf( "%s%*f%3hx%d", name, &hexnum, &decnum )
```

with input:

```
some_string 34.555e-3 abc1234
```

copies **"some_string"** into the array *name*, skips **34.555e-3**, assigns **0xabc** to *hexnum* and **1234** to *decnum*. The return value is 3.

The program:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main( void )
{
    char string1[80], string2[80];

    memset( string1, 0, 80 );
    memset( string2, 0, 80 );

    scanf( "%[abcdefghijklmnopqrstuvwxyz"
           "ABCDEFGHIJKLMNOPQRSTUVWZ ]%*2s%[^\n]",
           string1, string2 );

    printf( "%s\n", string1 );
    printf( "%s\n", string2 );

    return EXIT_SUCCESS;
}
```

with input:

```
They may look alike, but they don't perform alike.
```

assigns **"They may look alike"** to *string1*, skips the comma (the **"%*2s"** matches only the comma; the following blank terminates that field), and assigns **" but they don't perform alike."** to *string2*.

To scan a date in the form "Friday March 26 1999":

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
```

```
int main( void )
{
    int day, year;
    char weekday[10], month[12];
    int retval;

    memset( weekday, 0, 10 );
    memset( month, 0, 12 );

    retval = scanf( "%s %s %d %d",
                    weekday, month, &day, &year );
    if( retval != 4 ) {
        printf( "Error reading date.\n" );
        printf( "Format is: Friday March 26 1999\n" );

        return EXIT_FAILURE;
    }

    printf( "weekday: %s\n", weekday );
    printf( "month: %s\n", month );
    printf( "day: %d\n", day );
    printf( "year: %d\n", year );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fscanf(), fwscanf() sscanf(), swscanf(), vfscanf(), vfwscanf(), vscanf(), vsscanf(), vswscanf(), vwscanf(), wscanf()

sched_getparam()

Get the current priority of a process

Synopsis:

```
#include <sched.h>

int sched_getparam( pid_t pid,
                    struct sched_param *param );
```

Arguments:

pid The ID of the process whose priority you want to get, or 0 to get it for the current process.

param A pointer to a **sched_param** that the function fills with the scheduling parameters.

Library:

libc

Description:

The *sched_getparam()* function gets the current priority of the process specified by *pid*, and puts it in the *sched_priority* member of the **sched_param** structure pointed to by *param*.

If *pid* is zero, the priority of the calling process is returned.

Returns:

0 Success

-1 An error occurred (*errno* is set).

Errors:

EPERM The calling process doesn't have sufficient privilege to get the priority.

ESRCH The process *pid* doesn't exist.

Examples:

```
#include <sched.h>
#include <stdio.h>

#define PRIORITY_ADJUSTMENT 5

int main (void)
{
   int max_priority;
   struct sched_param param;

   /* Find out the MAX priority for the FIFO Schedular */
   max_priority = sched_get_priority_max(SCHED_FIFO);

   /* Find out what the current priority is. */
   sched_getparam(0, &param);

   printf("The assigned priority is %d.\n", param.sched_priority);
   printf("The current priority is %d.\n", param.sched_curpriority);

   param.sched_priority = ((param.sched_curpriority +
   PRIORITY_ADJUSTMENT) <= max_priority) ?
      (param.sched_curpriority + PRIORITY_ADJUSTMENT) : -1;

   if (param.sched_priority == -1)
   {
      printf("Cannot increase the priority by %d. Try a lesser value\n",
     PRIORITY_ADJUSTMENT);
      return(0);
   }

   sched_setscheduler (0, SCHED_FIFO, &param);

   sched_getparam(0, &qparam);
   printf("The newly assigned priority is %d.\n", param.sched_priority);
   printf("The current priority is %d.\n", param.sched_curpriority);

   return(0);
}
```

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Currently, the implementation of *sched_getparam()* isn't 100% POSIX 1003.1-1996. The *sched_getparam()* function returns the scheduling parameters for thread 1 in the process *pid*, or for the *calling thread* if *pid* is 0.

If you depend on this in new code, *it will not be portable.* POSIX 1003.1 says *sched_getparam()* should return -1 and set *errno* to EPERM in a multithreaded application.

See also:

errno, *getprio()*, *sched_get_priority_max()*, *sched_get_priority_min()*, *sched_getscheduler()*, **sched_param**, *sched_setparam()*, *sched_setscheduler()*, *sched_yield()*, *setprio()*

sched_get_priority_adjust()

Calculate the allowable priority for the scheduling policy

Synopsis:

```
#include <sched.h>

int sched_get_priority_adjust( int prio,
                               int policy,
                               int adjust );
```

Arguments:

prio The original priority value. If negative, the priority of the calling thread is used.

policy The scheduling algorithm being used. The valid arguments are listed in *sched_get_priority_max()*. If *policy* is SCHED_NOCHANGE, the function uses the algorithm of the calling thread.

adjust The priority change, relative to *prio*. A value of +10 results in a final priority of *prio*+10, provided that this amount of adjustment is allowed.

Library:

libc

Description:

The *sched_get_priority_adjust()* function calculates the requested priority change relative to another thread and returns the allowable value.

This function makes it easier for you to set relative priorities in order to ensure proper precedence.

Returns:

>0 The allowed priority value. The value will never exceed the range of values allowed by *sched_get_priority_min()* and *sched_get_priority_max()*.

<0	Failure; the negative of the *errno* value.

Errors:

EINVAL	The value of the *policy* parameter doesn't represent a defined scheduling policy.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *sched_getparam()*, *sched_get_priority_max()*, *sched_get_priority_min()*, *sched_setparam()*, *sched_getscheduler()*, *sched_setscheduler()*

sched_get_priority_max()

Get the maximum priority for the scheduling policy

Synopsis:

```
#include <sched.h>

int sched_get_priority_max( int policy );
```

Arguments:

policy The scheduling policy, which must be one of:

- SCHED_FIFO — a fixed-priority scheduler in which the highest priority ready thread runs until it blocks or is preempted by a higher priority thread.
- SCHED_RR — similar to SCHED_FIFO, except that threads at the same priority level timeslice (round robin) every 50 msec.
- SCHED_OTHER — currently the same as SCHED_RR.
- SCHED_SPORADIC — sporadic scheduling. For more information, see *pthread_attr_setschedpolicy()*, and "Scheduling algorithms" in the chapter on the Neutrino microkernel in the *System Architecture* guide.

Library:

libc

Description:

The *sched_get_priority_max()* function returns the maximum value for the scheduling policy specified by *policy*.

Returns:

The appropriate minimum for success, or -1 (*errno* is set).

Errors:

EINVAL	The value of the *policy* parameter doesn't represent a defined scheduling policy.
ENOSYS	The *sched_get_priority_max()* function isn't currently supported.

Examples:

See *sched_getparam()*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sched_getparam(), *sched_get_priority_min()*, *sched_setparam()*, *sched_getscheduler()*, *sched_setscheduler()*

sched_get_priority_min()

Get the minimum priority for the scheduling policy

Synopsis:

```
#include <sched.h>

int sched_get_priority_min( int policy );
```

Arguments:

policy The scheduling policy, which must be one of:

- SCHED_FIFO — a fixed-priority scheduler in which the highest priority ready thread runs until it blocks or is preempted by a higher priority thread.
- SCHED_RR — similar to SCHED_FIFO, except that threads at the same priority level timeslice (round robin) every 50 msec.
- SCHED_OTHER — currently the same as SCHED_RR.
- SCHED_SPORADIC — sporadic scheduling. For more information, see *pthread_attr_setschedpolicy()*, and "Scheduling algorithms" in the chapter on the Neutrino microkernel in the *System Architecture* guide.

Library:

libc

Description:

The *sched_get_priority_min()* function returns the minimum value for the scheduling policy specified by *policy*.

Returns:

The appropriate minimum for success, or -1 (*errno* is set).

Errors:

EINVAL	The value of the *policy* parameter doesn't represent a defined scheduling policy.
ENOSYS	The *sched_get_priority_min()* function isn't currently supported.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sched_getparam(), *sched_get_priority_max()*, *sched_setparam()*, *sched_getscheduler()*, *sched_setscheduler()*

sched_getscheduler()

Get the current scheduling policy for a process

Synopsis:

```
#include <sched.h>

int sched_getscheduler( pid_t pid );
```

Arguments:

pid The ID of the process whose scheduling policy you want to find, or zero if you want to get the policy for the current process.

Library:

libc

Description:

The *sched_getscheduler()* function gets the current scheduling policy of process *pid*. If *pid* is zero, the scheduling policy of the calling process is returned.

Returns:

The scheduling policy, or -1 if an error occurred (*errno* is set).

Errors:

ESRCH The process *pid* doesn't exist.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

Currently, the implementation of *sched_getscheduler()* isn't 100% POSIX 1003.1-1996. The *sched_getscheduler()* function returns the scheduling policy for thread 1 in the process *pid*, or for the *calling thread* if *pid* is 0.

If you depend on this in new code, *it will not be portable.* POSIX 1003.1 says *sched_getscheduler()* should return -1 and set *errno* to EPERM in a multithreaded application.

See also:

errno, *getprio()*, *sched_getparam()*, *sched_get_priority_max()*, *sched_get_priority_min()*, *sched_setparam()*, *sched_setscheduler()*, *sched_yield()*, *setprio()*

Synopsis:

```
#include <sched.h>

struct sched_param {
    int32_t  sched_priority;
    int32_t  sched_curpriority;
    union {
        int32_t  reserved[8];
        struct {
            int32_t  __ss_low_priority;
            int32_t  __ss_max_repl;
            struct timespec     __ss_repl_period;
            struct timespec     __ss_init_budget;
        }           __ss;
    }           __ss_un;
}

#define sched_ss_low_priority   __ss_un.__ss.__ss_low_priority
#define sched_ss_max_repl       __ss_un.__ss.__ss_max_repl
#define sched_ss_repl_period    __ss_un.__ss.__ss_repl_period
#define sched_ss_init_budget    __ss_un.__ss.__ss_init_budget
```

Description:

You'll use the **sched_param** structure when you get or set the scheduling parameters for a thread or process.

You can use these functions to get the scheduling parameters:

- *pthread_attr_getschedparam()*
- *pthread_getschedparam()*
- *sched_getparam()*
- *SchedGet()*

You can use these functions to set the scheduling parameters:

- *pthread_attr_setschedparam()*
- *pthread_setschedparam()*

- *sched_setparam()*
- *sched_setscheduler()*
- *SchedSet()*
- *ThreadCreate()*

The members of **sched_param** include:

sched_priority When you get the scheduling parameters, this member reflects the priority that was assigned to the thread or process. It doesn't reflect any temporary adjustments due to priority inheritance.

When you set the scheduling parameters, set this member to the priority that you want to use. The priority must be between the minimum and maximum values returned by *sched_get_priority_min()* and *sched_get_priority_max()* for the scheduling policy.

sched_curpriority

When you get the scheduling parameters, this member is set to the priority that the thread or process is currently running at. This is the value that the kernel uses when making scheduling decisions.

When you set the scheduling parameters, this member is ignored.

The other members are used with sporadic scheduling. The following **#define** directives create the POSIX names that correspond to those members and should be used instead of accessing members directly.

sched_ss_low_priority

The background or low priority for the thread that's executing.

sched_ss_max_repl

The maximum number of times a replenishment will be scheduled, typically because of a blocking operation. After a thread has blocked this many times, it automatically drops to the low-priority level for the remainder of its execution until its execution budget is replenished.

sched_ss_repl_period

The time that should be used for scheduling the replenishment of an execution budget after being blocked or having overrun the maximum number of replenishments. This time is used as an offset against the time that a thread is made READY.

sched_ss_init_budget

The time that should be used for the thread's execution budget. As the thread runs at its high-priority level, its execution time is carved out of this budget. Once the budget is entirely depleted, the thread drops to its low-priority level, where, if possible because of priority arrangements, it can continue to run until the execution budget is replenished.

- The *sched_priority* must always be higher than *sched_ss_low_priority*.
- The *sched_ss_max_repl* must be smaller than SS_REPL_MAX.
- The *sched_ss_init_budget* must be larger than *sched_ss_repl_period*.

For more information, see "Scheduling algorithms" in the Neutrino Microkernel chapter of the *System Architecture* guide.

Examples:

This code shows a duty-cycle usage of the sporadic server thread:

```
#include <stdio.h>
#include <errno.h>
#include <sched.h>
```

```
#include <pthread.h>
#include <inttypes.h>
#include <sys/syspage.h>
#include <sys/neutrino.h>

/* 50 % duty cycle of 5 secs on 5 secs off */
struct timespec g_init_budget = { 5, 0 };
struct timespec g_repl_period = { 10, 0 };

#define MY_HIGH_PRIORITY 5
#define MY_LOW_PRIORITY 4
#define MY_REPL_PERIOD g_repl_period
#define MY_INIT_BUDGET g_init_budget
#define MY_MAX_REPL 10

#define DUTY_CYCLE_LOOPS 10

/*
 Run a compute bound thread (minimal blocking) to show the duty cycle.
*/
void *st_duty_check(void *arg) {
struct sched_param params;
uint64_t stime, etime, cps;
double secs;
int ret, prio;
int prevprio, iterations;

stime = ClockCycles();
cps = SYSPAGE_ENTRY(qtime)->cycles_per_sec;
iterations = 0;

printf("\n");

prevprio = -1;
while(iterations < DUTY_CYCLE_LOOPS) {
etime = ClockCycles();
ret = pthread_getschedparam(pthread_self(), &prio, &params);

if(ret != 0) {
printf("pthread_getschedparam() failed %d \n", errno);
break;
} else if (prevprio != -1 && prevprio != params.sched_priority) {
stime = etime - stime;
secs = (double)stime / (double)cps;
printf("pri %d (cur %d) %lld cycles %g secs\n",
params.sched_priority,
params.sched_curpriority,
stime, secs);
stime = etime;
iterations++;
```

```
}
prevprio = params.sched_priority;
}

return NULL;
}

int main(int argc, char **argv) {
struct sched_param params;
pthread_attr_t    attr;
pthread_t    thr;
int    ret;

/* Set the attribute structure with the sporadic values */
printf("# Set sporadic attributes ...");
pthread_attr_init(&attr);
ret = pthread_attr_setinheritsched(&attr, PTHREAD_EXPLICIT_SCHED);
if(ret != 0) {
printf("pthread_attr_setinheritsched() failed %d \n", errno);
return 1;
}

ret = pthread_attr_setschedpolicy(&attr, SCHED_SPORADIC);
if(ret != 0) {
printf("pthread_attr_setschedpolicy() failed %d %d\n", ret, errno);
return 1;
}

params.sched_priority = MY_HIGH_PRIORITY;
params.sched_ss_low_priority = MY_LOW_PRIORITY;
memcpy(&params.sched_ss_init_budget, &MY_INIT_BUDGET, sizeof(MY_INIT_BUDGET));
memcpy(&params.sched_ss_repl_period, &MY_REPL_PERIOD, sizeof(MY_REPL_PERIOD));
params.sched_ss_max_repl = MY_MAX_REPL;
ret = pthread_attr_setschedparam(&attr, &params);
if(ret != 0) {
printf("pthread_attr_setschedparam() failed %d \n", errno);
return 1;
}
printf("OK\n");

/* Create a sporadic thread to check the duty cycle */
printf("# Creating thread duty cycle thread (%d changes) ... ", DUTY_CYCLE_LOOPS);
ret = pthread_create(&thr, &attr, st_duty_check, NULL);
if(ret != 0) {
printf("pthread_create() failed %d \n", errno);
return 1;
}
pthread_join(thr, NULL);
printf("OK\n");
```

```
return 0;
}
```

See also *sched_getparam()*.

Classification:

POSIX 1003.1 (Realtime Extensions)

See also:

pthread_attr_getschedparam(), *pthread_attr_setschedparam()*, *pthread_getschedparam()*, *pthread_setschedparam()*, *sched_getparam()*, *sched_setparam()*, *sched_setscheduler()*, *SchedGet()*, *SchedSet()*, *ThreadCreate()*

"Scheduling algorithms" in the Neutrino Microkernel chapter of the *System Architecture* guide

sched_rr_get_interval()

Get the execution time limit of a process

Synopsis:

```
#include <sched.h>

int sched_rr_get_interval(
                  pid_t pid,
                  struct timespec * interval );
```

Arguments:

pid The process ID whose execution time limit you want to get.

interval A pointer to a **timespec** structure that the function updates with the process's current execution time limit.

Library:

libc

Description:

The *sched_rr_get_interval()* function updates *interval* with the current execution time limit for the process, *pid*. If *pid* is 0, the current execution time limit for the calling process is returned.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

ENOSYS The *sched_rr_get_interval()* function isn't currently supported.

ESRCH The process *pid* can't be found.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

`timespec`

sched_setparam()

Change the priority of a process

Synopsis:

```
#include <sched.h>

int sched_setparam(
          pid_t pid,
          const struct sched_param *param );
```

Arguments:

pid The ID of the process whose priority you want to set, or 0 to set it for the current process.

param A pointer to a **sched_param** structure whose *sched_priority* member holds the priority that you want to assign to the process.

Library:

libc

Description:

The *sched_setparam()* function changes the priority of process *pid* to that of the *sched_priority* member in the **sched_param** structure pointed to by *param*. If *pid* is zero, the priority of the calling process is changed.

The *sched_priority* member in *param* must lie between the minimum and maximum values returned by *sched_get_priority_max()* and *sched_get_priority_min()*.

By default, the process priority and scheduling algorithm are inherited from or explicitly set by the parent process. Once running, the child process may change its priority by using this function.

Returns:

0 Success

-1 An error occurred (*errno* is set).

Errors:

EFAULT A fault occurred trying to access the buffers provided.

EINVAL The priority isn't a valid priority.

EPERM The calling process doesn't have sufficient privilege to set the priority.

ESRCH The process *pid* doesn't exist.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Currently, the implementation of *sched_setparam()* isn't 100% POSIX 1003.1-1996. The *sched_setparam()* function sets the scheduling parameters for thread 1 in the process *pid*, or for the *calling thread* if *pid* is 0.

If you depend on this in new code, *it will not be portable.* POSIX 1003.1 says *sched_setparam()* should return -1 and set *errno* to EPERM in a multithreaded application.

See also:

errno, *getprio()*, *sched_getparam()*, *sched_get_priority_max()*, *sched_get_priority_min()*, *sched_getscheduler()*, **sched_param**, *sched_setscheduler()*, *sched_yield()*, *setprio()*

sched_setscheduler()

Change the priority and scheduling policy of a process

Synopsis:

```
#include <sched.h>

int sched_setscheduler(
          pid_t pid,
          int policy,
          const struct sched_param *param );
```

Arguments:

pid The ID of the process whose priority and scheduling policy you want to set, or zero if you want to set them for the current process.

policy The scheduling policy, which must be one of:

- SCHED_FIFO — a fixed-priority scheduler in which the highest priority ready thread runs until it blocks or is preempted by a higher priority thread.
- SCHED_RR — similar to SCHED_FIFO, except that threads at the same priority level timeslice (round robin) every 50 msec.
- SCHED_OTHER — currently the same as SCHED_RR.

Currently, you can set a thread's scheduling policy to SCHED_SPORADIC only when you create the thread. If you use sporadic scheduling, you can't change the policy later. For more information, see *pthread_attr_setschedpolicy()*.

param A pointer to a **sched_param** structure whose *sched_priority* member holds the priority that you want to assign to the process.

Library:

libc

Description:

The *sched_setscheduler()* function changes the priority of process *pid* to that of the *sched_priority* member in the **sched_param** structure passed as *param*, and the scheduling policy is set to *policy*.

If *pid* is zero, the policy and priority of the calling process are set.

The *sched_priority* member in *param* must lie between the minimum and maximum values returned by *sched_get_priority_max()* and *sched_get_priority_min()*.

By default, process priority and scheduling algorithm are inherited from or explicitly set by the parent process. Once running, the child process may change its priority by using this function.

Returns:

The previous scheduling policy, or -1 if an error occurs (*errno* is set).

Errors:

EFAULT	A fault occurred trying to access the buffers provided.
EINVAL	The priority or scheduling policy isn't a valid value.
EPERM	The calling process doesn't have sufficient privilege to set the priority.
ESRCH	The process *pid* doesn't exist.

Examples:

See *sched_getparam()*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Currently, the implementation of *sched_setscheduler()* isn't 100% POSIX 1003.1-1996. The *sched_setscheduler()* function sets the scheduling policy for thread 1 in the process *pid*, or for the *calling thread* if *pid* is 0.

If you depend on this in new code, *it won't be portable.* POSIX 1003.1 says *sched_setscheduler()* should return -1 and set *errno* to EPERM in a multithreaded application.

See also:

errno, *getprio()*, *sched_getparam()*, *sched_get_priority_max()*, *sched_get_priority_min()*, *sched_getscheduler()*, **sched_param**, *sched_setparam()*, *sched_yield()*, *setprio()*

sched_yield()

Yield to other ready threads at the same priority

Synopsis:

```
#include <sched.h>

int sched_yield( void );
```

Library:

libc

Description:

The *sched_yield()* function checks to see if other threads, at the same priority as that of the calling thread, are READY to run. If so, the calling thread yields to them and places itself at the end of the READY thread queue. The *sched_yield()* function never yields to a lower priority thread.

A higher priority thread always forces a lower priority thread to yield (that is, preempt) the instant the higher priority thread becomes ready to run, without the need for the lower priority thread to give up the processor by calling the *sched_yield()* or *SchedYield()* functions.

The *sched_yield()* function calls the kernel function *SchedYield()*, and may be more portable across realtime POSIX systems.

You should avoid designing programs that contain busy wait loops. If you can't avoid them, you can use *sched_yield()* to reduce the system load at a given priority level. Note that a thread that calls *sched_yield()* in a tight loop will spend a great deal of time in the kernel, which will have a small effect on interrupt latency.

Returns:

This function always succeeds and returns zero.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <sched.h>

int main( void )
  {
    int i;

    for( ;; ) {
      /* Process something... */
      for( i = 0 ; i < 1000 ; ++i )
        fun();

      /* Yield to anyone else at the same priority */
      sched_yield();
    }
    return EXIT_SUCCESS;   /* Never reached */
  }

int fun()
  {
    int i;

    for( i = 0 ; i < 10 ; ++i )
      i += i;

    return( i );
  }
```

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

getprio(), *sched_getparam()*, *sched_get_priority_max()*, *sched_get_priority_min()*, *sched_getscheduler()*, *sched_setparam()*, *sched_setscheduler()*, *SchedYield()*, *setprio()*, *sleep()*

SchedGet(), *SchedGet_r()*

Get the scheduling policy for a thread

Synopsis:

```
#include <sys/neutrino.h>

int SchedGet( pid_t pid,
              int tid,
              struct sched_param *param );

int SchedGet_r( pid_t pid,
                int tid,
                struct sched_param *param );
```

Arguments:

pid	0 or a process ID; see below.
tid	0 or a thread ID; see below.
param	A pointer to a **sched_param** structure where the function can store the scheduling parameters.

Library:

libc

Description:

The *SchedGet()* and *SchedGet_r()* kernel calls return the current scheduling policy and the parameters for the thread specified by *tid* in the process specified by *pid*. If *pid* is zero, the current process is used to look up a nonzero *tid*. If *pid* and *tid* are zero, then the calling thread is used.

These functions are identical except in the way they indicate errors. See the Returns section for details.

The scheduling policy is returned on success and is one of SCHED_FIFO, SCHED_RR, SCHED_SPORADIC, or SCHED_OTHER.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

SchedGet() The current scheduling policy. If an error occurs, -1 is returned and *errno* is set.

SchedGet_r() The current scheduling policy. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EFAULT A fault occurred when the kernel tried to access the buffers provided.

ESRCH The process indicated by *pid* or thread indicated by *tid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sched_param, *SchedInfo()*, *SchedSet()*, *SchedYield()*

SchedInfo(), SchedInfo_r()

Get scheduler information

Synopsis:

```
#include <sys/neutrino.h>

int SchedInfo( pid_t pid,
               int policy,
               struct _sched_info* info );

int SchedInfo_r( pid_t pid,
                 int policy,
                 struct _sched_info* info );
```

Arguments:

pid A process ID, or 0 to get information about the current process.

policy One of the following:

- SCHED_FIFO — a fixed-priority scheduler in which the highest priority, ready thread runs until it blocks or is preempted by a higher-priority thread.
- SCHED_RR — the same as SCHED_FIFO, except threads at the same priority level time slice (round robin) every 50 msec.
- SCHED_OTHER — currently the same as SCHED_RR.
- SCHED_SPORADIC — sporadic scheduling. For more information, see *pthread_attr_setschedpolicy()*, and "Scheduling algorithms" in the chapter on the Neutrino microkernel in the *System Architecture* guide.

info A pointer to a **_sched_info** structure where the function can store the scheduler information.

Library:

libc

Description:

These kernel calls return information about the kernel's thread scheduler, including the minimum and maximum thread priority, for the process ID specified by *pid* when using the specified scheduling *policy*. If *pid* is `0`, the scheduler information for the current process is returned. In either case, the **`struct _sched_info`** pointed to by *info* is filled in with the appropriate information.

The *SchedInfo()* and *SchedInfo_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

The **`struct _sched_info`** structure pointed to by *info* contains at least these members:

`uint64_t` *interval*

The current execution time limit before the thread is suspended in favor of the scheduler.

`int` *priority_max*

The maximum priority for a thread using this scheduling *policy*.

`int` *priority_min*

The minimum priority for a thread using this scheduling *policy*.

Returns:

The only difference between these functions is the way they indicate errors:

SchedInfo()	If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.
SchedInfo_r()	EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EINVAL	The *pid* or *policy* is invalid.
ENOSYS	The *SchedInfo()* function isn't supported by this system.
ESRCH	The process specified by *pid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

SchedGet(), *SchedSet()*

SchedSet(), SchedSet_r()

Set the scheduling policy for a thread

Synopsis:

```
#include <sys/neutrino.h>

int SchedSet(
        pid_t pid,
        int tid,
        int policy,
        const struct sched_param *param );

int SchedSet_r(
        pid_t pid,
        int tid,
        int policy,
        const struct sched_param *param );
```

Arguments:

pid 0 or a process ID; see below.

tid 0 or a thread ID; see below.

policy The scheduling policy; one of:

- SCHED_FIFO — a fixed-priority scheduler in which the highest priority, ready thread runs until it blocks or is preempted by a higher priority thread.
- SCHED_RR — the same as SCHED_FIFO, except threads at the same priority level time slice (round robin) every 50 msec.
- SCHED_OTHER — currently the same as SCHED_RR.
- SCHED_NOCHANGE — this isn't actually a policy, but a special value that tells the kernel to update the parameters specified in *param*, without changing the policy.

Currently, you can set a thread's scheduling policy to SCHED_SPORADIC only when you create the thread. If you use sporadic scheduling, you can't change the policy later. For more information, see *pthread_attr_setschedpolicy()*.

param A pointer to a **sched_param** structure where the function can store the scheduling parameters.

Library:

libc

Description:

The *SchedSet()* and *SchedSet_r()* kernel calls set both the scheduling policy and the associated parameters for the thread specified by *tid* in the process specified by *pid*. If *pid* is zero the current process is used to look up a nonzero *tid*. If *tid* is zero, then the calling thread is used and *pid* is ignored.

These functions are identical except in the way they indicate errors. See the Returns section for details.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

SchedSet() If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

SchedSet_r() EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers you provided.
EINVAL	The given scheduling *policy* is invalid.
EPERM	The process doesn't have permission to change the scheduling of the indicated thread.
ESRCH	The process indicated by *pid* or thread indicated by *tid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sched_get_priority_max(), *sched_get_priority_min()*, **sched_param**, *SchedGet()*, *SchedInfo()*, *SchedYield()*

Synopsis:

```
#include <sys/neutrino.h>

int SchedYield( void );

int SchedYield_r( void );
```

Library:

libc

Description:

These kernel calls check to see if other threads at the same priority as that of the calling thread are ready to run. If so, the calling thread yields to them and places itself at the end of the ready thread queue for that priority. *SchedYield()* never yields to a lower priority thread. Higher priority threads always force a yield the instant they become ready to run. This call has no effect with respect to threads running at priorities other than the calling thread's.

The *SchedYield()* and *SchedYield_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

Avoid designing programs that contain busy-wait loops using *SchedYield()* to timeslice. If this is unavoidable, you can use *SchedYield()* to reduce the system load at a given priority level. Note that a program that calls *SchedYield()* in a tight loop will spend a great deal of time in the kernel, which will have a small effect on scheduling interrupt latency.

Blocking states

These calls don't block. However, if other threads are ready at the same priority, the calling thread is placed at the end of the ready queue for this priority.

Returns:

The only difference between these functions is the way they indicate errors:

SchedYield()	If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.
SchedYield_r()	EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

SchedGet(), *SchedSet()*

Add or remove one or more given addresses from an association

Synopsis:

```
#include <netinet/sctp.h>

int sctp_bindx(int sd,
               struct sockaddr *addrs,
               int addrcnt,
               int flags);
```

Arguments:

sd	Socket descriptor. Depending on the type of *sd*, the type of address is determined. If *sd* is an **IPv4** socket, the address passed is an **IPv4** address. If *sd* is an **IPv6** socket, the address passed is either an **IPv4** or an **IPv6** address. A single adddress is specified as INADDR_ANY or IN6ADDR_ANY.
addrs	Pointer to an array of one or more socket addresses. Each address is contained in its appropriate structure (i.e. struct **sockaddr_in** or struct **sockaddr_in6**). The family of the address type must be used to distinguish the address length. This representation is termed a “packed array” of addresses.
addrcnt	Number of addresses in the array.
flags	Either SCTP_BINDX_ADD_ADDR or SCTP_BINDX_REM_ADDR. It is formed from the bitwise OR of zero or more of these flags.

Library:

libsctp

Description:

The *sctp_bindx()* add or remove one or more given addresses from an association.

An application uses *sctp_bindx(SCTP_BINDX_ADD_ADDR)* to associate additional addresses with an endpoint after calling *bind()*. Otherwise, it may also call *sctp_bindx(SCTP_BINDX_REM_ADDR)* to remove some addresses a listening socket is associated with — so that no new association will be associated with those addresses. If the endpoint supports dynamic address, a SCTP_BINDX_REM_ADDR or SCTP_BINDX_ADD_ADDR may cause an endpoint to send the appropriate message to change the peer's address lists.

Returns:

0 Success.

-1 Failure; *errno* is set.

Errors:

EFAULT Passed-in flag was neither SCTP_BINDX_ADD_ADDR nor SCTP_BINDX_REM_ADDR.

EINVAL Passed-in address has a wrong family.

Classification:

Socket API extension for stream control transmission protocol in accord with *draft-ietf-tsvwg-sctpsocket-07.txt*.

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

SCTP, *sctp_connectx()*, *sctp_freeladdrs()*, *sctp_freepaddrs()*, *sctp_getladdrs()*, *sctp_getpaddrs()*, *sctp_peeloff()*, *sctp_recvmsg()*, *sctp_sendmsg()*

sctp_connectx()

Help associate an endpoint that is multi-homed

Synopsis:

```
#include <netinet/sctp.h>

int sctp_connectx(int s,
                  struct sockaddr *addrs,
                  int addrcnt);
```

Arguments:

s	Socket descriptor.
addrs	Array of addreses.
addrcnt	Number of addresses in the array.

Library:

libsctp

Description:

The *sctp_connectx()* function connects a host to a multi-homed endpoint by specifying a list of peer addresses.

Returns:

0	Success.
-1	Failure; *errno* is set.

Errors:

EINVAL	No valid address is passed in *addrs*.

Classification:

Socket API extension for stream control transmission protocol in accordance with *draft-ietf-tsvwg-sctpsocket-07.txt*.

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

SCTP, *sctp_bindx()*, *sctp_freeladdrs()*, *sctp_freepaddrs()*, *sctp_getladdrs()*, *sctp_getpaddrs()*, *sctp_peeloff()*, *sctp_recvmsg()*, *sctp_sendmsg()*

sctp_freeladdrs()

Free all resources allocated by sctp_getladdrs()

Synopsis:

```
#include <netinet/sctp.h>

void sctp_freeladdrs(struct sockaddr *addrs);
```

Arguments:

addrs Array of peer addresses returned by *sctp_getladdrs()*.

Library:

libsctp

Description:

The *sctp_freeladdrs()* free all resources allocated by *sctp_getladdrs()*.

Classification:

Socket API extension for stream control transmission protocol in accord with *draft-ietf-tsvwg-sctpsocket-07.txt*.

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

SCTP, *sctp_bindx()*, *sctp_connectx()*, *sctp_freepaddrs()*, *sctp_getladdrs()*, *sctp_getpaddrs()*, *sctp_peeloff()*, *sctp_recvmsg()*, *sctp_sendmsg()*

sctp_freepaddrs()

Free all resources allocated by sctp_getpaddrs()

Synopsis:

```
#include <netinet/sctp.h>

void sctp_freepaddrs(struct sockaddr *addrs);
```

Arguments:

addrs Array of peer addresses returned by *sctp_getpaddrs()*.

Library:

libsctp

Description:

The *sctp_freepaddrs()* free all resources allocated by *sctp_getpaddrs()*.

Classification:

Socket API extension for stream control transmission protocol in accord with *draft-ietf-tsvwg-sctpsocket-07.txt*.

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

SCTP, *sctp_bindx()*, *sctp_connectx()*, *sctp_freeladdrs()*, *sctp_getladdrs()*, *sctp_getpaddrs()*, *sctp_peeloff()*, *sctp_recvmsg()*, *sctp_sendmsg()*

sctp_getladdrs()

Return all locally bound addresses on a socket

Synopsis:

```
#include <netinet/sctp.h>

int sctp_getladdrs(int sd,
                   sctp_assoc_t  id,
                   struct sockaddr **addrs);
```

Arguments:

sd	Socket descriptor.
id	Specifies the association for one-to-many style sockets. It is ignored for one-to-one style sockets.
addrs	A pointer to an array of local addresses, returned by the stack.

Library:

libsctp

Description:

The *sctp_getladdrs()* return all locally bound addresses on a socket.

On return, *addrs* points to a dynamically allocated packed array of *sockaddr* structures of the appropriate type for each address. The caller should use *sctp_freepaddrs()* to free the memory. Note that the in/out parameter *addrs* must not be NULL.

Returns:

On success, *sctp_getladdrs()* returns the number of local addresses bound to the socket. If the socket is unbound, *sctp_getladdrs()* returns 0, and the value of **addrs* is undefined.

If an error occurs, *sctp_getladdrs()* returns -1, and the value of **addrs* is undefined.

Errors:

EINVAL	Address is wrong.
ENOTCONN	Socket is not bound.
ENOMEM	Can't allocate memory for address.

Classification:

Socket API extension for stream control transmission protocol in accord with *draft-ietf-tsvwg-sctpsocket-07.txt*.

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

SCTP, *sctp_bindx()*, *sctp_connectx()*, *sctp_freeladdrs()*, *sctp_freepaddrs()*, *sctp_getpaddrs()*, *sctp_peeloff()*, *sctp_recvmsg()*, *sctp_sendmsg()*

sctp_getpaddrs()

Return all peer addresses in an association

Synopsis:

```
#include <netinet/sctp.h>

int sctp_getpaddrs(int sd,
                   sctp_assoc_t  id,
                   struct sockaddr **addrs);
```

Arguments:

sd	Socket descriptor.
id	Specifies the association for one-to-many style sockets. It is ignored for one-to-one style sockets
addrs	A pointer to an array of peer addresses, returned by the stack.

Library:

libsctp

Description:

The *sctp_getpaddrs()* return all peer addresses in an association.

On return, *addrs* points to a dynamically packed array of *sockaddr* structures of the appropriate type for each address. The caller should use *sctp_freepaddrs()* to free the memory. Note that in and out parameters *addrs* must not be NULL.

Returns:

On success, *sctp_getpaddrs()* returns the number of peer addresses in the association. If there is no association, this function returns 0 and the value of ***addrs** is undefined.

If an error occurs, *sctp_getpaddrs()* returns -1, and the value of **addrs* is undefined.

Errors:

EINVAL	Passed-in address is wrong.
ENOMEM	Can't allocate memory for address.

Classification:

Socket API extension for stream control transmission protocol in accord with *draft-ietf-tsvwg-sctpsocket-07.txt*.

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

SCTP, *sctp_bindx()*, *sctp_connectx()*, *sctp_freeladdrs()*, *sctp_freepaddrs()*, *sctp_getladdrs()*, *sctp_peeloff()*, *sctp_recvmsg()*, *sctp_sendmsg()*

sctp_peeloff()

Branch off an association into a seperate socket

Synopsis:

```
#include <netinet/sctp.h>

int sctp_peeloff(int sd,
                 sctp_assoc_t assoc_id);
```

Library:

libsctp

Description:

You call this function to branch off an association into a seperate socket. The new socket is a one-to-one style socket. You should confine your operation to one that is allowed for a one-to-one style socket.

Using *sctp_peeloff()*, you create a new socket descriptor as follows:

```
new_sd = sctp_peeloff(int sd, sctp_assoc_t assoc_id);
```

Returns:

On success, it returns a new socket, which has the single association in it. On failure, it returns -1 and *errno* is set.

Errors:

EBADF	The *sd* is wrong.
ENOTSOCK	Can't branch off the association.

Classification:

Socket API extension for stream control transmission protocol in accord with *draft-ietf-tsvwg-sctpsocket-07.txt*.

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

SCTP, *sctp_bindx()*, *sctp_connectx()*, *sctp_freeladdrs()*, *sctp_freepaddrs()*, *sctp_getladdrs()*, *sctp_getpaddrs()*, *sctp_recvmsg()*, *sctp_sendmsg()*

SCTP

Stream Control Transmission Protocol

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>

int socket( PF_INET,
            SOCK_DGRAM,
            IPPROTO_SCTP);

Or,

int socket( PF_INET,
            SOCK_STREAM,
            IPPROTO_SCTP);
```

Description:

The SCTP protocol provides reliable end-to-end message transport service. It has the following features:

- Acknowledged error-free non-duplicated transfer of user data
- Data fragmentation to conform to path MTU size
- Sequenced delivery of user messages within multiple streams
- Multi-homing
- Protection against DOS attacks.

Returns:

A descriptor referencing the socket, or -1 if an error occurs (*errno* is set).

Errors:

EACCES	Permission to create a socket of the specified type and/or protocol is denied.
EMFILE	The per-process descriptor table is full.

ENFILE The system file table is full.

ENOBUFS Insufficient buffer space available. The socket can't be created until sufficient resources are freed.

ENOMEM Not enough memory.

EPROTONOSUPPORT
The protocol type or the specified protocol isn't supported within this domain.

See also:

IP

sctp_bindx(), sctp_connectx(), sctp_freeladdrs(), sctp_freepaddrs(), sctp_getladdrs(), sctp_getpaddrs(), sctp_peeloff(), sctp_recvmsg(), sctp_sendmsg()

RFC 2960, RFC 3257

Drafts:

- Socket API extension for stream control transmission protocol in accord with *draft-ietf-tsvwg-sctpsocket-07.txt*.
- Stream control transmission protocol dynamic address reconfiguration.

sctp_recvmsg()

Receive message using advanced SCTP features

Synopsis:

```
#include <netinet/sctp.h>

ssize_t sctp_recvmsg(int s,
                     void *msg,
                     size_t len,
                     struct sockaddr *from,
                     socklen_t *fromlen,
                     struct sctp_sndrcvinfo *sinfo,
                     int *msg_flags);
```

Arguments:

s	Socket descriptor.
msg	Message buffer to be filled.
len	Length of the message buffer.
from	A pointer to a **sockaddr** object where the function can store the source address of the message.
fromlen	A pointer to a **socklen_t** object that specifies the size of the *from* buffer. The function stores the actual size of the address in this object.
sinfo	A pointer to a **sctp_sndrcvinfo** structure to be filled upon receipt of the message.
msg_flags	A pointer to an integer to be filled with any message flags (e.g. MSG_NOTIFICATION).

Library:

libsctp

Description:

The *sctp_recvmsg()* function receive a message from socket *s*, whether or not a socket is connected. The difference between this function and the generic function *recvmsg()* is that you could pass in a pointer to **sctp_sndrcvinfo** structure, and the structure is filled upon receipt of the message. The structure has detailed information about the message you just received. Note that you must enable **sctp_data_io_events** with the SCTP_EVENTS socket option first, to be able to have the **sctp_sndrcvinfo** structure be filled in.

Returns:

Number of bytes received, or -1 if an error occurs (*errno* is set).

Errors:

ENOMEM Not enough stack memory.

Classification:

Socket API extension for stream control transmission protocol in accordance with *draft-ietf-tsvwg-sctpsocket-07.txt*.

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

SCTP, *sctp_bindx()*, *sctp_connectx()*, *sctp_freeladdrs()*, *sctp_freepaddrs()*, *sctp_getladdrs()*, *sctp_getpaddrs()*, *sctp_peeloff()*, *sctp_sendmsg()*

sctp_sendmsg()

Send message using advanced SCTP features

Synopsis:

```
#include <netinet/sctp.h>

ssize_t sctp_sendmsg(int s,
                     const void *msg,
                     size_t len,
                     struct sockaddr *to,
                     socklen_t tolen,
                     uint32_t ppid,
                     uint32_t flags,
                     uint16_t stream_no,
                     uint32_t timetolive,
                     uint32_t context);
```

Arguments:

s	Socket descriptor.
msg	Message to be sent.
len	Length of the message.
to	Destination address of the message.
tolen	Length of the destination address.
ppid	An opaque unsigned value that is passed to the remote end in each user message. The byte order issues are not accounted for and this information is passed opaquely by the SCTP stack from one end to the other.
flags	Flags composed of bitwise OR of these values:

MSG_UNORDERED

This flag requests the un-ordered delivery of the message. If the flag is clear, the datagram is considered an ordered send.

MSG_ADDR_OVER
: This flag, in one-to-many style, requests the SCTP stack to override the primary destination address.

MSG_ABORT
: This flag causes the specified association to abort — by sending an ABORT message to the peer (one-to-many style only).

MSG_EOF
: This flag invokes the SCTP graceful shutdown procedures on the specified association. Graceful shutdown assures that all data enqueued by both endpoints is successfully transmitted before closing the association (one-to-many style only).

stream_no
: Message stream number — for the application to send a message. If a sender specifies an invalid stream number, an error indication is returned and the call fails.

timetolive
: Message time to live in milliseconds. The sending side expires the message within the specified time period if the message has not been sent to the peer within this time period. This value overrides any default value set using socket option. If you use a value of 0, it indicates that no timeout should occur on this message.

context
: An opaque 32-bit context datum. This value is passed back to the upper layer if an error occurs while sending a message, and is retrieved with each undelivered message.

Library:

libsctp

Description:

The *sctp_sendmsg()* function allows you to send extra information to a remote application. Using advanced SCTP features, you can send a message through a specified stream, pass extra opaque information to a remote application, or define a timeout for the particular message.

Returns:

The number of bytes sent, or -1 if an error occurs (*errno* is set).

Errors:

EBADF — An invalid descriptor was specified.

EDESTADDRREQ — A destination address is required.

EFAULT — An invalid user space address was specified for a parameter.

EMSGSIZE — The socket requires that the message be sent atomically, but the size of the message made this impossible.

ENOBUFS — The system couldn't allocate an internal buffer. The operation may succeed when buffers become available.

ENOTSOCK — The argument *s* isn't a socket.

EWOULDBLOCK — The socket is marked nonblocking and the requested operation would block.

Classification:

Socket API extension for stream control transmission protocol in accord with *draft-ietf-tsvwg-sctpsocket-07.txt*.

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

SCTP, *sctp_bindx()*, *sctp_connectx()*, *sctp_freeladdrs()*, *sctp_freepaddrs()*, *sctp_getladdrs()*, *sctp_getpaddrs()*, *sctp_peeloff()*, *sctp_recvmsg()*,

searchenv()

Search the directories listed in an environment variable

Synopsis:

```
#include <stdlib.h>

void searchenv( const char* name,
                const char* env_var,
                char* buffer );
```

Arguments:

name The name of the file that you want to search for.

env_var The name of an environment variable whose value is a list of directories that you want to search. Common values for *env_var* are **"PATH"**, **"LIB"** and **"INCLUDE"**.

The *searchenv()* function doesn't search the current directory unless it's specified in the environment variable.

buffer A buffer where the function can store the full path of the file found. This buffer should be PATH_MAX bytes long. If the specified file can't be found, the function stores an empty string in the buffer.

Library:

libc

Description:

The *searchenv()* function searches for the file specified by *name* in the list of directories assigned to the environment variable specified by *env_var*.

Use *pathfind()* or *pathfind_r()* instead of this function.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <limits.h>

void display_help( FILE *fp )
{
    printf( "display_help T.B.I.\n" );
}

int main( void )
{
    FILE *help_file;
    char full_path[ PATH_MAX ];

    searchenv( "lib_ref.html", "PATH", full_path );
    if( full_path[0] == '\0' ) {
        printf( "Unable to find help file\n" );
    } else {
        help_file = fopen( full_path, "r" );
        display_help( help_file );
        fclose( help_file );
    }

    return EXIT_SUCCESS;
}
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

The *searchenv()* function manipulates the environment pointed to by the global *environ* variable.

See also:

getenv(), *pathfind()*, *pathfind_r()*, *setenv()*

Initialize the seed for a sequence of pseudo-random numbers

Synopsis:

```
#include <stdlib.h>

unsigned short int *seed48(
    unsigned short int seed16v[3] );
```

Arguments:

seed16v An array that comprises the 48 bits of the seed.

Library:

libc

Description:

The *seed48()* initializes the internal buffer *r*(*n*) of *drand48()*, *lrand48()*, and *mrand48()*. All 48 bits of the seed can be specified in an array of 3 short integers, where the entry with index 0 specifies the lowest bits. The constant multiplicand and addend of the algorithm are reset to the defaults: the multiplicand *a* = **0xFDEECE66D** = 25214903917 and the addend *c* = **0xB** = 11.

Returns:

A pointer to an array of 3 shorts which contains the old seed. This array is statically allocated, thus its contents are lost after each new call to *seed48()*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

drand48(), *erand48()*, *jrand48()*, *lcong48()*, *lrand48()*, *mrand48()*, *nrand48()*, *srand48()*

seekdir()

Set the position for the next read of the directory stream

Synopsis:

```
#include <dirent.h>

void seekdir( DIR * dirp,
              long int pos );
```

Arguments:

dirp A pointer to the directory stream, for which you want to set the current location.

pos The new position for the directory stream. You should have obtained this value from an earlier call to *telldir()*.

Library:

libc

Description:

The *seekdir()* function sets the position of the next *readdir()* operation on the directory stream specified by *dirp* to the position specified by *pos*.

The new position reverts to the one associated with the directory stream when the *telldir()* operation was performed.

Values returned by *telldir()* are good only for the lifetime of the **DIR** pointer, *dirp*, from which they're derived. If the directory is closed and then reopened, the *telldir()* value may be invalidated due to undetected directory compaction. It's safe to use a previous *telldir()* value immediately after a call to *opendir()* and before any calls to *readdir()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

closedir(), errno, lstat(), opendir(), readdir(), readdir_r(), rewinddir(), telldir(), stat()

Synopsis:

```
#include <sys/select.h>

int select( int width,
            fd_set * readfds,
            fd_set * writefds,
            fd_set * exceptfds,
            struct timeval * timeout );

FD_SET( int fd, fd_set * fdset );
FD_CLR( int fd, fd_set * fdset );
FD_ISSET( int fd, fd_set * fdset );
FD_ZERO( fd_set * fdset );
```

Arguments:

width The number of descriptors to check in the given sets. Only the descriptors from 0 through (*width*-1) in the descriptor sets are examined. Therefore, the value of *width* must be at least as large as:

(*highest valued file descriptor in the sets*) +1

readfds NULL, or a pointer to a **fd_set** object that specifies the descriptors to check for files that are ready for reading. The function replaces the set with the file descriptors that are actually ready for reading.

writefds NULL, or a pointer to a **fd_set** object that specifies the descriptors to check for files that are ready for writing. The function replaces the set with the file descriptors that are actually ready for writing.

exceptfds NULL, or a pointer to a **fd_set** object that specifies the descriptors to check for files that have an exceptional condition pending. The function replaces the set with the file descriptors that actually have an exceptional condition pending.

timeout NULL, or a pointer to a **timeval** that specifies how long to wait for the selection to complete.

Library:

libc

Description:

The *select()* function examines the file descriptor sets whose addresses are passed in *readfds*, *writefds*, and *exceptfds* to see if some of their descriptors are ready for reading, ready for writing, or have an exceptional condition pending. Any of *readfds*, *writefds*, and *exceptfds* may be NULL pointers if no descriptors are of interest.

In earlier versions of QNX Neutrino, *select()* and the associated macros were defined in **sys/time.h**. They're now defined in **sys/select.h**, which **sys/time.h** includes.

The *select()* function replaces the given descriptor sets with subsets consisting of those descriptors that are ready for the requested operation, and returns the total number of ready descriptors in all the sets.

If *timeout* isn't NULL, it specifies a maximum interval to wait for the selection to complete. If *timeout* is NULL, *select()* blocks until one of the selected conditions occurs. To effect a poll, the *timeout* argument should be a non-NULL pointer, pointing to a zero-valued **timeval** structure.

If the current operating system configuration supports a larger number of open files than is specified in FD_SETSIZE, you can increase the number of open file descriptors used with *select()* by changing the definition of FD_SETSIZE before including **<sys/select.h>** or **<sys/time.h>**.

If you use *select()* with a timeout, you should reset the timeout value after calling *select()*.

☞ If you're using *select()* in conjunction with the socket API package, note that selecting for reading on a socket descriptor on which a *listen()* has been performed indicates that a subsequent *accept()* on that descriptor won't block.

Manipulating file-descriptor sets

At least the following macros are defined in **<sys/select.h>** for manipulating file-descriptor sets:

FD_ZERO(&*fdset*)

Initialize a descriptor set *fdset* to the null set.

FD_SET(*fd*, &*fdset*)

Add the file descriptor *fd* to the set *fdset*.

FD_CLR(*fd*, &*fdset*)

Remove *fd* from *fdset*.

FD_ISSET(*fd*, &*fdset*)

Is nonzero if *fd* is a member of *fdset*; otherwise, zero.

The behavior of these macros is undefined if a descriptor value is less than zero, or greater than or equal to FD_SETSIZE.

Returns:

The number of ready descriptors in the descriptor sets, 0 if the *timeout* expired, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	One of the descriptor sets specified an invalid descriptor.
EFAULT	One of the pointers given in the call referred to a nonexistent portion of the address space for the process.

EINTR — A signal was delivered before any of the selected events occurred, or before the time limit expired.

EINVAL — A component of the pointed-to time limit is outside the acceptable range: *t_sec* must be between 0 and 10^8, inclusive; *t_usec* must be greater than or equal to 0, and less than 10^6.

Examples:

```
/*
 *  This example opens a console and a serial port for
 *  read mode, and calls select() with a 5 second timeout.
 *  It waits for data to be available on either descriptor.
 */

#include <unistd.h>
#include <stdlib.h>
#include <fcntl.h>
#include <sys/select.h>

int main( void )
{
    int console, serial;
    struct timeval tv;
    fd_set rfd;
    int n;

    if( ( console = open( "/dev/con1", O_RDONLY ) ) == -1
    ||    ( serial  = open( "/dev/ser1", O_RDONLY ) ) == -1 )
    {
      perror( "open" );
      return EXIT_FAILURE;
    }

    /*
     * Clear the set of read file descriptors, and
     * add the two we just got from the open calls.
     */
    FD_ZERO( &rfd );
    FD_SET( console, &rfd );
    FD_SET( serial,  &rfd );

    /*
     *    Set a 5 second timeout.
     */
    tv.tv_sec = 5;
    tv.tv_usec = 0;
```

```
    switch ( n = select( 1 + max( console, serial ),
           &rfd, 0, 0, &tv ) ) {
      case -1:
        perror( "select" );
        return EXIT_FAILURE;
      case  0:
        puts( "select timed out" );
        break;
      default:
        printf( "%d descriptors ready ...\n", n );
        if( FD_ISSET( console, &rfd ) )
          puts( " -- console descriptor has data pending" );
        if( FD_ISSET( serial, &rfd ) )
          puts( " -- serial descriptor has data pending" );
    }
    return EXIT_SUCCESS;
}
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

The *select()* function only works with raw file descriptors; it doesn't work with file descriptors in edited mode. See the ICANON flag in the description of the *tcgetattr()* function.

See also:

errno, fcntl(), read(), sysconf(), tcsetattr(), write()

select_attach()

Attach a file descriptor to a dispatch handle

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int select_attach
        ( void *dpp,
          select_attr_t *attr,
          int fd,
          unsigned flags,
          int (*func)( select_context_t *ctp,
                       int fd,
                       unsigned flags,
                       void *handle ),
          void *handle );
```

Arguments:

dpp The dispatch handle, as returned by *dispatch_create()*, that you want to attach to a file descriptor.

attr A pointer to a **select_attr_t** structure. This structure is defined as:

```
typedef struct _select_attr {
   unsigned                flags;
} select_attr_t;
```

Currently, no attribute flags are defined.

fd The file descriptor that you want to attach to the dispatch handle.

flags Flags that specify the events that you're interested in. For more information, see "Flags," below.

func The function that you want to call when the file descriptor unblocks. For more information, see "Function," below.

handle A pointer to arbitrary data that you want to pass to *func*.

Library:

libc

Description:

The function *select_attach()* attaches the file descriptor *fd* to the dispatch handle *dpp* and selects *flags* events. When *fd* "unblocks", *func* is called with *handle*.

Flags

The available flags are defined in **<sys/dispatch.h>**. The following flags use *ionotify()* mechanisms (see *ionotify()* for further details):

SELECT_FLAG_EXCEPT

Out-of-band data is available. The definition of out-of-band data depends on the resource manager.

SELECT_FLAG_READ

There's input data available. The amount of data available defaults to 1. For a character device such as a serial port, this is a character. For a POSIX message queue, it's a message. Each resource manager selects an appropriate object.

SELECT_FLAG_WRITE

There's room in the output buffer for more data. The amount of room available needed to satisfy this condition depends on the resource manager. Some resource managers may default to an empty output buffer, while others may choose some percentage of the empty buffer.

These flags are specific to dispatch:

SELECT_FLAG_REARM

Rearm the *fd* after an event is dispatched.

SELECT_FLAG_SRVEXCEPT

Register a function that's called whenever a server, to which this client is connected, dies. (This flag uses the *ChannelCreate()* function's _NTO_CHF_COID_THREADDEATH flag. In this case, *fd* is ignored.)

Function

The argument *func* is the user-supplied function that's called when one of the registered events occurs on *fd*. This function should return 0 (zero); other values are reserved. The function is passed the following arguments:

ctp Context pointer.

fd The *fd* on which the event occurred.

flags The type of event that occurred. The possible *flags* are:

- SELECT_FLAG_EXCEPT
- SELECT_FLAG_READ
- SELECT_FLAG_WRITE

For descriptions of the flags passed to *func*, see "Flags," above.

handle The *handle* passed to *select_attach()*.

Returns:

Zero on success, or -1 if an error occurred (*errno* is set).

Errors:

EINVAL Invalid argument.

ENOMEM Insufficient memory was available.

Examples:

For an example with *select_attach()*, see *dispatch_create()*. For other examples using the dispatch interface, see *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

select_detach(), *select_query()*

select_detach()

Detach a file descriptor from a dispatch handle

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int select_detach( void *dpp,
                   int fd );
```

Arguments:

dpp The dispatch handle, as returned by *dispatch_create()*, that you want to detach from the file descriptor.

fd The file descriptor that you want to detach.

Library:

libc

Description:

The function *select_detach()* detaches the file descriptor *fd* that was registered with dispatch *dpp*, using the *select_attach()* call.

Returns:

0 Success.

-1 The file descriptor *fd* wasn't registered with the dispatch *dpp*.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>
#include <fcntl.h>

int my_func( ... ) {
   ⋮
}

int main( int argc, char **argv ) {
```

```
    dispatch_t          *dpp;
    int                 fd;
    select_attr_t       attr;


    if( ( dpp = dispatch_create() ) == NULL ) {
      fprintf( stderr, "%s: Unable to allocate \
               dispatch handle.\n",argv[0] );
      return EXIT_FAILURE;
    }

    if( argc ≤ 2 || ( fd = open( argv[1],
                    O_RDWR | O_NONBLOCK )) == -1 ) {
      exit(0);
    }

    select_attach( dpp, &attr, fd,
       SELECT_FLAG_READ | SELECT_FLAG_REARM, my_func, NULL );

    .
    .
    .

    if ( (select_detach( dpp, fd )) == -1 ) {
       fprintf( stderr, "Failed to detach \
                the file descriptor.\n" );
       return 1;
    }
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

select_attach(), *select_query()*

select_query()

Decode the last select event

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int select_query
        ( select_context_t *ctp,
          int *fd,
          unsigned *flags,
          int (**func)( select_context_t *ctp,
                        int fd,
                        unsigned flags,
                        void *handle ),
          void **handle );
```

Arguments:

ctp	A pointer to a **select_context_t** structure that defines the context of the event that you want to get information about.
fd	A pointer to a location where the function can store the file descriptor that's associated with the event.
flags	A pointer to a location where the function can store the flags associated with the event; see "Flags" in the documentation for *select_attach()*.
func	A pointer to a location where the function can store the function associated with the event; see "Function" in the documentation for *select_attach()*.
handle	A pointer to a location where the function can store the address of any data that you arranged to pass to *func*.

Library:

libc

Description:

The function *select_query()* stores the values of the last select event, for context *ctp*, in *fd*, *flags*, *func*, and *handle*.

Returns:

If an error occurs, the function returns -1. An error occurs if the received event doesn't belong to one of the file descriptors attached with *select_attach()*.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>
#include <fcntl.h>

int my_func( select_context_t *ctp,
             int fd,
             unsigned flags,
             void *handle ) {

   .
   .
   .

}

int main( int argc, char **argv ) {
   dispatch_t           *dpp;
   dispatch_context_t   *ctp;
   int                  fd;
   unsigned             flag;
   void                 *handle;
   select_attr_t        *attr;
   int                  (*func)( select_context_t *,
                                 int, unsigned, void * );

   if( ( dpp = dispatch_create() ) == NULL ) {
     fprintf( stderr, "%s: Unable to allocate \
              dispatch handle.\n",argv[0] );
     return EXIT_FAILURE;
   }

   if( argc ≤ 2 || (fd = open( argv[1],
                    O_RDWR | O_NONBLOCK )) == -1 ) {
     exit(0);
   }
```

```
    select_attach( dpp, attr, fd,
       SELECT_FLAG_READ | SELECT_FLAG_REARM, &my_func, NULL );

    ctp = dispatch_context_alloc( dpp );

    .
    .
    .

    if( select_query( (select_context_t *)ctp, &fd, &flag,
                      &func, &handle ) == -1 ) {
      fprintf( stderr, "Failed to decode last select event.\n");
      return 1;
    }
}
```

For more examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

select_attach(), *select_detach()*

sem_close()

Close a named semaphore

Synopsis:

```
#include <semaphore.h>

int sem_close( sem_t * sem );
```

Arguments:

sem A pointer to a semaphore, as returned by *sem_open()*.

Library:

libc

Description:

The *sem_close()* function closes the named semaphore *sem* opened by *sem_open()*, releasing any system resources associated with the *sem*.

☞ Don't mix named semaphore operations (*sem_open()* and *sem_close()*) with unnamed semaphore operations (*sem_init()* and *sem_destroy()*) on the same semaphore.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL Invalid semaphore descriptor *sem*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The **mqueue** manager must be running for applications to use named semaphores.

See also:

sem_init(), *sem_open()*, *sem_unlink()*

mqueue in the *Utilities Reference*

sem_destroy()

Destroy a semaphore

Synopsis:

```
#include <semaphore.h>

int sem_destroy( sem_t * sem );
```

Arguments:

sem A pointer to the **sem_t** object for the semaphore that you want to destroy.

Library:

libc

Description:

The *sem_destroy()* function destroys the unnamed semaphore referred to by the *sem* argument. The semaphore must have been previously initialized by the *sem_init()* function.

The effect of using a semaphore after it has been destroyed is undefined. If you destroy a semaphore that other processes are currently blocked on, they're unblocked, with an error (EINVAL).

☞ Don't mix named semaphore operations (*sem_open()* and *sem_close()*) with unnamed semaphore operations (*sem_init()* and *sem_destroy()*) on the same semaphore.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL Invalid semaphore descriptor *sem*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sem_init(), *sem_post()*, *sem_trywait()*, *sem_wait()*

sem_getvalue()

Get the value of a named or unnamed semaphore

Synopsis:

```
#include <semaphore.h>

int sem_getvalue( sem_t * sem,
                  int  * value );
```

Arguments:

sem A pointer to the **sem_t** object for the semaphore whose value you want to get.

value A pointer to a location where the function can store the semaphore's value. A positive value (i.e. greater than zero) indicates an unlocked semaphore, and a *value* of 0 (zero) indicates a locked semaphore.

Library:

libc

Description:

The *sem_getvalue()* function takes a snapshot of the value of the semaphore, *sem*, and stores it in *value*. This value can change at any time, and is guaranteed valid only at some point in the *sem_getvalue()* call.

This function is provided for debugging semaphore code.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL Invalid semaphore descriptor *sem*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sem_destroy(), *sem_init()*, *sem_trywait()*, *sem_wait()*

Synopsis:

```
#include <semaphore.h>

int sem_init( sem_t * sem,
              int pshared,
              unsigned value );
```

Arguments:

sem	A pointer to the **sem_t** object for the semaphore that you want to initialize.
pshared	Nonzero if you want the semaphore to be shared between processes via shared memory.
value	The initial value of the semaphore. A positive value (i.e. greater than zero) indicates an unlocked semaphore, and a *value* of 0 (zero) indicates a locked semaphore. This value must not exceed SEM_VALUE_MAX.

Library:

libc

Description:

The *sem_init()* function initializes the unnamed semaphore referred to by the *sem* argument. The initial counter value of this semaphore is specified by the *value* argument.

You can use the initialized semaphore in subsequent calls to *sem_wait()*, *sem_trywait()*, *sem_post()*, and *sem_destroy()*. An initialized semaphore is valid until it's destroyed by the *sem_destroy()* function, or until the memory where the semaphore resides is released.

If the *pshared* argument is nonzero, then the semaphore can be shared between processes via shared memory. Any process can then use *sem*

with the *sem_wait()*, *sem_trywait()*, *sem_post()* and *sem_destroy()* functions.

☞ Don't mix named semaphore operations (*sem_open()* and *sem_close()*) with unnamed semaphore operations (*sem_init()* and *sem_destroy()*) on the same semaphore.

Returns:

0 Success. The semaphore referred to by *sem* is initialized.

-1 An error occurred (*errno* is set).

Errors:

EAGAIN	A resource required to initialize the semaphore has been exhausted.
EINVAL	The *value* argument exceeds SEM_VALUE_MAX.
EPERM	The process lacks the appropriate privileges to initialize the semaphore.
ENOSPC	A resource required to initialize the semaphore has been exhausted.
ENOSYS	The *sem_init()* function isn't supported.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

Don't initialize the same semaphore from more than one thread. It's best to set up semaphores before starting any threads.

See also:

errno, sem_destroy(), sem_post(), sem_trywait(), sem_wait()

sem_open()

Create or access a named semaphore

Synopsis:

```
#include <semaphore.h>

sem_t * sem_open( const char * sem_name,
                  int oflags,
                  ... );
```

Arguments:

sem_name The name of the semaphore that you want to create or access; see below.

oflags Flags that affect how the function creates a new semaphore. This argument is a combination of:

- O_CREAT
- O_EXCL

☞ Don't set *oflags* to O_RDONLY, O_RDWR, or O_WRONLY. A semaphore's behavior is undefined with these flags. The QNX libraries silently ignore these options, but they may reduce your code's portability.

For more information, see below.

If you set O_CREAT in *oflags*, you must also pass the following arguments:

mode_t *mode* The semaphore's mode (just like file modes). For portability, you should set the read, write, *and* execute bits to the same value. An easy way of doing this is to use the constants from **<sys/stat.h>**:

- S_IRWXG for group access.
- S_IRWXO for other's access.
- S_IRWXU for your own access.

For more information, see "Access permissions" in the documentation for *stat()*.

unsigned int *value*

The initial value of the semaphore. A positive value (i.e. greater than zero) indicates an unlocked semaphore, and a *value* of 0 (zero) indicates a locked semaphore. This value must not exceed SEM_VALUE_MAX.

Library:

libc

Description:

The *sem_open()* function creates or accesses a named semaphore. Named semaphores are slower than the unnamed semaphores created with *sem_init()*. Semaphores persist as long as the system is up.

The *sem_open()* function returns a semaphore descriptor that you can use with *sem_wait()*, *sem_trywait()*, and *sem_post()*. You can use it until you call *sem_close()*.

The *sem_name* argument is interpreted as follows:

name	Pathname space entry
entry	*CWD*/*entry*
/*entry*	/dev/sem/*entry*
entry/*newentry*	*CWD*/*entry*/*newentry*
/*entry*/*newentry*	/*entry*/*newentry*

where *CWD* is the current working directory for the program at the point that it calls *mq_open()*.

If you want to create or access a semaphore on another node, you have to specify the name as **/net/***node***/***sem_location*.

The *oflags* argument is used only for semaphore creation. When creating a new semaphore, you can set *oflags* to O_CREAT or (O_CREAT | O_EXCL):

O_CREAT	Create a new named semaphore. If you set this bit, you must provide the *mode* and *value* arguments to *sem_open()*.
O_EXCL	When creating a new named semaphore, O_EXCL causes *sem_open()* to fail if a semaphore with *sem_name* already exists. Without O_EXCL, *sem_open()* attaches to an existing semaphore or creates a new one if *sem_name* doesn't exist.

Don't mix named semaphore operations (*sem_open()* and *sem_close()*) with unnamed semaphore operations (*sem_init()* and *sem_destroy()*) on the same semaphore.

Returns:

A pointer to the created or accessed semaphore, or -1 for failure (*errno* is set).

Errors:

EACCES	Either the named semaphore exists and you don't have permission to access it, or you're trying to create a new semaphore and you don't have permission.
EEXIST	You specified O_CREAT and O_EXCL in *oflags*, but the semaphore already exists.
EINVAL	The *sem_name* argument is invalid or, when creating a semaphore, *value* is greater than SEM_VALUE_MAX.

EINTR	The call was interrupted by a signal.
ELOOP	Too many levels of symbolic links or prefixes.
EMFILE	The process is using too many files or semaphores.
ENFILE	The system ran out of resources and couldn't open the semaphore.
ENAMETOOLONG	The *sem_name* argument is longer than (NAME_MAX - 8).
ENOENT	Either the **mqueue** manager isn't running, or the *sem_name* argument doesn't exist and you didn't specify O_CREAT in *oflags*.
ENOSPC	There's insufficient space to create a new named semaphore.
ENOSYS	The *sem_open()* function isn't implemented for the filesystem specified in *sem_name*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The **mqueue** manager must be running for applications to use named semaphores.

See also:

sem_close(), sem_destroy(), sem_init(), sem_post(), sem_trywait(), sem_unlink(), sem_wait()

mqueue in the *Utilities Reference*

sem_post()

Increment a semaphore

Synopsis:

```
#include <semaphore.h>

int sem_post( sem_t * sem );
```

Arguments:

sem A pointer to the **sem_t** object for the semaphore whose value you want to increment.

Library:

libc

Description:

The *sem_post()* function increments the semaphore referenced by the *sem* argument. If any processes are currently blocked waiting for the semaphore, then one of these processes will return successfully from its call to *sem_wait*.

The process to be unblocked is determined in accordance with the scheduling policies in effect for the blocked processes. The highest priority waiting process is unblocked, and if there is more than one highest priority process blocked waiting for the semaphore, then the highest priority process that has been waiting the longest is unblocked.

The *sem_post()* function is reentrant with respect to signals, and can be called from a signal handler.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL	Invalid semaphore descriptor *sem*.
ENOSYS	The *sem_post()* function isn't supported.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *sem_destroy()*, *sem_init()*, *sem_trywait()*, *sem_wait()*

sem_timedwait()

Wait on a semaphore, with a timeout

Synopsis:

```
#include <semaphore.h>
#include <time.h>

int sem_timedwait(
        sem_t * sem,
        const struct timespec * abs_timeout );
```

Arguments:

sem	The semaphore that you want to wait on.
abs_timeout	A pointer to a **timespec** structure that specifies the maximum time to wait to lock the semaphore, expressed as an absolute time.

Library:

libc

Description:

The *sem_timedwait()* function locks the semaphore referenced by *sem* as in the *sem_wait()* function. However, if the semaphore can't be locked without waiting for another process or thread to unlock the semaphore by calling *sem_post()*, the wait is terminated when the specified timeout expires.

The timeout expires when the absolute time specified by *abs_timeout* passes, as measured by the clock on which timeouts are based (i.e. when the value of that clock equals or exceeds *abs_timeout*), or if the absolute time specified by *abs_timeout* has already been passed at the time of the call. The timeout is based on the CLOCK_REALTIME clock.

Returns:

0	The calling process successfully performed the semaphore lock operation on the semaphore designated by *sem*.
-1	The call was unsuccessful (*errno* is set). The state of the semaphore is unchanged.

Errors:

EDEADLK	A deadlock condition was detected.
EINTR	A signal interrupted this function.
EINVAL	Invalid semaphore *sem*, or the thread would have blocked, and the *abs_timeout* parameter specified a nanoseconds field value less than zero or greater than or equal to 1000 million.
ETIMEDOUT	The semaphore couldn't be locked before the specified timeout expired.

Examples:

```
#include <stdio.h>
#include <semaphore.h>
#include <time.h>

main(){

    struct timespec tm;
    sem_t sem;
    int i=0;

    sem_init( &sem, 0, 0);

    do {
        clock_gettime(CLOCK_REALTIME, &tm);
        tm.tv_sec += 1;
        i++;
        printf("i=%d\n",i);
        if (i==10) {
            sem_post(&sem);
        }

    } while ( sem_timedwait( &sem, &tm ) == -1 );
```

```
    printf("Semaphore acquired after %d timeouts\n", i);
    return;
}
```

Classification:

POSIX 1003.1d (draft)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sem_post(), *sem_trywait()*, *sem_wait()*, *time()*, **timespec**

sem_trywait()

Wait on a semaphore, but don't block

Synopsis:

```
#include <semaphore.h>

int sem_trywait( sem_t * sem );
```

Arguments:

sem A pointer to the **sem_t** object for the semaphore that you want to wait on.

Library:

libc

Description:

The *sem_trywait()* function decrements the semaphore if the semaphore's value is greater than zero; otherwise, the function simply returns.

Returns:

0 The semaphore was successfully decremented.

-1 The state of the semaphore is unchanged (*errno* is set).

Errors:

EAGAIN	The semaphore was already locked, so it couldn't be immediately locked by the *sem_trywait()* function.
EDEADLK	A deadlock condition was detected.
EINVAL	Invalid semaphore descriptor *sem*.
EINTR	A signal interrupted this function.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sem_destroy(), sem_init(), sem_post(), sem_wait()

sem_unlink()

Destroy a named semaphore

Synopsis:

```
#include <semaphore.h>

int sem_unlink( const char * sem_name );
```

Arguments:

sem_name The name of the semaphore that you want to destroy.

Library:

libc

Description:

The *sem_unlink()* function destroys the named semaphore, *sem_name*. Open semaphores are removed the same way that *unlink()* removes open files; the processes that have the semaphore open can still use it, but the semaphore will disappear as soon as the last process uses *sem_close()* to close it.

Any attempt to use *sem_open()* on an unlinked semaphore will refer to a *new* semaphore.

Semaphores are persistent as long as the system remains up.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCESS You don't have permission to unlink the semaphore.

ELOOP Too many levels of symbolic links or prefixes.

ENOENT The semaphore *sem_name* doesn't exist.

ENAMETOOLONG
The *sem_name* argument is longer than (NAME_MAX - 8).

ENOSYS
The *sem_unlink()* function isn't implemented for the filesystem specified in *path*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The **mqueue** manager must be running for applications to use named semaphores.

See also:

sem_open(), *sem_close()*, *sem_wait()*, *sem_trywait()*, *sem_post()*

mqueue in the *Utilities Reference*

sem_wait()

Wait on a semaphore

Synopsis:

```
#include <semaphore.h>

int sem_wait( sem_t * sem );
```

Arguments:

sem A pointer to the **sem_t** object for the semaphore that you want to wait on.

Library:

libc

Description:

The *sem_wait()* function decrements the semaphore referred to by the *sem* argument. If the semaphore value is not greater than zero, then the calling process blocks until it can decrement the counter, or the call is interrupted by signal.

Some process should eventually call *sem_post()* to increment the semaphore.

Returns:

0 The semaphore was successfully decremented.

-1 The state of the semaphore is unchanged (*errno* is set).

Errors:

EDEADLK	A deadlock condition was detected.
EINVAL	Invalid semaphore descriptor *sem*.
EINTR	A signal interrupted this function.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sem_destroy(), sem_init(), sem_post(), sem_trywait()

send()

Send a message to a connected socket

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

ssize_t send( int s,
              const void * msg,
              size_t len,
              int flags );
```

Arguments:

s The descriptor for the socket; see *socket()*.

msg A pointer to the message that you want to send.

len The length of the message.

flags A combination of the following:

- MSG_OOB — process out-of-band data. Use this bit when you send "out-of-band" data on sockets that support this notion (e.g. SOCK_STREAM). The underlying protocol must also support out-of-band data.
- MSG_DONTROUTE — bypass routing; create a direct interface. You normally use this bit only in diagnostic or routing programs.

The tiny TCP/IP stack doesn't support MSG_OOB and MSG_DONTROUTE. For more information, see **npm-ttcpip.so** in the *Utilities Reference*.

Library:

libsocket

Description:

The *send(), sendto(),* and *sendmsg()* functions are used to transmit a message to another socket. The *send()* function can be used only when the socket is in a *connected* state, while *sendto()* and *sendmsg()* can be used at any time.

The length of the message is given by *len.* If the message is too long to pass atomically through the underlying protocol, the error EMSGSIZE is returned, and the message isn't transmitted.

No indication of failure to deliver is implicit in a *send().* Locally detected errors are indicated by a return value of -1.

If no message space is available at the socket to hold the message to be transmitted, then *send()* normally blocks, unless the socket has been placed in nonblocking I/O mode. You can use *select()* to determine when it's possible to send more data.

Returns:

The number of bytes sent, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	An invalid descriptor was specified.
EDESTADDRREQ	A destination address is required.
EFAULT	An invalid user space address was specified for a parameter.
EMSGSIZE	The socket requires that the message be sent atomically, but the size of the message made this impossible.
ENOBUFS	The system couldn't allocate an internal buffer. The operation may succeed when buffers become available.
ENOTSOCK	The argument *s* isn't a socket.

EPIPE
An attempt was made to write to a pipe (or FIFO) that isn't open for reading by any process. A SIGPIPE signal is also sent to the process.

EWOULDBLOCK
The socket is marked nonblocking and the requested operation would block.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getsockopt(), ioctl(), recv(), select(), sendmsg(), sendto(), socket(), write()

sendmsg()

Send a message and its header to a socket

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

ssize_t sendmsg( int s,
                 const struct msghdr * msg,
                 int flags );
```

Arguments:

s The descriptor for the socket; see *socket()*.

msg A pointer to the message that you want to send. For a description of the **msghdr** structure, see *recvmsg()*.

flags A combination of the following:

- MSG_OOB — process out-of-band data. Use this bit when you send "out-of-band" data on sockets that support this notion (e.g. SOCK_STREAM). The underlying protocol must also support out-of-band data.
- MSG_DONTROUTE — bypass routing; create a direct interface. You normally use this bit only in diagnostic or routing programs.

The tiny TCP/IP stack doesn't support MSG_OOB and MSG_DONTROUTE. For more information, see **npm-ttcpip.so** in the *Utilities Reference*.

Library:

libsocket

Description:

The *sendmsg()* function is used to transmit a message to another socket. You can use *send()* only when the socket is in a *connected* state; you can use *sendmsg()* at any time.

No indication of failure to deliver is implicit in a *sendmsg()*. Locally detected errors are indicated by a return value of -1.

If no message space is available at the socket to hold the message to be transmitted, then *sendmsg()* normally blocks, unless the socket has been placed in nonblocking I/O mode. You can use *select()* to determine when it's possible to send more data.

Returns:

The number of bytes sent, or -1 if an error occurs (*errno* is set).

Errors:

EBADF — An invalid descriptor was specified.

EDESTADDRREQ — A destination address is required.

EFAULT — An invalid user space address was specified for a parameter.

EMSGSIZE — The socket requires that the message be sent atomically, but the size of the message made this impossible.

ENOBUFS — The system couldn't allocate an internal buffer. The operation may succeed when buffers become available.

ENOTSOCK — The argument *s* isn't a socket.

EWOULDBLOCK — The socket is marked nonblocking and the requested operation would block.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getsockopt(), ioctl(), recv(), select(), send(), sendto(), socket(), write()

sendto()

Send a message to a socket at a specific address

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

ssize_t sendto( int s,
                const void * msg,
                size_t len,
                int flags,
                const struct sockaddr * to,
                socklen_t tolen );
```

Arguments:

s The descriptor for the socket; see *socket()*.

msg A pointer to the message that you want to send.

len The length of the message.

flags A combination of the following:

- MSG_OOB — process out-of-band data. Use this bit when you send "out-of-band" data on sockets that support this notion (e.g. SOCK_STREAM). The underlying protocol must also support out-of-band data.
- MSG_DONTROUTE — bypass routing; create a direct interface. You normally use this bit only in diagnostic or routing programs.

The tiny TCP/IP stack doesn't support MSG_OOB and MSG_DONTROUTE. For more information, see **npm-ttcpip.so** in the *Utilities Reference*.

to A pointer to a **sockaddr** object that specifies the address of the target.

tolen A **socklen_t** object that specifies the size of the *to* address.

Library:

libsocket

Description:

The *sendto()* function is used to transmit a message to another socket. You can use *send()* only when the socket is in a *connected* state; you can use *sendto()* at any time.

The address of the target is given by *to*, with *tolen* specifying its size. The length of the message is given by *len*. If the message is too long to pass atomically through the underlying protocol, the error EMSGSIZE is returned, and the message isn't transmitted.

No indication of failure to deliver is implicit in a *sendto()*. Locally detected errors are indicated by a return value of -1.

If no message space is available at the socket to hold the message to be transmitted, then *sendto()* normally blocks, unless the socket has been placed in nonblocking I/O mode. You can use *select()* to determine when it's possible to send more data.

Returns:

The number of bytes sent, or -1 if an error occurs (*errno* is set).

Errors:

EBADF — An invalid descriptor was specified.

EDESTADDRREQ — A destination address is required.

EFAULT — An invalid user space address was specified for a parameter.

EMSGSIZE — The socket requires that the message be sent atomically, but the size of the message made this impossible.

ENOBUFS — The system couldn't allocate an internal buffer. The operation may succeed when buffers become available.

ENOTSOCK — The argument *s* isn't a socket.

EWOULDBLOCK — The socket is marked nonblocking and the requested operation would block.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

getsockopt(), ioctl(), recv(), select(), send(), sendmsg(), socket(), write()

Synopsis:

```
#include <netdb.h>

struct servent {
     char *  s_name;
     char ** s_aliases;
     int     s_port;
     char *  s_proto;
};
```

Description:

This structure is used to hold the broken-out fields of a line in the network services database, **/etc/services**. The members of this structure are:

s_name	The name of the service.
s_aliases	A zero-terminated list of alternate names for the service.
s_port	The port number that the service resides at. Port numbers are returned in network byte order.
s_proto	The name of the protocol to use when contacting the service.

Classification:

Unix, POSIX 1003.1-2001

See also:

endservent(), *getservbyname()*, *getservbyport()*, *getservent()*, *setservent()*

/etc/services in the *Utilities Reference*

setbuf()

Associate a buffer with a stream

Synopsis:

```
#include <stdio.h>

void setbuf( FILE *fp,
             char *buffer );
```

Arguments:

fp	The stream that you want to associate with a buffer.
buffer	NULL, or a pointer to the buffer; see below.

Library:

libc

Description:

The *setbuf()* function associates the supplied *buffer* with the stream specified by *fp*. If you want to call *setbuf()*, you must call it after opening the stream, but before doing any reading, writing, or seeking.

If *buffer* is NULL, all input/output for the stream is completely unbuffered. If *buffer* isn't NULL, then it must point to an array that's at least BUFSIZ characters long, and all input/output is fully buffered.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char *buffer;
    FILE *fp;

    buffer = (char *)malloc( BUFSIZ );
    if( buffer == NULL ) {
        return EXIT_FAILURE;
    }

    fp = fopen( "some_file", "r" );
```

```
    setbuf( fp, buffer );

    /* . */
    /* . */
    /* . */

    fclose( fp );

    free( buffer );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fopen(), *setvbuf()*

setbuffer()

Assign block buffering to a stream

Synopsis:

```
#include <unix.h>

void setbuffer( FILE *iop,
                char *abuf,
                size_t asize );
```

Arguments:

iop	The stream that you want to set the buffering for.
abuf	NULL, or a pointer to the buffer that you want the stream to use.
asize	The size of the buffer.

Library:

libc

Description:

The *setbuffer()* and *setlinebuf()* functions assign buffering to a stream. The types of buffering available are:

Unbuffered	Information appears on the destination file or terminal as soon as written.
Block-buffered	Many characters are saved and written as a block.
Line-buffered	Characters are saved until either a newline is encountered or input is read from *stdin*.

You can use *fflush()* to force the block out early. Normally all files are block-buffered. A buffer is obtained from *malloc()* when you perform the first *getc()* or *putc()* on the file. If the standard stream *stdout* refers to a terminal, it's line-buffered. The standard stream *stderr* is unbuffered by default.

If you want to use *setbuffer()*, you must call it after opening the stream, but before doing any reading or writing. It uses the character array *abuf*, whose size is given by *asize*, instead of an automatically allocated buffer. If *abuf* is NULL, input and output are completely unbuffered. A manifest constant BUFSIZ, defined in the **<stdio.h>** header, tells how large an array is needed:

```
char buf[BUFSIZ];
```

You can use *freopen()*. to change a stream from unbuffered or line-buffered to block buffered. To change a stream from block-buffered or line-buffered to unbuffered, call *freopen()*, and then call *setbuf()* with a buffer argument of NULL.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

A common source of error is allocating buffer space as an **automatic** variable in a code block, and then failing to close the stream in the same block.

See also:

fclose(), fflush(), fopen(), fread(), freopen(), getc(), malloc(), printf(), putc(), puts(), setbuf(), setlinebuf(), setvbuf()

setdomainname()

Set the domain name of the current host

Synopsis:

```
#include <unistd.h>

int setdomainname( const char * name,
                   size_t namelen );
```

Arguments:

name	The domain name.
namelen	The length of the name.

Library:

libsocket

Description:

The *setdomainname()* function sets the domain *name* of the host machine. Only the superuser (**root**) can use this function and even then, the function is normally used only when bootstrapping a system.

Returns:

0	Success.
-1	Failure; *errno* is set.

Errors:

EFAULT	The *name* or *namelen* parameters gave an invalid address.
EPERM	The caller tried to set the domain name without being the superuser.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

getdomainname()

setegid()

Set the effective group ID for a process

Synopsis:

```
#include <unistd.h>

int setegid( gid_t gid );
```

Arguments:

gid The effective group ID that you want to use for the process.

Library:

libc

Description:

The *setegid()* function lets the calling process set the effective group ID based on the following:

- If the process is the superuser, the *setegid()* function sets the effective group ID to *gid*.
- If the process isn't the superuser, but *gid* is equal to the real group ID or saved set-group ID, *setegid()* sets the effective group ID to *gid*.

The real and saved group ID aren't changed.

If a set-group ID process sets its effective group ID to its real group ID, it can still set its effective group ID back to the saved set-group ID.

The "superuser" is defined as any process with an effective user ID of **0**, or an effective user ID of **root**.

Returns:

Zero for success, or -1 if an error occurs (*errno* is set).

Errors:

EINVAL	The value of *gid* is out of range.
EPERM	The process isn't the superuser, and *gid* doesn't match the real group ID or the saved set-group ID.

Examples:

```
/*
 * This process sets its effective group ID to 2
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <unistd.h>

int main( void )
{
    gid_t oegid;

    oegid = getegid();
    if( setegid( 2 ) == -1 ) {
        perror( "setegid" );
        return EXIT_FAILURE;
    }

    printf( "Was effective group %d, is 2\n", oegid );
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *getegid()*, *seteuid()*, *setgid()*, *setuid()*

setenv()

Create or change an environment variable

Synopsis:

```
#include <stdlib.h>

int setenv( const char* name,
            const char* value,
            int overwrite );
```

Arguments:

name	The name of the environment variable that you want to set.
value	NULL, or the value for the environment variable; see below.
overwrite	A nonzero value if you want the function to overwrite the variable if it exists, or 0 if you don't want to overwrite the variable.

Library:

libc

Description:

The *setenv()* function sets the environment variable *name* to *value*. If *name* doesn't exist in the environment, it's created; if *name* exists and *overwrite* is nonzero, the variable's old value is overwritten with *value*; otherwise, it isn't changed.

Copies of the specified *name* and *value* are placed in the environment.

If *value* is NULL, the environment variable specified by *name* is removed from the environment.

The value of the global *environ* pointer could be changed by a call to the *setenv()* function.

Environment variable names are case-sensitive.

Returns:

0	Success.
Nonzero	An error occurred (*errno* is set).

Errors:

ENOMEM	Not enough memory to allocate a new environment variable.

Examples:

Change the string assigned to **INCLUDE** and then display the new string:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char* path;

    if( setenv( "INCLUDE",
                "/usr/nto/include:/home/fred/include",
                1 ) == 0 ) {
        if( (path = getenv( "INCLUDE" )) != NULL ) {
            printf( "INCLUDE=%s\n", path );
        }
    }

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

The *setenv()* function manipulates the environment pointed to by the global *environ* variable.

See also:

clearenv(), *errno*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *searchenv()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *system()*, *unsetenv()*

seteuid()

Set the effective user ID

Synopsis:

```
#include <unistd.h>

int seteuid( uid_t uid );
```

Arguments:

uid The effective user ID that you want to use for the process.

Library:

libc

Description:

The *seteuid()* function lets the calling process set the effective user ID, based on the following:

- If the process is the superuser, the *seteuid()* function sets the effective user ID to *uid*.
- If the process isn't the superuser, and *uid* is equal to the real user ID or saved set-user ID, *seteuid()* sets the effective user ID to *uid*.

The real and saved user IDs aren't changed.

If a set-UID process sets its effective user ID to its real user ID, it can still set its effective user ID back to the saved set-UID.

The "superuser" is defined as any process with an effective user ID of **0**, or an effective user ID of **root**.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL	The value of *uid* is out of range.
EPERM	The process isn't the superuser, and *uid* doesn't match the real user ID or the saved set-user ID.

Examples:

```
/*
 * This process sets its effective userid to 0 (root).
 */

#include <stdio.h>
#include <sys/types.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
{
    uid_t oeuid;

    oeuid = geteuid();
    if( seteuid( 0 ) == -1 ) {
        perror( "seteuid" );
        return EXIT_FAILURE;
    }

    printf( "effective userid now 0, was %d\n",
        oeuid );

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

errno, *geteuid()*, *setegid()*, *setuid()*, *setgid()*

setgid()

Set the real, effective and saved group IDs

Synopsis:

```
#include <unistd.h>

int setgid( gid_t gid );
```

Arguments:

gid The group ID that you want to use for the process.

Library:

libc

Description:

The *setgid()* function lets the calling process set the real, effective and saved group IDs, based on the following:

- If the process is the superuser, the *setgid()* function sets the real group ID, effective group ID and saved group ID to *gid*.
- If the process isn't the superuser, but *gid* is equal to the real group ID, *setgid()* sets the effective group ID to *gid*; the real and saved group IDs aren't changed.

This function doesn't change any supplementary group IDs of the calling process.

If you wish to change only the effective group ID, and even if you are the superuser, you should consider using the *setegid()* function.

The "superuser" is defined as any process with an effective user ID of **0**, or an effective user ID of **root**.

Returns:

0 Success.

-1 An error occurred; *errno* is set to indicate the error.

Errors:

EINVAL	The value of *gid* is invalid.
EPERM	The process doesn't have appropriate privileges, and *gid* doesn't match the real group ID.

Examples:

```
#include <stdio.h>
#include <sys/types.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {
    gid_t ogid;

    ogid = getgid();
    if( setgid( 2 ) == -1 ) {
       perror( "setgid" );
       return EXIT_FAILURE;
    }
    printf( "group id is now 2, was %d\n", ogid );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, setegid(), seteuid(), setuid()

setgrent()

Rewind to the start of the group database file

Synopsis:

```
#include <grp.h>

int setgrent( void );
```

Library:

libc

Description:

The *setgrent()* function rewinds to the start of the group name database file. It's provided for programs that make multiple lookups in the group database (using the *getgrgid()* and *getgrnam()* calls) to avoid the default opening and closing of the group database for each access.

Returns:

0 Success.

-1 An error occurred.

Errors:

The *setgrent()* function uses *fopen()*. As a result, *errno* can be set to an error for the *fopen()* call.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	No

See also:

endgrent(), *getgrent()*

setgroups()

Set supplementary group IDs

Synopsis:

```
#include <unistd.h>

int setgroups( int ngroups,
               const gid_t *gidset );
```

Arguments:

ngroups	The number of entries in the *gidset* array.
gidset	An array of the supplementary group IDs that you want to assign to the current user. This number of entries in this array can't exceed NGROUPS_MAX.

Library:

libc

Description:

The *setgroups()* function sets the group access list of the current user to the array of group IDs in *gidset*.

Only **root** can set new groups.

Returns:

0, or -1 if an error occurred (*errno* is set).

Errors:

EFAULT	The *gidset* argument isn't a valid pointer.
EPERM	The caller isn't **root**.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

getgroups(), initgroups()

sethostent()

Open the host database file

Synopsis:

```
#include <netdb.h>

void sethostent( int stayopen );
```

Arguments:

stayopen Nonzero if you want all queries to the name server to use TCP and you want the connection to be retained after each call to *gethostbyname()* or *gethostbyaddr()*.

If the *stayopen* flag is zero, queries use UDP datagrams.

Library:

libsocket

Description:

The *sethostent()* routine opens the host database file.

You can use the *sethostent()* function to request the use of a connected TCP socket for queries.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if the data is needed for future use, it should be copied before any subsequent calls overwrite it.

See also:

endhostent(), *gethostbyaddr()*, *gethostbyname()*, *gethostent()*, *gethostent_r()*, **hostent**

/etc/hosts, **/etc/resolv.conf** in the *Utilities Reference*

sethostname()

Set the name of the current host

Synopsis:

```
#include <unistd.h>

int sethostname( const char * name,
                 size_t namelen );
```

Arguments:

name	The name that you want to use for the host machine. Hostnames are limited to MAXHOSTNAMELEN characters (defined in **<sys/param.h>**).
namelen	The length of the name.

Library:

libc

Description:

The *sethostname()* function sets the name of the host machine to be *name*. Only the superuser can call this function; this is normally done only at boot time.

This function sets the value of the **_CS_HOSTNAME** configuration string, not that of the **HOSTNAME** environment variable.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EFAULT	Either *name* or *namelen* gave an invalid address.
EPERM	Although the caller wasn't the superuser, it tried to set the hostname.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

This function is restricted to the superuser, and is normally used only at boot time.

See also:

gethostname()

SETIOV()

Fill in the fields of an **iov_t** *structure*

Synopsis:

```
#include <unistd.h>

void SETIOV( iov_t *msg,
             void *addr,
             size_t len );
```

Arguments:

msg A pointer to the **iov_t** structure structure that you want to set.

addr The value you want to use for the structure's *iov_base* member.

len The value you want to use for the structure's *iov_len* member.

Description:

The *SETIOV()* macro fills in the fields of an **iov_t** message structure. The **iov_t** structure consists of two fields:

```
typedef struct iovec {
    void    *iov_base;
    size_t   iov_len;
} iov_t;
```

SETIOV() doesn't make a copy of the data that *addr* points to; it just copies the pointer.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

GETIOVBASE(), GETIOVLEN(), MsgKeyData(), MsgReadv(), MsgReceivev(), MsgReplyv(), MsgSendv(), MsgWritev()

setitimer()

Set the value of an interval timer

Synopsis:

```
#include <sys/time.h>

int setitimer ( int which,
                const struct itimerval *value,
                struct itimerval *ovalue );
```

Arguments:

which The interval time whose value you want to set. Currently, this must be ITIMER_REAL.

value A pointer to a **itimerval** structure that specifies the value that you want to set the interval timer to.

ovalue NULL, or a pointer to a **itimerval** structure where the function can store the old value of the interval timer.

Library:

libc

Description:

The system provides each process with interval timers, defined in **<sys/time.h>**. The *setitimer()* function sets the value of the timer specified by *which* to the value specified in the structure pointed to by *value*, and if *ovalue* isn't NULL, stores the previous value of the timer in the structure it points to.

A timer value is defined by the **itimerval** structure (see *gettimeofday()* for the definition of **timeval**), which includes the following members:

```
struct timeval    it_interval;    /* timer interval */
struct timeval    it_value;       /* current value */
```

The *it_value* member indicates the time to the next timer expiration. The *it_interval* member specifies a value to be used in reloading

it_value when the timer expires. Setting *it_value* to 0 disables a timer, regardless of the value of *it_interval*. Setting *it_interval* to 0 disables a timer after its next expiration (assuming *it_value* is nonzero).

Time values smaller than the resolution of the system clock are rounded up to the resolution of the system clock.

The only supported timer is ITIMER_REAL, which decrements in real time. A SIGALRM signal is delivered when this timer expires.

The SIGALRM so generated isn't maskable on this bound thread by any signal-masking function, *pthread_sigmask()*, or *sigprocmask()*.

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Errors:

EINVAL The specified number of seconds is greater than 100,000,000, the number of microseconds is greater than or equal to 1,000,000, or the *which* argument is unrecognized.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

All flags to *setitimer()* other than ITIMER_REAL behave as documented only with "bound" threads. Their ability to mask the signal works only with bound threads. If the call is made using one of these flags from an unbound thread, the system call returns -1 and sets *errno* to EACCES.

These behaviors are the same for bound or unbound POSIX threads. A POSIX thread with system-wide scope, created by the call:

```
pthread_attr_setscope(&attr, PTHREAD_SCOPE_SYSTEM);
```

is equivalent to a Solaris bound thread. A POSIX thread with local process scope, created by the call:

```
pthread_attr_setscope(&attr, PTHREAD_SCOPE_PROCESS);
```

is equivalent to a Solaris unbound thread.

The microseconds field shouldn't be equal to or greater than one second.

The *setitimer()* function is independent of *alarm()*.

Don't use *setitimer*(ITIMER_REAL) with the *sleep()* routine. A *sleep()* call wipes out knowledge of the user signal handler for SIGALRM.

The granularity of the resolution of the alarm time is platform-dependent.

See also:

alarm(), getitimer(), gettimeofday(), pthread_attr_setscope(), pthread_sigmask(), sigprocmask(), sleep(), sysconf()

setjmp()

Save the calling environment for longjmp()

Synopsis:

```
#include <setjmp.h>

int setjmp( jmp_buf env );
```

Arguments:

env A buffer where the function can save the calling environment.

Library:

libc

Description:

The *setjmp()* function saves the calling environment in its *env* argument for use by the *longjmp()* function.

Error handling can be implemented by using *setjmp()* to record the point to return to following an error. When an error is detected in a function, that function uses *longjmp()* to jump back to the recorded position. The original function that called *setjmp()* must still be active (that is, it can't have returned to the function that called it).

Be careful to ensure that any resources (allocated memory, opened files, etc) are cleaned up properly.

WARNING: Do *not* use *longjmp()* or *siglongjmp()* to restore an environment saved by a call to *setjmp()* or *sigsetjmp()* in another thread. If you're lucky, your application will crash; if not, it'll look as if it works for a while, until random scribbling on the stack causes it to crash.

Returns:

Zero on the first call, or nonzero if the return is the result of a call to the *longjmp()* function.

Examples:

```
#include <stdio.h>
#include <setjmp.h>
#include <stdlib.h>

jmp_buf env;

void rtn( void )
{
    printf( "about to longjmp()\n" );
    longjmp( env, 14 );
}

int main( void )
{
    int ret_val;

    ret_val = setjmp( env );

    if( ret_val == 0 ) {
        printf( "after setjmp(): %d\n", ret_val );
        rtn();
        printf( "back from rtn(): %d\n", ret_val );
    } else {
        printf( "back from longjmp(): %d\n", ret_val );
    }

    return EXIT_SUCCESS;
}
```

produces the output:

```
after setjmp(): 0
about to longjmp()
back from longjmp(): 14
```

Classification:

ANSI, POSIX 1003.1

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

longjmp()

setkey()

Set the key used in encryption

Synopsis:

```
#include <stdlib.h>

void setkey( const char *__key );
```

Arguments:

__key A 64-character array of binary values (numeric 0 or 1).

Library:

libc

Description:

The *setkey()* function allows limited access to the NBS Data Encryption Standard (DES) algorithm itself. It derives a 56-bit key from the given *__key* by dividing the array into groups of 8 and ignoring the last bit in each group.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

crypt(), encrypt()

setlinebuf()

Assign line buffering to a stream

Synopsis:

```
#include <unix.h>

int setlinebuf( FILE *iop );
```

Arguments:

iop The stream that you want to use line buffering.

Library:

libc

Description:

The *setbuffer()* and *setlinebuf()* functions assign buffering to a stream. The types of buffering available are:

Unbuffered	Information appears on the destination file or terminal as soon as written.
Block-buffered	Many characters are saved and written as a block.
Line-buffered	Characters are saved until either a newline is encountered or input is read from *stdin*.

You can use *fflush()* to force the block out early. Normally all files are block-buffered. A buffer is obtained from *malloc()* when the first *getc()* or *putc()* is performed on the file. If the standard stream *stdout* refers to a terminal, it's line-buffered. The standard stream *stderr* is unbuffered by default.

You can use *setlinebuf()* to change the buffering on a stream from block-buffered or unbuffered to line-buffered. Unlike *setbuffer()*, you can call *setlinebuf()* at any time that the stream *iop* is active.

You can use *freopen()*. to change a stream from unbuffered or line-buffered to block buffered. To change a stream from block-buffered or line-buffered to unbuffered, call *freopen()*, and then call *setbuf()* with a buffer argument of NULL.

Returns:

No useful value.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fclose(), *fflush()*, *fopen()*, *fread()*, *freopen()*, *getc()*, *malloc()*, *printf()*, *putc()*, *puts()*, *setbuf()*, *setbuffer()*, *setvbuf()*

setlocale()

Select a program's locale

Synopsis:

```
#include <locale.h>

char * setlocale( int category,
                  const char * locale );
```

Arguments:

category The part of the environment that you want to set; one of:

- LC_ALL — select the entire locale environment.
- LC_COLLATE — select only the collating sequence.
- LC_CTYPE — select only the character-handling information.
- LC_MESSAGES — specify the language to be used for messages.
- LC_MONETARY — select only monetary formatting information.
- LC_NUMERIC — select only the numeric-format environment.
- LC_TIME — select only the time-related environment.

locale The locale that you want to use. The following built-in locales are offered:

- **C** (default)
- **C-TRADITIONAL**
- **POSIX**

Library:

libc

Description:

The *setlocale()* function selects a program's *locale*, according to the specified *category* and the specified *locale*.

A locale affects several things:

- The collating sequence (the order in which characters compare with one another) used by *strcoll()* or *wcscoll()*.
- The way certain character-handling functions (such as *isalnum()* and *isalpha()*) operate. The wide-character versions include *iswalnum()* and *iswalpha()*.
- The decimal-point character used in formatted input/output and string conversion (*printf()*, *scanf()*, and friends).
- The format and names used in the string produced by the *strftime()* and *wcsftime()* functions.

See the *localeconv()* function for more information about the locale.

At the start of a program, the default `C` locale is initialized as if the following call to *setlocale()* appeared at the start of *main()*:

```
(void)setlocale( LC_ALL, "C" );
```

Returns:

A pointer to a system-generated string indicating the previous locale, or NULL if an error occurs.

Classification:

ANSI

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

isalpha(), isascii(), localeconv(), printf(), scanf(), strcat(), strchr(), strcmp(), strcoll(), strcpy(), strftime(), strlen(), strpbrk(), strspn(), strtod(), strtok(), strxfrm() `tm`,

setlogmask()

Set the system log priority mask

Synopsis:

```
#include <syslog.h>

int setlogmask( int maskpri );
```

Arguments:

maskpri The new log priority mask; see below.

Library:

libc

Description:

The *setlogmask()* function sets the log priority mask to *maskpri* and returns the previous mask. Calls to *syslog()* or *vsyslog()* with a priority that isn't set in *maskpri* are rejected.

You can calculate the mask for an individual priority *pri* with the macro:

```
LOG_MASK(pri);
```

You can get the mask for all priorities up to and including *toppri* with the macro:

```
LOG_UPTO(toppri);
```

The default allows all priorities to be logged. See the *syslog()* function for a list of the priorities.

Returns:

The previous log mask level.

Examples:

See *syslog()*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

closelog(), *openlog()*, *syslog()*, *vsyslog()*,
logger, **syslogd** in the *Utilities Reference*

setnetent()

Open the network name database file

Synopsis:

```
#include <netdb.h>

void setnetent( int stayopen );
```

Arguments:

stayopen Nonzero if you don't want the network database to be closed after each call to *getnetbyname()* or *getnetbyaddr()*.

Library:

libsocket

Description:

The *setnetent()* function opens and rewinds the network name database file.

Files:

/etc/networks

Network name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if you need the data for future use, you should copy it before any subsequent calls overwrite it.

See also:

endnetent(), *getnetbyaddr()*, *getnetbyname()*, *getnetent()*, **`netent`**

`/etc/networks` in the *Utilities Reference*

setpgid()

Join or create a process group

Synopsis:

```
#include <process.h>

int setpgid( pid_t pid,
             pid_t pgid );
```

Arguments:

pid 0, or the ID of the process whose process group you want to set.

pgid 0, or the process group ID that you want to join or create.

Library:

libc

Description:

The *setpgid()* function is used either to join an existing process group or to create a new process group within the session of the calling process. The process group ID of a session leader doesn't change.

The following definitions are worth mentioning:

Process	An executing instance of a program, identified by a nonnegative integer called a process ID.
Process group	A collection of one or more processes, with a unique process group ID. A process group ID is a positive integer.

On successful completion, the process group ID of the process with a process ID matching *pid* is set to *pgid*. As a special case, you can specify either *pid* or *pgid* as zero, meaning that the process ID of the calling process is to be used.

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Errors:

EACCES The value of the *pid* argument matches the process ID of a child process of the calling process, and the child process has successfully executed one of the *exec*()* functions.

EINVAL The value of *pgid* is less than zero.

ENOSYS The *setpgid()* function isn't supported by this implementation (included for POSIX compatibility).

EPERM The calling process doesn't have sufficient privilege to set the process group id *pgid* on process *pid*.

ESRCH The process *pid* doesn't exist.

Examples:

```
/*
 * The process joins process group 0.
 */
#include <stdio.h>
#include <sys/types.h>
#include <unistd.h>
#include <stdlib.h>
#include <process.h>

int main( void )
  {
    if( setpgid( getpid(), 0 ) == -1 ) {
        perror( "setpgid" );
    }
    printf( "%d belongs to process group %d\n",
         getpid(), getpgrp() );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, getpgid(), getsid(), setsid()

setpgrp()

Set the process group

Synopsis:

```
#include <unistd.h>

pid_t setpgrp( void );
```

Library:

libc

Description:

If the calling process isn't already a session leader, *setpgrp()* makes it one by setting its process group ID and session ID to the value of its process ID, and releases its controlling terminal.

Returns:

The new process group ID.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *fork()*, *getpid()*, *getpgrp()*, *getsid()*, *kill()*, *signal()*

setprio()

Set the priority of a process

Synopsis:

```
#include <sched.h>

int setprio( pid_t pid,
             int prio );
```

Arguments:

pid The process ID of the process whose priority you want to set.

prio The new priority.

Library:

libc

Description:

The *setprio()* function changes the priority of thread 1 of process *pid* to priority *prio*. If *pid* is zero, the priority of the calling thread is set.

Returns:

The previous priority, or -1 if an error occurred (*errno* is set).

Errors:

EINVAL The priority *prio* isn't a valid priority.

EPERM The calling process doesn't have sufficient privilege to set the priority.

ESRCH The process *pid* doesn't exist.

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *getprio()* and *setprio()* functions are included in the QNX Neutrino libraries for porting QNX 4 applications. For new programs, use *sched_setparam()* or *pthread_setschedparam()*.

See also:

errno, *getprio()*, *pthread_getschedparam()*, *pthread_setschedparam()*, *sched_getparam()*, *sched_get_priority_max()*, *sched_get_priority_min()*, *sched_getscheduler()*, *sched_setscheduler()*, *sched_yield()*

setprotoent()

Open the protocol name database file

Synopsis:

```
#include <netdb.h>

void setprotoent( int stayopen );
```

Arguments:

stayopen	Nonzero if you don't want the database to be closed after each call to *getprotobyname()* or *getprotobynumber()*.

Library:

libsocket

Description:

The *setprotoent()* function opens and rewinds the protocol name database file. If the *stayopen* flag is nonzero, the protocol name database isn't closed after each call to *getprotobyname()* or *getprotobynumber()*.

Files:

/etc/protocols

Protocol name database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No

continued...

Safety	
Thread	No

Caveats:

This function uses static data; if you need the data for future use, you should copy it before any subsequent calls overwrite it.

Currently, only the Internet protocols are understood.

See also:

endprotoent(), *getprotobyname()*, *getprotobynumber()*, *getprotoent()*, **`protoent`**

`/etc/protocols` in the *Utilities Reference*

setpwent()

Rewind the password database file

Synopsis:

```
#include <sys/types.h>
#include <pwd.h>

int setpwent( void );
```

Library:

libc

Description:

The *setpwent()* function rewinds to the start of the password name database file. It's provided for programs that make multiple lookups in the password database (using the *getpwuid()* and *getpwnam()* calls) to avoid opening and closing the password database for each access.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

endpwent(), *getpwent()*

setregid()

Set real and effective group IDs

Synopsis:

```
#include <unistd.h>

int setregid( gid_t rgid,
              gid_t egid );
```

Arguments:

rgid The real group ID that you want to use for the process, or -1 if you don't want to change it.

egid The effective group ID that you want to use for the process, or -1 if you don't want to change it.

Library:

libc

Description:

The *setregid()* function sets the real and effective group IDs of the calling process. If *rgid* or *egid* is **-1**, the corresponding real or effective group ID is left unchanged.

If the effective user ID of the calling process is the superuser, you can set the real group ID and the effective group ID to any legal value.

If the effective user ID of the calling process isn't the superuser, you can set either the real group ID to the saved set-group ID, or the effective group ID to either the saved set-group ID or the real group ID.

If a set-group ID process sets its effective group ID to its real group ID, it can still set its effective group ID back to the saved set-group ID.

The "superuser" is defined as any process with an effective user ID of **0**, or an effective user ID of **root**.

In either case, if you're changing the real group ID (i.e. *rgid* isn't `-1`), or you're changing the effective group ID to a value that isn't equal to the real group ID, the saved set-group ID is set to the new effective group ID.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL The *rgid* or *egid* is out of range.

EPERM The calling process isn't the superuser, and you tried to change the effective group ID to a value other than the real or saved set-group ID.

Or:

The calling process isn't the superuser, and you tried to change the real group ID to a value other than the effective group ID.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

execve(), getgid(), setreuid(), setuid()

setreuid()

Set real and effect user IDs

Synopsis:

```
#include <unistd.h>

int setreuid( uit_t ruid,
              uid_t euid );
```

Arguments:

ruid The real user ID that you want to use for the process, or -1 if you don't want to change it.

euid The effective user ID that you want to use for the process, or -1 if you don't want to change it.

Library:

libc

Description:

The *setreuid()* function sets the real and effective user IDs of the calling process. If *ruid* or *euid* is **-1**, the corresponding real or effective user ID isn't changed.

If the effective user ID of the calling process is the superuser, you can set the real user ID and the effective user ID to any legal value.

If the effective user ID of the calling process isn't the superuser, you can set either the real user ID to the effective user ID, or the effective user ID to the saved set-user ID or the real user ID.

☞ If a set-UID process sets its effective user ID to its real user ID, it can still set its effective user ID back to the saved set-UID.

In either case, if you're changing the real user ID (i.e. *ruid* is not **-1**), or you're changing the effective user ID to a value that isn't equal to the real user ID, the saved set-user ID is set equal to the new effective user ID.

The "superuser" is defined as any process with an effective user ID of `0`, or an effective user ID of `root`.

Returns:

Zero on success, or -1 if an error occurs (*errno* is set).

Errors:

EINVAL — The *ruid* or *euid* is out of range.

EPERM — The calling process isn't the superuser, and you tried to change the effective user ID to a value other than the real or saved set-user ID.

Or

The calling process isn't the superuser, and you tried to change the real user ID to a value other than the effective user ID.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

execve(), *getuid()*, *setregid()*, *setuid()*

setrlimit(), setrlimit64()

Set the limit on a system resource

Synopsis:

```
#include <sys/resource.h>

int setrlimit( int resource,
               const struct rlimit * rlp );

int setrlimit64( int resource,
                 const struct rlimit64 * rlp );
```

Arguments:

resource The resource whose limit you want to get. For a list of the possible resources, their descriptions, and the actions taken when the current limit is exceeded, see below.

rlp A pointer to a **rlimit** or **rlimit64** structure that specifies the limit that you want to set for the resource. The **rlimit** and **rlimit64** structures include at least the following members:

```
rlim_t rlim_cur; /* current (soft) limit */
rlim_t rlim_max; /* hard limit */
```

The **rlim_t** type is an arithmetic data type to which you can cast objects of type **int**, **size_t**, and **off_t** without loss of information.

Library:

libc

Description:

The *setrlimit()* function sets the limits on the consumption of a variety of system resources by a process and each process it creates. The *setrlimit64()* function is a 64-bit version of *setrlimit()*.

Each call to *setrlimit()* identifies a specific resource to be operated upon as well as a resource limit. A resource limit is a pair of values:

one specifying the current (soft) limit, the other a maximum (hard) limit.

A process can change soft limits to any value that's less than or equal to the hard limit. A process may (irreversibly) lower its hard limit to any value that's greater than or equal to the soft limit. Only a process with an effective user ID of superuser can raise a hard limit. Both hard and soft limits can be changed in a single call to *setrlimit()*, subject to the constraints described above. Limits may have an "infinite" value of RLIM_INFINITY.

RLIM_INFINITY is a special value, and it's actual numerical value doesn't represent a valid VM/AS size in bytes.

The possible resources, their descriptions, and the actions taken when the current limit is exceeded are summarized below:

Resource	Description	Action
RLIMIT_CORE	The maximum size, in bytes, of a core file that may be created by a process. A limit of 0 prevents the creation of a core file.	The writing of a core file terminates at this size.
RLIMIT_CPU	The maximum amount of CPU time, in seconds, used by a process. This is a soft limit only.	SIGXCPU is sent to the process. If the process is holding or ignoring SIGXCPU, the behavior is defined by the scheduling class.
RLIMIT_DATA	The maximum size of a process's heap in bytes	The *brk()* function fails with *errno* set to ENOMEM.

continued...

Resource	Description	Action
RLIMIT_FSIZE	The maximum size of a file in bytes that may be created by a process. A limit of 0 prevents the creation of a file.	The SIGXFSZ signal is sent to the process. If the process is holding or ignoring SIGXFSZ, continued attempts to increase the size of a file beyond the limit fail with *errno* set to EFBIG.
RLIMIT_NOFILE	One more than the maximum value that the system may assign to a newly created descriptor. This limit constrains the number of file descriptors that a process may create.	

continued...

Resource	Description	Action
RLIMIT_STACK	The maximum size of a process's stack in bytes. The system will not automatically grow the stack beyond this limit. Within a process, *setrlimit()* increases the limit on the size of your stack, but doesn't move current memory segments to allow for that growth. To guarantee that the process stack can grow to the limit, the limit must be altered prior to the execution of the process in which the new stack size is to be used. Within a multithreaded process, *setrlimit()* has no impact on the stack size limit for the calling thread if the calling thread isn't the main thread. A call to *setrlimit()* for RLIMIT_STACK impacts only the main thread's stack, and should be made only from the main thread, if at all.	The SIGSEGV signal is sent to the process. If the process is holding or ignoring SIGSEGV, or is catching SIGSEGV and hasn't made arrangements to use an alternate stack, the disposition of SIGSEGV is set to SIG_DFL before it's sent.
RLIMIT_VMEM	The maximum size of a process's mapped address space in bytes.	If the limit is exceeded, the *brk()*, *mmap()* and *sbrk()* functions fail with *errno* set to ENOMEM. In addition, the automatic stack growth fails with the effects outlined above.

continued...

Resource	Description	Action
RLIMIT_AS	Same as RLIMIT_VMEM.	Same as RLIMIT_VMEM.

Because limit information is stored in the per-process information, the shell builtin **`ulimit`** command must directly execute this system call if it's to affect all future processes created by the shell.

The values of the current limit of the following resources affect these parameters:

Resource	Parameter
RLIMIT_FSIZE	FCHR_MAX
RLIMIT_NOFILE	OPEN_MAX

When using the *setrlimit()* function, if the requested new limit is RLIM_INFINITY, there's no new limit; otherwise, if the requested new limit is RLIM_SAVED_MAX, the new limit is the corresponding saved hard limit; otherwise, if the requested new limit is RLIM_SAVED_CUR, the new limit is the corresponding saved soft limit; otherwise, the new limit is the requested value. In addition, if the corresponding saved limit can be represented correctly in an object of type **`rlim_t`**, then it's overwritten with the new limit.

The result of setting a limit to RLIM_SAVED_MAX or RLIM_SAVED_CUR is unspecified unless a previous call to *getrlimit()* returned that value as the soft or hard limit for the corresponding resource limit.

A limit whose value is greater than RLIM_INFINITY is permitted.

The *exec** family of functions also cause resource limits to be saved.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EFAULT	The *rlp* argument points to an illegal address.
EINVAL	An invalid resource was specified, the new *rlim_cur* exceeds the new *rlim_max*, or the limit specified can't be lowered because current usage is already higher than the limit.
EPERM	The limit specified to *setrlimit()* would've raised the maximum limit value, and the effective user of the calling process isn't the superuser.

Classification:

setrlimit() is standard Unix; *setrlimit64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

brk(), *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *fork()*, *getdtablesize()*, *getrlimit()*, *getrlimit64()*, *malloc()*, *open()*, *signal()*, *sysconf()*

setservent()

Open the network services database file

Synopsis:

```
#include <netdb.h>

void setservent( int stayopen );
```

Arguments:

stayopen Nonzero if you don't want the database to be closed after each call to *getservbyname()* or *getservbyport()*.

Library:

libsocket

Description:

The *setservent()* function opens and rewinds the network services database file. If the *stayopen* flag is nonzero, the network services database won't be closed after each call to *getservbyname()* or *getservbyport()*.

Files:

/etc/services

Network services database file.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

This function uses static data; if you need the data for future use, you should copy it before any subsequent calls overwrite it.

See also:

endservent(), *getservbyname()*, *getservbyport()*, *getservent()*, **servent**

/etc/services in the *Utilities Reference*.

setsid()

Create a new session

Synopsis:

```
#include <unistd.h>

pid_t setsid( void );
```

Library:

libc

Description:

The *setsid()* function creates a new session with the calling process becoming the process group leader with no controlling terminal. The process group ID of the calling process is set to the process ID of the calling process. The calling process is the only process in the new process group, and is also the only process in the new session.

If the calling process is already a process group leader, a new session isn't created and an error is returned.

Returns:

The new process group ID for the calling process, or -1 if an error occurred (*errno* is set).

Errors:

EPERM — The calling process is already a process group leader, or the process group ID of a process other than the calling process matches the process ID of the calling process.

Examples:

```
/*
 * You can only become a session leader if you are not
 * a process group leader that is the default for a
 * command run from the shell.
 */

#include <stdio.h>
#include <sys/types.h>
```

```
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {

    if( fork() )
      {
      if( setsid() == -1 )
        perror( "parent: setsid" );
      else
        printf( "parent: I am a session leader\n" );
      }
    else
      {
      if( setsid() == -1 )
        perror( "child: setsid" );
      else
        printf( "child: I am a session leader\n" );
      }
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *getsid()*, *setpgid()*

setsockopt()

Set options associated with a socket

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

int setsockopt( int s,
                int level,
                int optname,
                const void * optval,
                socklen_t optlen );
```

Arguments:

s	The file descriptor of the socket that the option is to be applied on, as returned by *socket()*.
level	The protocol layer that the option is to be applied to. In most cases, it's a socket-level option and is indicated by SOL_SOCKET.
optname	The option for the socket file descriptor.
optval	A pointer to the value of the option (in most cases, whether the option is to be turned on or off). If no option value is to be returned, *optval* may be NULL. Most socket-level options use an **int** parameter for *optval*. Others, such as the SO_LINGER, SO_SNDTIMEO, and SO_RCVTIMEO options, use structures that also let you get data associated with the option.
optlen	A pointer to the length of the value of the option. This argument is a value-result parameter; you should initialize it to indicate the size of the buffer pointed to by *optval*.

Library:

libsocket

Description:

The *setsockopt()* function sets the options associated with a socket.

See *getsockopt()* for more detailed information.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid file descriptor *s*.

EDOM Value was set out of range.

EFAULT The address pointed to by *optval* isn't in a valid part of the process address space.

EINVAL No *optval* value was specified.

ENOPROTOOPT
The option is unknown at the level indicated.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ICMP, IP, TCP, and UDP protocols

getsockopt(), socket()

setspent()

Rewind the shadow password database file

Synopsis:

```
#include <sys/types.h>
#include <shadow.h>

void setspent( void );
```

Library:

libc

Description:

The *setspent()* function rewinds to the start of the shadow password database file. It's provided for programs that make multiple lookups in the database (using the *getspnam()* call) to avoid opening and closing the shadow password database for each access.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

fgetspent() endspent(), getspnam(), getspent() putspent()

setstate()

Reset the state of a pseudo-random number generator

Synopsis:

```
#include <stdlib.h>

char *setstate( const char *state );
```

Arguments:

state A pointer to the state array that you want to use.

Library:

libc

Description:

Once the state of the pseudo-random number generator has been initialized, *setstate()* allows switching between state arrays. The array defined by the *state* argument is used for further random-number generation until *initstate()* is called or *setstate()* is called again. The *setstate()* function returns a pointer to the previous state array.

This function is used in conjunction with the following:

initstate()	Initialize the state of the pseudo-random number generator.
random()	Generate a pseudo-random number using a default state.
srandom()	Set the seed used by the pseudo-random number generator.

After initialization, you can restart a state array at a different point in one of two ways:

- Call *initstate()* with the desired seed, state array, and size of the array.

- Call *setstate()* with the desired state, then call *srandom()* with the desired seed. The advantage of using both of these functions is that the size of the state array doesn't have to be saved once it's initialized.

Returns:

A pointer to the previous state array, or NULL if an error occurred.

Examples:

See *initstate()*.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

drand48(), *initstate()*, *rand()*, *random()*, *srand()*, *srandom()*

settimeofday()

Set the time and date

Synopsis:

```
#include <sys/time.h>

int settimeofday( const struct timeval *when,
                  void *not_used );
```

Arguments:

when A pointer to a **timeval** structure that specifies the the time that you want to set. The **struct timeval** contains the following members:

- **long** *tv_sec* — the number of seconds since the start of the Unix Epoch.
- **long** *tv_usec* — the number of microseconds.

not_used This pointer must be NULL or the behavior of *settimeofday()* is unspecified. This argument is provided only for backwards compatibility.

Library:

libc

Description:

This function sets the time and date to the values stored in the structure pointed to by *when*.

Returns:

0, or -1 if an error occurred (*errno* is set).

Errors:

EFAULT An error occurred while accessing the *when* buffer.

EPERM The calling process doesn't have superuser permissions.

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *settimeofday()* function is provided for compatibility with existing Unix code. You shouldn't use it in new code — use *clock_settime()* instead.

See also:

asctime(), *asctime_r()*, *clock_gettime()*, *clock_settime()*, *ctime()*, *ctime_r()*, *difftime()*, *gettimeofday()*, *gmtime()*, *gmtime_r()*, *localtime()*, *localtime_r()*, *time()*

setuid()

Set the real, effective and saved user IDs

Synopsis:

```
#include <unistd.h>

int setuid( uid_t uid );
```

Arguments:

uid The user ID that you want to use for the process.

Library:

libc

Description:

The *setuid()* function lets the calling process set the real, effective and saved user IDs based on the following:

- If the process is the superuser, *setuid()* sets the real user ID, effective user ID and saved user ID to *uid*.
- If the process isn't the superuser, but *uid* is equal to the real user ID or saved set-user ID, *setuid()* sets the effective user ID to *uid*; the real and saved user IDs aren't changed.

If a set-UID process sets its effective user ID to its real user ID, it can still set its effective user ID back to the saved set-UID.

If you wish to change only the effective user ID, and even if you are the superuser, you should consider using the *seteuid()* function.

The "superuser" is defined as any process with an effective user ID of **0**, or an effective user ID of **root**.

Returns:

0 for success, or -1 if an error occurs (*errno* is set).

Errors:

EINVAL	The value of *uid* is out of range.
EPERM	The process isn't the superuser, and *uid* doesn't match the real user ID or saved set-user ID.

Examples:

```
/*
 * This process sets its userid to 0 (root)
 */
#include <stdio.h>
#include <sys/types.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
{
    uid_t ouid;

    ouid = getuid();
    if( setuid( 0 ) == -1 ) {
        perror( "setuid" );
        return EXIT_FAILURE;
    }

    printf( "userid %d switched to 0\n", ouid );
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, getuid(), setegid(), seteuid(), setgid()

setutent()

Return to the beginning of the user-information file

Synopsis:

```
#include <utmp.h>

void setutent( void );
```

Library:

libc

Description:

The *setutent()* function resets the input stream to the beginning of the file specified in *_PATH_UTMP*. Do this before each search for a new entry if you want the entire file to be examined.

Files:

_PATH_UTMP

Specifies the user information file.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

endutent(), *getutent()*, *getutid()*, *getutline()*, *pututline()*, **utmp**, *utmpname()*

login in the *Utilities Reference*

setvbuf()

Associate a buffer with a stream

Synopsis:

```
#include <stdio.h>

int setvbuf( FILE *fp,
             char *buf,
             int mode,
             size_t size );
```

Arguments:

fp The stream that you want to associate with a buffer.

buffer NULL, or a pointer to the buffer; see below.

mode How you want the stream to be buffered:

- _IOFBF — input and output are fully buffered.
- _IOLBF — output is line buffered (i.e. the buffer is flushed when a newline character is written, when the buffer is full, or when input is requested).
- _IONBF — input and output are completely unbuffered.

size The size of the buffer.

Library:

libc

Description:

The *setvbuf()* function associates a buffer with the stream designated by *fp*. If you want to call *setvbuf()*, you must call it after opening the stream, but before doing any reading, writing, or seeking.

If *buf* isn't NULL, the buffer it points to is used instead of an automatically allocated buffer.

Returns:

0	Success.
EINVAL	The *mode* argument isn't valid.
ENOMEM	The *buf* argument is NULL, *size* isn't 0, and there isn't enough memory available to allocate a buffer.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char *buf;
    FILE *fp;

    fp = fopen( "file", "r" );
    buf = malloc( 1024 );
    setvbuf( fp, buf, _IOFBF, 1024 );

    /* work with fp */
    ...

    fclose( fp );

    /* This is OUR buffer, so we have
     * to free it.  Do that AFTER
     * you've closed the file.
     */

    free( buf );
    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fopen(), setbuf()

Deallocate a block of memory

Synopsis:

```
#include <malloc.h>

void _sfree( void *ptr,
             size_t size );
```

Arguments:

ptr NULL, or a pointer to the block of memory that you want to free.

size The number of bytes to deallocate.

Library:

libc

Description:

When the value of the argument *ptr* is NULL, the *_sfree()* function does nothing; otherwise, the *_sfree()* function deallocates *size* bytes of memory located by the argument *ptr*, which was previously returned by a call to the appropriate version of *_scalloc()* or *_smalloc()*. After the call, the freed block is available for allocation.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Calling *_sfree()* on a pointer already deallocated by a call to *_sfree()* could corrupt the memory allocator's data structures.

The *size must* match the size of the allocated block.

See also:

calloc(), free(), realloc(), _scalloc(), _smalloc(), _srealloc()

Synopsis:

```
#include <sys/mman.h>

int shm_ctl( int fd,
             int flags,
             _uint64 paddr,
             _uint64 size );
```

Arguments:

fd The file descriptor that's associated with the shared memory object, as returned by *shm_open()*.

flags One or more of the following bits, defined in **<sys/mman.h>**:

- SHMCTL_ANON — grow the object to be *size* bytes.
- SHMCTL_PHYS — assign the physical address, *paddr*, to the object.
- SHMCTL_GLOBAL — a hint that any mapping to the object could be global across all processes.
- SHMCTL_PRIV — a hint that a mapping of this object may require privileged access.
- SHMCTL_LOWERPROT — a hint that the system may map this object in such a way that it trades lower memory protection for better performance.

paddr A physical address to assign to the object, if you set SHMCTL_PHYS in *flags*.

size The new size of the object, in bytes, if you set SHMCTL_ANON in *flags*.

Library:

libc

Description:

The *shm_ctl()* function modifies the attributes of the shared memory object identified by the handle, *fd*. This handle is the value returned by *shm_open()*.

The combination SHMCTL_ANON | SHMCTL_PHYS has the same behavior as for *mmap()*: it indicates that you want physically contiguous RAM to be allocated for the object.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL An invalid combination of flags was specified, or the shared memory object is already “special.”

Examples:

The following examples go together. Run **sharephyscreator**, followed by **sharephysuser**.

The **sharephyscreator** process maps in an area of physical memory and then overlays it with a shared memory object. The **sharephysuser** process opens that shared memory object in order to access the physical memory.

```
/*
 *  sharephyscreator.c
 *
 *  This maps in an area of physical memory and then
 *  overlays it with a shared memory object.  This way, another process
 *  can open that shared memory object in order to access the physical
 *  memory.  The other process in this case is sharephysuser.
```

```
 *
 *  Note that the size and address that you pass to shm_ctl() must be
 *  even multiples of the page size (sysconf(_SC_PAGE_SIZE)).
 *
 *  For VGA color text mode video memory:
 *    sharephyscreator /wally b8000
 *  Note that for VGA color text mode video memory, each character
 *  is followed by an attribute byte.  Here we just use a space.
*/

#include <errno.h>
#include <fcntl.h>
#include <inttypes.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
#include <sys/mman.h>
#include <sys/neutrino.h>
#include <sys/stat.h>

char        *progname = "sharephyscreator";

main( int argc, char *argv[] )
{
    char        *text = "H e l l o   w o r l d ! ";
    int         fd, memsize;
    char        *ptr, *name;
    uint64_t    physaddr;

    if ( argc != 3 ) {
        printf( "use: sharephyscreator shared_memory_object_name physical_address_in_hex\n" );
        printf( "Example: sharephyscreator wally b8000\n" );
        exit( EXIT_FAILURE );
    }
    name = argv[1];
    physaddr = atoh(argv[2]);
    memsize = sysconf( _SC_PAGE_SIZE ); /* this should be enough
                                           for our string */

    /* map in the physical memory */

    ptr = mmap_device_memory( 0, memsize, PROT_READ|PROT_WRITE, 0, physaddr );
    if ( ptr == MAP_FAILED ) {
        printf( "%s: mmap_device_memory for physical address %llx failed: %s\n",
            progname, physaddr, strerror(errno) );
        exit( EXIT_FAILURE );
    }

    /* open the shared memory object, create it if it doesn't exist */

    fd = shm_open( name, O_RDWR | O_CREAT, 0 );
    if ( fd == -1 ) {
        printf( "%s: error creating the shared memory object '%s': %s\n",
                progname, name, strerror(errno) );
        exit( EXIT_FAILURE );
    }

    /* overlay the shared memory object onto the physical memory */
```

```
    if ( shm_ctl( fd, SHMCTL_PHYS, physaddr, memsize ) == -1 ) {
        printf( "%s: shm_ctl failed: %s\n", progname, strerror(errno) );
        close( fd );
        munmap( ptr, memsize );
        shm_unlink( name );
        exit( EXIT_FAILURE );
    }
    strcpy( ptr, text ); /* write to the shared memory */

    printf( "\n%s: Physical memory mapped in, shared memory overlayed onto it.\n"
            "%s: Wrote '%s' to physical memory.\n"
            "%s: Sleeping for 20 seconds.  While this program is sleeping\n"
            "%s: run 'sharephysuser %s %d'.\n",
            progname, progname, ptr, progname, progname, name,
            strlen(text)+1 );
    sleep( 20 );

    printf( "%s: Woke up.  Cleaning up and exiting ...\n", progname );

    close( fd );
    munmap( ptr, memsize );
    shm_unlink( name );
}
```

The following is meant to be run with **sharephyscreator**.

```
/*
 *  sharephysuser.c
 *
 *  This one is meant to be run in tandem with sharephyscreator.
 *
 *  Run it as: sharephysuser shared_memory_object_name length
 *  Example: sharephysuser wally 49
 *
*/

#include <errno.h>
#include <fcntl.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
#include <sys/mman.h>
#include <sys/neutrino.h>
#include <sys/stat.h>

char        *progname = "sharephysuser";

main( int argc, char *argv[] )
{
    int     fd, len, i;
    char    *ptr, *name;
```

```
    if ( argc != 3 ) {
        fprintf( stderr, "use: sharephysuser shared_memory_object_name length\n" );
        fprintf( stderr, "Example: sharephysuser wally 49\n" );
        exit( EXIT_FAILURE );
    }
    name = argv[1];
    len = atoi( argv[2] );

    /* open the shared memory object */

    fd = shm_open( name, O_RDWR, 0 );
    if ( fd == -1 ) {
        fprintf( stderr, "%s: error opening the shared memory object '%s': %s\n",
                progname, name, strerror(errno) );
        exit( EXIT_FAILURE );
    }

    /* get a pointer to a piece of the shared memory, note that we
       only map in the amount we need to */

    ptr = mmap( 0, len, PROT_READ | PROT_WRITE, MAP_SHARED, fd, 0 );
    if ( ptr == MAP_FAILED ) {
        fprintf( stderr, "%s: mmap failed: %s\n", progname, strerror(errno) );
        exit( EXIT_FAILURE );
    }

    printf( "%s: reading the text: ", progname );
    for ( i = 0; i < len; i++ )
        printf( "%c", ptr[i] );
    printf( "\n" );

    close( fd );
    munmap( ptr, len );
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

mmap(), *munmap()*, *mprotect()*, *shm_open()*, *shm_unlink()*

shm_open()

Open a shared memory object

Synopsis:

```
#include <fcntl.h>
#include <sys/mman.h>

int shm_open( const char * name,
              int oflag,
              mode_t mode );
```

Arguments:

name The name of the shared memory object that you want to open; see below.

oflag A combination of the following bits (defined in **<fcntl.h>**):

- O_RDONLY — open for read access only.
- O_RDWR — open for read and write access.
- O_CREAT — if the shared memory object exists, this flag has no effect, except as noted under O_EXCL below. Otherwise, the shared memory object is created, and its permissions are set in accordance with the value of *mode* and the file mode creation mask of the process.
- O_EXCL — if O_EXCL and O_CREAT are set, then *shm_open()* fails if the shared memory segment exists. The check for the existence of the shared memory object, and the creation of the object if it doesn't exist, are atomic with respect to other processes executing *shm_open()*, naming the same shared memory object with O_EXCL and O_CREAT set.
- O_TRUNC — if the shared memory object exists, and it's successfully opened O_RDWR, the object is truncated to zero length and the mode and owner are unchanged.

mode The permission bits for the memory object are set to the value of *mode*, except those bits set in the process's file creation mask. For more information, see *umask()*, and "Access permissions" in the documentation for *stat()*.

Library:

libc

Description:

The *shm_open()* function returns a file descriptor that's associated with the shared "memory object" specified by *name*. This file descriptor is used by other functions to refer to the shared memory object (for example, *mmap()*, *mprotect()*). The FD_CLOEXEC file descriptor flag in *fcntl()* is set for this file descriptor.

The *name* argument is interpreted as follows:

name	Pathname space entry
entry	*CWD*/*entry*
/*entry*	**/dev/shmem/***entry*
entry/*newentry*	*CWD*/*entry*/*newentry*
/*entry*/*newentry*	/*entry*/*newentry*

where *CWD* is the current working directory for the program at the point that it calls *mq_open()*.

If you want to open a shared memory object on another node, you have to specify the name as **/net/***node*/*shmem_location*.

The state of the shared memory object, including all data associated with it, persists until the shared memory object is unlinked and all other references are gone.

Returns:

A nonnegative integer, which is the lowest numbered unused file descriptor, or -1 if an error occurred (*errno* is set).

Errors:

EACCES — Permission to create the shared memory object is denied.

The shared memory object exists and the permissions specified by *oflag* are denied, or O_TRUNC is specified and write permission is denied.

EEXIST — O_CREAT and O_EXCL are set, and the named shared memory object already exists.

EINTR — The *shm_open()* call was interrupted by a signal.

ELOOP — Too many levels of symbolic links or prefixes.

EMFILE — Too many file descriptors are currently in use by this process.

ENAMETOOLONG

The length of the *name* argument exceeds NAME_MAX.

ENFILE — Too many shared memory objects are currently open in the system.

ENOENT — O_CREAT isn't set, and the named shared memory object doesn't exist, or O_CREAT is set and either the name prefix doesn't exist or the *name* argument points to an empty string.

ENOSPC — There isn't enough space to create the new shared memory object.

ENOSYS — The *shm_open()* function isn't supported by this implementation.

Examples:

This example sets up a shared memory object, but doesn't really do anything with it:

```
#include <stdio.h>
#include <string.h>
#include <fcntl.h>
#include <errno.h>
#include <stdlib.h>
#include <unistd.h>
#include <limits.h>
#include <sys/mman.h>

int main( int argc, char** argv )
{
    int fd;
    unsigned* addr;

    /*
     * In case the unlink code isn't executed at the end
     */
    if( argc != 1 ) {
        shm_unlink( "/bolts" );
        return EXIT_SUCCESS;
    }

    /* Create a new memory object */
    fd = shm_open( "/bolts", O_RDWR | O_CREAT, 0777 );
    if( fd == -1 ) {
        fprintf( stderr, "Open failed:%s\n",
            strerror( errno ) );
        return EXIT_FAILURE;
    }

    /* Set the memory object's size */
    if( ftruncate( fd, sizeof( *addr ) ) == -1 ) {
        fprintf( stderr, "ftruncate: %s\n",
            strerror( errno ) );
        return EXIT_FAILURE;
    }

    /* Map the memory object */
    addr = mmap( 0, sizeof( *addr ),
            PROT_READ | PROT_WRITE,
            MAP_SHARED, fd, 0 );
    if( addr == MAP_FAILED ) {
        fprintf( stderr, "mmap failed: %s\n",
            strerror( errno ) );
        return EXIT_FAILURE;
    }

    printf( "Map addr is 0x%08x\n", addr );

    /* Write to shared memory */
```

```
    *addr = 1;

    /*
     * The memory object remains in
     * the system after the close
     */
    close( fd );

    /*
     * To remove a memory object
     * you must unlink it like a file.
     *
     * This may be done by another process.
     */
    shm_unlink( "/bolts" );

    return EXIT_SUCCESS;
}
```

This example uses a shared memory object to share data with a forked process:

```
#include <stdio.h>
#include <string.h>
#include <fcntl.h>
#include <errno.h>
#include <stdlib.h>
#include <unistd.h>
#include <sys/mman.h>

main(int argc, char * argv[])
{
int        fd;
unsigned  *addr;

  /*
   * In case the unlink code isn't executed at the end
   */
  if (argc != 1) {
     shm_unlink("/bolts");
     return EXIT_SUCCESS;
  }

  /* Create a new memory object */
  fd = shm_open("/bolts", O_RDWR | O_CREAT, 0777);
  if (fd == -1) {
     fprintf(stderr, "Open failed : %s\n",
       strerror(errno));
     return EXIT_FAILURE;
```

```
    }

    /* Set the memory object's size */
    if (ftruncate(fd, sizeof(*addr)) == -1) {
       fprintf(stderr, "ftruncate : %s\n", strerror(errno));
       return EXIT_FAILURE;
    }

    /* Map the memory object */
    addr = mmap(0, sizeof(*addr), PROT_READ | PROT_WRITE,
                MAP_SHARED, fd, 0);
    if (addr == MAP_FAILED) {
       fprintf(stderr, "mmap failed:%s\n", strerror(errno));
       return EXIT_FAILURE;
    }

    printf("Map addr is %6.6X\n", addr);
    printf("Press break to stop.\n");
    sleep(3);    /* So you can read above message */

    /*
     * We unlink so object goes away on last close.
     */
    shm_unlink("/bolts");

    *addr = '0';
    if (fork())
       for (;;)
         if (*addr == '0')
           putc(*addr = '1', stderr);
         else
           sched_yield();
    else
      for (;;)
         if (*addr == '1')
           putc(*addr = '0', stderr);
         else
           sched_yield();
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

fcntl(), ftruncate(), mmap(), munmap(), mprotect(), open(), shm_ctl(), shm_unlink(), sysconf()

shm_unlink()

Remove a shared memory object

Synopsis:

```
#include <sys/mman.h>

int shm_unlink( const char * name );
```

Arguments:

name The name of the shared memory object that you want to remove.

Library:

libc

Description:

The *shm_unlink()* function removes the name of the shared memory object specified by *name*. After removing the name, you can't use *shm_open()* to access the object.

This function doesn't affect any references to the shared memory object (i.e. file descriptors or memory mappings). If more than one reference to the shared memory object exists, then the link count is decremented, but the shared memory segment isn't actually removed until you remove all open and map references to it.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES Permission to unlink the shared memory object is denied.

ELOOP Too many levels of symbolic links or prefixes.

ENAMETOOLONG
The length of the *name* argument exceeds NAME_MAX.

ENOENT
The named shared memory object doesn't exist, or the *name* argument points to an empty string.

ENOSYS
The *shm_unlink()* function isn't supported by this implementation.

Examples:

See *shm_open()*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

mmap(), *munmap()*, *mprotect()*, *shm_ctl()*, *shm_open()*

shutdown()

Shut down part of a full-duplex connection

Synopsis:

```
#include <sys/socket.h>

int shutdown( int s,
              int how );
```

Arguments:

s A descriptor for the socket, as returned by *socket()*.

how How you want to shut down the connection:

If *how* is:	The TCP/IP manager won't allow:
SHUT_RD	Further receives
SHUT_WR	Further sends
SHUT_RDWR	Further sends and receives

Library:

libsocket

Description:

The *shutdown()* call shuts down all or part of a full-duplex connection on the socket associated with *s*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF Invalid descriptor *s*.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

close(), connect(), socket()

sigaction()

Examine or specify the action associated with a signal

Synopsis:

```
#include <signal.h>

int sigaction( int sig,
               const struct sigaction * act,
               struct sigaction * oact );
```

Arguments:

sig The signal number (defined in **<signal.h>**). For more information, see "POSIX signals" in the documentation for *SignalAction()*.

act NULL, or a pointer to a **sigaction** structure that specifies how you want to modify the action for the given signal. For more information about this structure, see below.

oact NULL, or a pointer to a **sigaction** structure that the function fills with information about the current action for the signal.

Library:

libc

Description:

You can use *sigaction()* to examine or specify (or both) the action that's associated with a specific signal:

- If *act* isn't NULL, the specified signal is modified.
- If *oact* isn't NULL, the previous action is stored in the structure it points to.

The structure **sigaction** contains the following members:

void (**sa_handler*)();

Address of a signal handler or action for nonqueued signals.

void (**sa_sigaction*)(**int** *signo*, **siginfo_t*** *info*, **void*** *other*);
Address of a signal handler or action for queued signals.

sigset_t *sa_mask*
An additional set of signals to be masked (blocked) during execution of the signal-catching function.

int *sa_flags* Special flags to affect behavior of the signal:

- SA_NOCLDSTOP is only used when the signal is SIGCHLD. It tells the system not to generate a SIGCHLD on the parent for children who stop via SIGSTOP.
- SA_SIGINFO tells the OS to queue this signal. The default is not to queue a signal delivered to a process. If a signal isn't queued, setting the same signal multiple times on a process or thread before it runs results in only the last signal's being delivered. If you set SA_SIGINFO, the signals are queued and they're all delivered.

The *sa_handler* and *sa_sigaction* members of *act* are implemented as a **union** and share common storage. They differ only in their prototypes, with *sa_handler* being used for POSIX 1003.1a signals and *sa_sigaction* being used for POSIX 1003.1b queued realtime signals. The values stored using either name can be one of:

function The address of a signal catching function. See below for details.

SIG_DFL This sets the signal to the default action:

- SIGCHLD, SIGIO, SIGURG and SIGWINCH — ignore the signal (SIG_IGN).
- SIGSTOP — stop the process.
- SIGCONT — continue the program.

- All other signals — kill the process.

SIG_IGN — This ignores the signal. Setting SIG_IGN for a signal that's pending discards all pending signals, whether it's blocked or not. New signals are discarded. If you ignore SIGCHLD, your process's children don't enter the zombie state and you're unable to wait on their death using *wait()* or *waitpid()*.

The *function* member of *sa_handler* or *sa_sigaction* is always invoked with the following arguments:

```
void handler(int signo, siginfo_t *info, void *other)
```

If you have an old-style signal handler of the form:

```
void handler(int signo)
```

the extra arguments are still placed by the kernel, but the function simply ignores them.

While in the handler, *signo* is masked, preventing nested signals of the same type. In addition, any signals set in the *sa_mask* member of *act* are also ORed into the mask. When the handler returns through a normal return, the previous mask is restored and any pending and now unmasked signals are acted on. You return to the point in the program where it was interrupted. If the thread was blocked in the kernel when the interruption occurred, the kernel call returns with an EINTR (see *ChannelCreate()* and *SyncMutexLock()* for exceptions to this).

The **siginfo_t** structure of the *function* in *sa_handler* or *sa_sigaction* contains at least the following members:

int *si_signo* — The signal number, which should match the *signo* argument to the handler.

int *si_code* — A signal code, provided by the generator of the signal:

- SI_USER — the *kill()* function generated the signal.
- SI_QUEUE — the *sigqueue()* function generated the signal.
- SI_TIMER — a timer generated the signal.
- SI_ASYNCIO — asynchronous I/O generated the signal.
- SI_MESGQ — POSIX (not QNX) messages queues generated the signal.

union sigval *si_value*

A value associated with the signal, provided by the generator of the signal.

You can't ignore or catch SIGKILL or SIGSTOP.

Signal handlers and actions are defined for the process and affect all threads in the process. For example, if one thread ignores a signal, then all threads ignore the signal.

You can target a signal at a thread, process, or process group (see *SignalKill()*). When targeted at a process, at most one thread receives the signal. This thread must have the signal unblocked (see *SignalProcmask()*) to be a candidate for receiving it. All synchronously generated signals (e.g. SIGSEGV) are always delivered to the thread that caused them.

If you use *longjmp()* to return from a signal handler, the signal remains masked. You can use *siglongjmp()* to restore the mask to the state saved by a previous call to *sigsetjmp()*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EAGAIN	Insufficient system resources are available to set up the signal's action.
EFAULT	A fault occurred trying to access the buffers provided.
EINVAL	The signal *signo* isn't valid.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>

int main( void )
  {
    extern void handler();
    struct sigaction act;
    sigset_t set;

    sigemptyset( &set );
    sigaddset( &set, SIGUSR1 );
    sigaddset( &set, SIGUSR2 );

    /*
     * Define a handler for SIGUSR1 such that when
     * entered both SIGUSR1 and SIGUSR2 are masked.
     */
    act.sa_flags = 0;
    act.sa_mask = set;
    act.sa_handler = &handler;
    sigaction( SIGUSR1, &act, NULL );

    kill( getpid(), SIGUSR1 );

    /* Program will terminate with a SIGUSR2 */
    return EXIT_SUCCESS;
  }

void handler( signo )
  {
    static int first = 1;

    if( first ) {
      first = 0;
      kill( getpid(), SIGUSR1 );  /* Prove signal masked */
      kill( getpid(), SIGUSR2 );  /* Prove signal masked */
```

```
    }
  }

/*
 * - SIGUSR1 is set from main(), handler() is called.
 * - SIGUSR1 and SIGUSR2 are set from handler().
 * - however, signals are masked until we return to main().
 * - returning to main() unmasks SIGUSR1 and SIGUSR2.
 * - pending SIGUSR1 now occurs, handler() is called.
 * - pending SIGUSR2 now occurs. Since we don't have
 *   a handler for SIGUSR2, we are killed.
 */
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *kill()*, *raise()*, *sigaddset()*, *sigdelset()*, *sigemptyset()*, *sigfillset()*, *sigismember()*, *signal()*, *SignalAction()*, *SignalKill()*, *sigpending()*, *sigprocmask()*

sigaddset()

Add a signal to a set

Synopsis:

```
#include <signal.h>

int sigaddset( sigset_t *set,
               int signo );
```

Arguments:

set A pointer to the **sigset_t** object that you want to add the signal to.

signo The signal that you want to add. For more information, see "POSIX signals" in the documentation for *SignalAction()*.

Library:

libc

Description:

The *sigaddset()* function adds *signo* to the set pointed to by *set*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL The signal *signo* isn't valid.

Examples:

See *sigemptyset()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

kill(), raise(), sigaction(), sigdelset(), sigemptyset(), sigfillset(), sigismember(), signal(), sigpending(), sigprocmask()

sigblock()

Add to the mask of signals to block

Synopsis:

```
#include <unix.h>

int sigblock( int mask );
```

Arguments:

mask A bitmask of the signals that you want to block.

Library:

libc

Description:

The *sigblock()* function adds the signals specified in *mask* to the set of signals currently being blocked from delivery. Signals are blocked if the appropriate bit in *mask* is a 1; the macro *sigmask()* is provided to construct the mask for a given signum. The *sigblock()* returns the previous mask. You can restore the previous mask by calling *sigsetmask()*.

In normal usage, a signal is blocked using *sigblock()*. To begin a critical section, variables modified on the occurrence of the signal are examined to determine that there's no work to be done, and the process pauses awaiting work by using *sigpause()* with the mask returned by *sigblock()*.

It isn't possible to block SIGKILL, SIGSTOP, or SIGCONT; this restriction is silently imposed by the system.

Returns:

The previous set of masked signals.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	No

Caveats:

Use of these interfaces should be restricted to only applications written on BSD platforms. Use of these interfaces with any of the system libraries or in multithreaded applications is unsupported.

See also:

kill(), sigaction(), sigmask(), signal(), sigpause(), sigprocmask(), sigsetmask(), sigunblock()

sigdelset()

Delete a signal from a set

Synopsis:

```
#include <signal.h>

int sigdelset( sigset_t *set,
               int signo );
```

Arguments:

set A pointer to the **sigset_t** object that you want to remove the signal from.

signo The signal that you want to remove. For more information, see "POSIX signals" in the documentation for *SignalAction()*.

Library:

libc

Description:

The *sigdelset()* function deletes *signo* from the set pointed to by *set*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL The signal *signo* isn't valid.

Examples:

See *sigemptyset()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

kill(), raise(), sigaction(), sigaddset(), sigemptyset(), sigfillset(), sigismember(), signal(), sigpending(), sigprocmask()

sigemptyset()

Initialize a set to contain no signals

Synopsis:

```
#include <signal.h>

int sigemptyset( sigset_t *set );
```

Arguments:

set A pointer to the **sigset_t** object that you want to initialize.

Library:

libc

Description:

The *sigemptyset()* function initializes *set* to contain no signals.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <signal.h>

void print( sigset_t set, int signo )
  {

    printf( "Set %8.8lx. Signal %d is ", set, signo );
    if( sigismember( &set, signo ) )
      printf( "a member.\n" );
    else
      printf( "not a member.\n" );
  }

int main( void )
  {
    sigset_t set;
```

```
    sigemptyset( &set );
    print( set, SIGINT );

    sigfillset( &set );
    print( set, SIGINT );

    sigdelset( &set, SIGINT );
    print( set, SIGINT );

    sigaddset( &set, SIGINT );
    print( set, SIGINT );
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

kill(), raise(), sigaction(), sigaddset(), sigdelset(), sigfillset(), sigismember(), signal(), sigpending(), sigprocmask()

Structure that describes an event

Synopsis:

```
#include <sys/siginfo.h>

union sigval {
    int        sival_int;
    void     * sival_ptr;
};
```

The **sigevent** structure is complicated; see below.

Description:

This structure describes an event. The **int** *sigev_notify* member indicates how the notification is to occur, as well as which of the other members are used:

sigev_notify	*sigev_signo*	*sigev_coid*	*sigev_priority*	*sigev_code*	*sigev_value*
SIGEV_INTR					
SIGEV_NONE					
SIGEV_PULSE		Connection	Priority	Code	Value
SIGEV_SIGNAL	Signal				
SIGEV_SIGNAL_CODE	Signal			Code	Value
SIGEV_SIGNAL_THREAD	Signal			Code	Value
SIGEV_THREAD (special — see below)					Value
SIGEV_UNBLOCK					

The **<sys/siginfo.h>** file also defines some macros to make initializing the **sigevent** structure easier. All the macros take a pointer to a **sigevent** structure as their first argument, *event*, and set the *sigev_notify* member to the appropriate value.

☞ These macros are QNX Neutrino extensions.

SIGEV_INTR

Raise an interrupt. No other fields in the structure are used.

The initialization macro is:

SIGEV_INTR_INIT(&*event*)

SIGEV_NONE

Don't send any notification. No other fields in the structure are used.

The initialization macro is:

SIGEV_NONE_INIT(&*event*)

SIGEV_PULSE

Send a pulse. The following fields are used:

int *sigev_coid*

The connection ID. This should be attached to the channel with which the pulse will be received.

short *sigev_priority*

The priority of the pulse.

short *sigev_code*

A code to be interpreted by the pulse handler. Although *sigev_code* can be any 8-bit signed value, you should avoid *sigev_code* values less than zero in order to avoid conflict with kernel or pulse codes generated by a QNX manager. These codes all start with _PULSE_CODE_ and are defined in **<sys/neutrino.h>**; for more information, see the documentation for the **_pulse** structure. A safe range of pulse values is _PULSE_CODE_MINAVAIL to _PULSE_CODE_MAXAVAIL.

**void ****sigev_value.sival_ptr*

A 32-bit value to be interpreted by the pulse handler.

The initialization macro is:

SIGEV_PULSE_INIT(&*event*, *coid*, *priority*, *code*, *value*)

SIGEV_SIGNAL

Send a signal to a process. The following fields are used:

int *sigev_signo*

The signal to raise. This must be in the range from 1 through NSIG – 1.

The initialization macro is:

SIGEV_SIGNAL_INIT(&*event*, *signal*)

If you need to set the *sigev_value* for a SIGEV_SIGNAL event (for example if SA_SIGINFO is set), you can use this macro:

SIGEV_SIGNAL_VALUE_INIT(&*event*, *signal*, *value*)

SIGEV_SIGNAL_CODE

This is similar to SIGEV_SIGNAL, except that SIGEV_SIGNAL_CODE also includes a value and a code. The following fields are used:

int *sigev_signo*

The signal to raise. This must be in the range from 1 through NSIG – 1.

short *sigev_code*

A code to be interpreted by the signal handler. This must be in the range from SI_MINAVAIL through SI_MAXAVAIL.

**void ****sigev_value.sival_ptr*

A 32-bit value to be interpreted by the signal handler.

The initialization macro is:

SIGEV_SIGNAL_CODE_INIT(&*event*, *signal*, *value*, *code*)

SIGEV_SIGNAL_THREAD

Send a signal to a specific thread. The following fields are used:

int *sigev_signo*

The signal to raise. This must be in the range from 1 through NSIG – 1.

short *sigev_code*

A code to be interpreted by the signal handler. This must be in the range from SI_MINAVAIL through SI_MAXAVAIL.

**void ***sigev_value.sival_ptr*

A 32-bit value to be interpreted by the signal handler.

The initialization macro is:

SIGEV_SIGNAL_THREAD_INIT(&*event*, *signal*, *value*, *code*)

SIGEV_THREAD

Create a new thread.

We don't recommend using this type of event. Pulses are more efficient.

The following fields are used:

void (***sigev_notify_function*) (**union sigval**)

A pointer to the function to be notified.

**pthread_attr ***sigev_notify_attributes*

A pointer to thread attributes. This must be NULL, or point to a structure initialized by *pthread_attr_init()* at the time of delivery.

**void ****sigev_value.sival_ptr*

A value that's to be passed to the notification function.

The initialization macro is:

SIGEV_THREAD_INIT(&*event*, *fn*, *value*, *attr*)

SIGEV_UNBLOCK

Force a thread to become unblocked. No other fields in the structure are used.

The initialization macro is:

SIGEV_UNBLOCK_INIT(&*event*)

Classification:

QNX Neutrino

See also:

ds_create(), *InterruptAttach()*, *InterruptAttachEvent()*, *iofunc_notify()*, *iofunc_notify_trigger()*, *ionotify()*, *lio_listio()*, *mq_notify()*, *MsgDeliverEvent()*, *procmgr_event_notify()*, **_pulse**, *TimerCreate()*, *timer_create()*, *TimerInfo()*, *TimerTimeout()*, *timer_timeout()*

"Neutrino IPC" in the Neutrino microkernel chapter of the *System Architecture* guide

sigfillset()

Initialize a set to contain all signals

Synopsis:

```
#include <signal.h>

int sigfillset( sigset_t *set );
```

Arguments:

set A pointer to the **sigset_t** object that you want to initialize.

Library:

libc

Description:

The *sigfillset()* function initializes *set* to contain all signals.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Examples:

See *sigemptyset()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

kill(), raise(), sigaction(), sigaddset(), sigdelset(), sigemptyset(), sigismember(), signal(), sigpending(), sigprocmask()

sigismember()

See if a given signal is in a given set

Synopsis:

```
#include <signal.h>

int sigismember( const sigset_t *set,
                 int signo );
```

Arguments:

set A pointer to the **sigset_t** object that you want to check.

signo The signal that you want to check for membership in the set. For more information, see "POSIX signals" in the documentation for *SignalAction()*.

Library:

libc

Description:

The *sigismember()* function tests if *signo* is in the set pointed to by *set*.

Returns:

1 The *signo* is in the set.

0 The *signo* isn't in the set.

-1 An error occurred (*errno* is set).

Errors:

EINVAL The signal *signo* isn't valid.

Examples:

See *sigemptyset()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

kill(), *raise()*, *sigaction()*, *sigaddset()*, *sigdelset()*, *sigemptyset()*, *sigfillset()*, *signal()*, *sigpending()*, *sigprocmask()*

siglongjmp()

Restore the environment saved by sigsetjmp(), including the signal mask

Synopsis:

```
#include <setjmp.h>

void siglongjmp( sigjmp_buf env,
                 int val );
```

Arguments:

env The environment saved by the most recent call to *sigsetjmp()*.

val The value that you want *sigsetjmp()* to return.

Library:

libc

Description:

The *siglongjmp()* function is a superset of the *longjmp()* function, but also restores the thread's saved signal mask if (and only if) one was saved in the *env* argument by a previous call to *sigsetjmp()*.

WARNING: *Don't* use *longjmp()* or *siglongjmp()* to restore an environment saved by a call to *setjmp()* or *sigsetjmp()* in another thread. If you're lucky, your application will crash; if not, it'll look as if it works for a while, until random scribbling on the stack causes it to crash.

Returns:

The same values that *longjmp()* returns.

Examples:

See *longjmp()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

longjmp(), sigaction(), sigprocmask(), sigsuspend()

sigmask()

Construct a mask for a signal number

Synopsis:

```
#include <unix.h>

#define sigmask(s)      (1L<<((s)-1))
```

Arguments:

s The signal that you want to create a mask for. For more information, see "POSIX signals" in the documentation for *SignalAction()*.

Library:

libc

Description:

This macro constructs the mask for a given signal number. Use *sigmask()* in conjunction with *sigblock()*, *sigsetmask()*, and *sigunblock()*.

Returns:

The signal mask.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

Use of these interfaces should be restricted to only applications written on BSD platforms. Use of these interfaces with any of the system libraries or in multithreaded applications is unsupported.

See also:

kill(), sigaction(), sigblock(), signal(), sigpause(), sigsetmask(), sigunblock()

Synopsis:

```
#include <signal.h>

void ( * signal( int sig,
                 void ( * func)(int) ) )( int );
```

Arguments:

sig The signal number (defined in **<signal.h>**). For more information, see "POSIX signals" in the documentation for *SignalAction()*.

func The function that you want to call when the signal is raised.

Library:

libc

Description:

The *signal()* function is used to specify an action to take place when certain conditions are detected while a program executes. See the **<signal.h>** header file for definitions of these conditions, and also refer to the *System Architecture* manual.

There are three types of actions that can be associated with a signal: SIG_DFL, SIG_IGN or a pointer to a function. Initially, all signals are set to SIG_DFL or SIG_IGN prior to entry of the *main()* routine. An action can be specified for each of the conditions, depending upon the value of the *func* argument, as discussed below.

func is a function

When *func* is a function name, that function is called in a manner equivalent to the following code sequence:

```
/* "sig_no" is condition being signalled */
signal( sig_no, SIG_DFL );
(*func)( sig_no );
```

The *func* function may do the following:

- Return.
- Terminate the program by calling *exit()* or *abort()*.
- Call *longjmp()* or *siglongjmp()*. If you use *longjmp()* to return from a signal handler, the signal remains masked. You can use *siglongjmp()* to restore the mask to the state saved in a previous call to *sigsetjmp()*.

After returning from the signal-catching function, the receiving process resumes execution at the point at which it was interrupted.

The signal catching function is described as follows:

```
void func( int sig_no )
{
  ...
}
```

It isn't possible to catch the SIGSTOP or SIGKILL signals.

Since signal-catching functions are invoked asynchronously with process execution, use the *atomic_**, *InterruptLock()*, and *InterruptUnlock()* functions for atomic operations.

func is SIG_DFL

If *func* is SIG_DFL, the default action for the condition is taken.

If the default action is to stop the process, the execution of that process is temporarily suspended. When a process stops, a SIGCHLD signal is generated for its parent process, unless the parent process has set the SA_NOCLDSTOP flag (see *sigaction()*). While a process is stopped, any additional signals that are sent to the process aren't delivered until the process is continued, except SIGKILL, which always terminates the receiving process.

Setting a signal action to SIG_DFL for a signal that is pending, and whose default action is to ignore the signal (for example, SIGCHLD), causes the pending signal to be discarded, whether or not it's blocked.

func is SIG_IGN

If *func* is SIG_IGN, the indicated condition is ignored.

You can't set the action for the SIGSTOP and SIGKILL signals to SIG_IGN.

Setting a signal action to SIG_IGN for a signal that's pending causes the pending signal to be discarded, whether or not it is blocked.

If a process sets the action for the SIGCHLD signal to SIG_IGN, the behavior is unspecified.

Handling a condition

When a condition is detected, it may be handled by a program, it may be ignored, or it may be handled by the usual default action (often causing an error message to be printed on the *stderr* stream followed by program termination).

A condition can be generated by a program using the *raise()* or *kill()* function

Returns:

The previous value of *func* for the indicated condition, or SIG_ERR if the request couldn't be handled (*errno* is set to EINVAL).

Examples:

```
#include <stdlib.h>
#include <signal.h>

sig_atomic_t signal_count;

void MyHandler( int sig_number )
  {
     ++signal_count;
  }

int main( void )
  {
    signal( SIGFPE, MyHandler );   /* set own handler */
    signal( SIGABRT, SIG_DFL );    /* Default action */
    signal( SIGFPE, SIG_IGN );     /* Ignore condition */
    return (EXIT_SUCCESS);
```

```
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

atomic_add(), atomic_add_value(), atomic_clr(), atomic_clr_value(), atomic_set(), atomic_set_value(), atomic_sub(), atomic_sub_value(), atomic_toggle(), atomic_toggle_value(), InterruptLock(), InterruptUnlock(), kill(), longjmp(), raise(), siglongjmp(), sigprocmask()

Synopsis:

```
#include <sys/neutrino.h>

int SignalAction( pid_t pid,
                  void ( * sigstub)(),
                  int signo,
                  const struct sigaction * act,
                  struct sigaction * oact );

int SignalAction_r( pid_t pid,
                    void * (sigstub)(),
                    int signo,
                    const struct sigaction * act,
                    struct sigaction * oact );
```

Arguments:

pid A process ID, or 0 for the current process.

sigstub The address of a signal stub handler. This is a small piece of code in the user's space that interfaces the user's signal handler to the kernel. The library provides a standard one, *__signalstub()*.

signo The signal whose action you want to set or get; see "POSIX signals," below.

act NULL, or a pointer to a **sigaction** structure that specifies the new action for the signal. For more information, see "Signal actions," below.

oact NULL, or a pointer to a **sigaction** structure where the function can store the old action.

Library:

libc

Description:

The *SignalAction()* and *SignalAction_r()* kernel calls let the calling process examine or specify (or both) the action to be associated with a specific signal in the process *pid*. If *pid* is zero, the calling process is used. The argument *signo* specifies the signal.

You should call *sigaction()* instead of using these kernel calls directly.

These functions are identical except in the way they indicate errors. See the Returns section for details.

POSIX signals

The signals are defined in **<signal.h>**, and so are these global variables:

char * const *sys_siglist*[]
: An array of signal names.

int *sys_nsig*
: The number of entries in the *sys_siglist* array.

There are 32 POSIX 1003.1a signals, including:

SIGHUP
: Hangup.

SIGINT
: Interrupt.

SIGQUIT
: Quit.

SIGILL
: Illegal instruction (not reset when caught).

SIGTRAP
: Trace trap (not reset when caught).

SIGIOT
: IOT instruction.

SIGABRT
: Used by *abort()*.

SIGEMT
: EMT instruction.

SIGFPE	Floating point exception.
SIGKILL	Kill (can't be caught or ignored)
SIGBUS	Bus error.
SIGSEGV	Segmentation violation.
SIGSYS	Bad argument to system call.
SIGPIPE	Write on pipe with no reader.
SIGALRM	Realtime alarm clock.
SIGTERM	Software termination signal from kill.
SIGUSR1	User-defined signal 1.
SIGUSR2	User-defined signal 2.
SIGCHLD	Death of child.
SIGPWR	Power-fail restart.
SIGWINCH	Window change.
SIGURG	Urgent condition on I/O channel.
SIGPOLL	System V name for SIGIO.
SIGIO	Asynchronous I/O.
SIGSTOP	Sendable stop signal not from tty.
SIGTSTP	Stop signal from tty.
SIGCONT	Continue a stopped process.
SIGTTIN	Attempted background tty read.
SIGTTOU	Attempted background tty write.

You can't ignore or catch SIGKILL or SIGSTOP.

There are 16 POSIX 1003.1b realtime signals, including:

SIGRTMIN — First realtime signal.

SIGRTMAX — Last realtime signal.

The entire range of signals goes from _SIGMIN (1) to _SIGMAX (64).

Signal actions

If *act* isn't NULL, then the specified signal is modified. If *oact* isn't NULL, the previous action is stored in the structure it points to. You can use various combinations of *act* and *oact* to query or set (or both) the action for a signal.

The structure **sigaction** contains the following members:

void (**sa_handler*)();
The address of a signal handler or action for nonqueued signals.

void (**sa_sigaction*) (**int** *signo*, **siginfo_t** **info*, **void** **other*);
The address of a signal handler or action for queued signals.

sigset_t *sa_mask*
An additional set of signals to be masked (blocked) during execution of the signal-catching function.

int *sa_flags* — Special flags that affect the behavior of the signal:

- SA_NOCLDSTOP — don't generate a SIGCHLD on the parent for children who stop via SIGSTOP. This flag is used only when the signal is SIGCHLD.

- SA_SIGINFO — queue this signal. The default is not to queue a signal delivered to a process. If a signal isn't queued, and the same signal is set multiple times on a process or thread before it runs, only the last signal is delivered. If you set the SA_SIGINFO flag, the signals are queued, and they're all delivered.

The *sa_handler* and *sa_sigaction* members of *act* are implemented as a **union**, and share common storage. They differ only in their prototype, with *sa_handler* being used for POSIX 1003.1a signals, and *sa_sigaction* being used for POSIX 1003.1b queued realtime signals. The values stored using either name can be one of:

function The address of a signal-catching function. See below for details.

SIG_DFL Use the default action for the signal:

- SIGCHLD, SIGIO, SIGURG, and SIGWINCH — ignore the signal (SIG_IGN).
- SIGSTOP — stop the process.
- SIGCONT — continue the program.
- All other signals — kill the process.

SIG_IGN Ignore the signal. Setting SIG_IGN for a signal that's pending discards all pending signals, whether it's blocked or not. New signals are discarded. If your process ignores SIGCHLD, its children won't enter the zombie state and the process can't use *wait()* or *waitpid()* to wait on their deaths.

The *function* member of *sa_handler* or *sa_sigaction* is always invoked with the following arguments:

```
void handler(int signo, siginfo_t* info, void* other)
```

If you have an old-style signal handler of the form:

```
void handler(int signo)
```

the microkernel passes the extra arguments, but the function simply ignores them.

While in the handler, *signo* is masked, preventing nested signals of the same type. In addition, any signals set in the *sa_mask* member of *act* are also ORed into the mask. When the handler returns through a normal return, the previous mask is restored, and any pending and now unmasked signals are acted on. You return to the point in the program where it was interrupted. If the thread was blocked in the kernel when the interruption occurred, the kernel call returns with an EINTR (see *ChannelCreate()* and *SyncMutexLock()* for exceptions to this).

When you specify a handler, you must provide the address of a signal stub handler for *sigstub*. This is a small piece of code in the user's space that interfaces the user's signal handler to the kernel. The library provides a standard one, *__signalstub()*.

The **siginfo_t** structure of the *function* in *sa_handler* or *sa_sigaction* contains at least the following members:

int *si_signo* The signal number, which should match the *signo* argument to the handler.

int *si_code* A signal code, provided by the generator of the signal:

- SI_USER — the *kill()* function generated the signal.
- SI_QUEUE — the *sigqueue()* function generated the signal.
- SI_TIMER — a timer generated the signal.
- SI_ASYNCIO — asynchronous I/O generated the signal.
- SI_MESGQ — POSIX (not QNX) messages queues generated the signal.

union sigval *si_value*

A value associated with the signal, provided by the generator of the signal.

Signal handlers and actions are defined for the process and affect all threads in the process. For example, if one thread ignores a signal, then all threads ignore the signal.

You can target a signal at a thread, process or process group (see *SignalKill()*). When targeted at a process, at most one thread receives the signal. This thread must have the signal unblocked (see *SignalProcmask()*) to be a candidate for receiving it. All synchronously generated signals (e.g. SIGSEGV) are always delivered to the thread that caused them.

In a multithreaded process, if a signal terminates a thread, by default all threads and thus the process are terminated. You can override this standard POSIX behavior when you create the thread; see *ThreadCreate()*.

CAUTION: If you use *longjmp()* to return from a signal handler, the signal remains masked. You can use *siglongjmp()* to restore the mask to the state saved by a previous call to *sigsetjmp()*.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

SignalAction()	If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.
SignalAction_r()	EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EAGAIN	The system was unable to allocate a signal handler. This indicated critically low memory.
EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EINVAL	The value of *signo* is less than 1 or greater than _SIGMAX, or you tried to set SIGKILL or SIGSTOP to something other than SIG_DFL.
EPERM	The process doesn't have permission to change the signal actions of the specified process.
ESRCH	The process indicated by *pid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

abort(), ChannelCreate(), kill(), longjmp(), siglongjmp(), SignalKill(), SignalProcmask(), sigqueue(), sigsetjmp(), SyncMutexLock(), ThreadCreate(), wait(), waitpid()

SignalKill(), SignalKill_r()

Send a signal to a process group, process, or thread

Synopsis:

```
#include <sys/neutrino.h>

int SignalKill( uint32_t nd,
                pid_t pid,
                int tid,
                int signo,
                int code,
                int value );

int SignalKill_r( uint32_t nd,
                  pid_t pid,
                  int tid,
                  int signo,
                  int code,
                  int value );
```

Arguments:

nd	The node descriptor of the node on which to look for *pid* and *tid*. To search the local node, set *nd* to ND_LOCAL_NODE or 0.
pid	0, or the ID of the process to send the signal to; see below.
tid	0, or the ID of the thread to send the signal to; see below.
signo	The signal that you want to send. There are a total of 64 signals available. Of these, at least 8 are POSIX realtime signals that range from SIGRTMIN to SIGRTMAX. For a complete list of signals, see "POSIX signals" in the documentation for *SignalAction()*. Valid user signals range from 1 to (NSIG - 1).
code, *value*	The code and value associated with the signal; see *SignalAction()*.

Library:

libc

Description:

The *SignalKill()* and *SignalKill_r()* kernel calls send the signal *signo* with a code specified by *code* and a value specified by *value* to a process group, process, or thread.

These functions are identical except in the way they indicate errors. See the Returns section for details.

If *signo* is zero, no signal is sent, but the validity of *pid* and *tid* are checked. You can use this as a test for existence.

SignalKill() implements the capabilities of the POSIX functions *kill()*, *sigqueue()*, and *pthread_kill()* in one call. The *pid* and *tid* determine the target of the signal, as follows:

pid	***tid***	**target**
= 0	—	Hit the process group of the caller
< 0	—	Hit a process group identified by *-pid*
> 0	= 0	Hit a single process identified by *pid*
> 0	> 0	Hit a single thread in process *pid* identified by *tid*

If the target is a thread, the signal is always delivered to exactly that thread. If the thread has the signal blocked — see *SignalProcmask()* — the signal remains pending on the thread.

If the target is a process, the signal is delivered to a thread that has the signal unblocked; see *SignalProcmask()*, *SignalSuspend()*, and *SignalWaitinfo()*. If multiple threads have the signal unblocked, only one thread is given the signal. Which thread receives the signal isn't deterministic. To make it deterministic, you can:

- Have all threads except one block all signals; that thread handles all signals.

Or:

- Target the signals to specific threads.

If all threads have the signal blocked, it's made pending on the process. The first thread to unblock the signal receives the pending signal. If a signal is pending on a thread, it's never retargetted to the process or another thread, regardless of changes to the signal-blocked mask.

If the target is a process group, the signal is delivered as above to each process in the group.

A multithreaded application typically has one thread responsible for catching most or all signals. Threads that don't wish to be directly involved with signals block all signals in their mask.

The signal-blocked mask is maintained on a per-thread basis. The signal-ignore mask and signal handlers are maintained at the process level and are shared by all threads.

If multiple signals are delivered before the target can run and process the signals, the system queues them in priority order if the SA_SIGINFO bit was set for *signo*. Lower numbered signals have greater priority. If the SA_SIGINFO bit isn't set for *signo*, then at most one signal is queued at any time. Additional signals with the same *signo* replace existing ones. This is the default behavior for POSIX signal handlers installed using the old *signal()* function. The newer *sigaction()* function lets you control queuing or not on a per-signal basis. Signals with a *code* of SI_TIMER are never queued.

The *code* and *value* are always saved with the signal. This allows you to deliver data with the signal whether or not SA_SIGINFO has been set on the *signo*. If SA_SIGINFO is set, you can use signals to deliver small amounts of data without loss. If you wish to pass significant data, you may wish to consider using *MsgSendPulse()* and *MsgSendv()*, which deliver data with much greater efficiency.

When a thread receives a signal by a signal handler or *SignalWaitinfo()* call, it can retrieve the *signo*, *code* and *value* from a **`siginfo_t`** structure, which contains at least the following members:

int *si_signo* The signal number.

int *si_code* The signal code.

union sigval *si_value*
The signal value.

The value of *si_code* is limited to an 8-bit signed value as follows:

Value	Description
-128 <= *si_code* <= 0	User values
0 < *signo* <= 127	System values generated by the kernel

Some of the common user values defined by POSIX are:

- SI_USER — the *kill()* function generated the signal.
- SI_QUEUE — the *sigqueue()* function generated the signal.
- SI_TIMER — a timer generated the signal.
- SI_ASYNCIO — asynchronous I/O generated the signal.
- SI_MESGQ — POSIX (not QNX) messages queues generated the signal.

A successful return from this function means the signal has been delivered. What the process(es) or thread does with the signal isn't considered.

If a thread delivers signals that the receiving process has marked as queued faster than the receiver can consume them, the kernel may fail the call if it runs out of signal queue entries. If the *signo*, *code*, and *value* don't change, the kernel performs signal compression by saving an 8-bit count with each queued signal.

Blocking states

None. In the network case, lower priority threads may run.

Returns:

The only difference between these functions is the way they indicate errors:

SignalKill()	If an error occurs, -1 is returned and sets *errno*. Any other value returned indicates success.
SignalKill_r()	EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EINVAL	The value of *signo* is less than 0 or greater than (_NSIG -1).
ESRCH	The process or process group indicated by *pid* or thread indicated by *tid* doesn't exist.
EPERM	The process doesn't have permission to send the signal to any receiving process.
EAGAIN	The kernel had insufficient resources to enqueue the signal.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

SignalAction(), *SignalProcmask()*, *SignalSuspend()*, *SignalWaitinfo()*

SignalProcmask(), SignalProcmask_r()

Modify or examine the signal-blocked mask of a thread

Synopsis:

```
#include <sys/neutrino.h>

int SignalProcmask( pid_t pid,
                    int tid,
                    int how,
                    const sigset_t* set,
                    sigset_t* oldset );

int SignalProcmask_r( pid_t pid,
                      int tid,
                      int how,
                      const sigset_t* set,
                      sigset_t* oldset );
```

Arguments:

pid 0, or a process ID; see below.

tid 0, or a thread ID; see below.

how The manner in which you want to change the set:

- SIG_BLOCK — the resulting set is the union of the current set and the signal set pointed to by *set*.
- SIG_UNBLOCK — the resulting set is the intersection of the current set and the signal set pointed to by *set*.
- SIG_SETMASK — the resulting set is the signal set pointed to by *set*.

As a special case, you can use the *how* argument to query the current set of pending signals:

- SIG_PENDING — the combined set of pending signals on the thread and process are saved in the signal set pointed to by *oldset*. The *set* argument is ignored.

set NULL, or a pointer to a **sigset_t** object that specified the set of signals to be used to change the currently blocked set.

oldset NULL, or a pointer to a **sigset_t** object where the function can store the previous blocked mask.

You can use various combinations of *set* and *oldset* to query or change (or both) the signal-blocked mask for a signal.

Library:

libc

Description:

These kernel calls modify or examine the signal-blocked mask of the thread *tid* in process *pid*. If *pid* is zero, the current process is assumed. If *tid* is zero, *pid* is ignored and the calling thread is used.

The *SignalProcmask()* and *SignalProcmask_r()* functions are identical, except in the way they indicate errors. See the Returns section for details.

When a signal is unmasked, the kernel checks for pending signals on the thread and, if there aren't any pending, checks for pending signals on the process:

Check	Action
Signal pending on thread	The signal is immediately acted upon.
Signal pending on process	The signal is moved to the thread and is immediately acted upon.
No signal pending	No signal action performed until delivery of an unblocked signal.

It isn't possible to block the SIGKILL or SIGSTOP signals.

When a signal handler is invoked, the signal responsible is automatically masked before its handler is called; see *SignalAction()*. If the handler returns normally, the operating system restores the

signal mask present just before the handler was called as an atomic operation. Changes made using *SignalProcmask()* in the handler are undone.

When a signal is targeted at a process, the kernel delivers it to at most one thread (see *SignalKill()*) that has the signal unblocked. If multiple threads have the signal unblocked, only one thread is given the signal. Which thread receives the signal isn't deterministic. To make it deterministic, you can:

- Have all threads except one block all signals; that thread handles all signals.

  Or:

- Target signals to specific threads.

If all threads have the signal blocked, it's made pending on the process. The first thread to unblock the signal receives the pending signal. If a signal is pending on a thread, it's never retargetted to the process or another thread, regardless of changes to the signal-blocked mask.

Signals targeted at a thread always affect that thread alone.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

SignalProcmask()

If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

SignalProcmask_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EAGAIN	The system was unable to allocate a signal handler. This indicates critically low memory.
EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EINVAL	The value of *how* is invalid, or you tried to set SIGKILL or SIGSTOP to something other than SIG_DFL.
EPERM	The process doesn't have permission to change the signal mask of the specified process.
ESRCH	The process indicated by *pid* or thread indicated by *tid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

SignalAction(), SignalKill()

SignalSuspend(), SignalSuspend_r()

Suspend a thread until a signal is received

Synopsis:

```
#include <sys/neutrino.h>

int SignalSuspend( const sigset_t* set );

int SignalSuspend_r( const sigset_t* set );
```

Arguments:

set A pointer to a **sigset_t** object that specifies the signals you want to wait for.

Library:

libc

Description:

These kernel calls replace the thread's signal mask with the set of signals pointed to by *set* and then suspends the thread until delivery of a signal whose action is either to execute a signal-catching function (then return), or to terminate the thread. On return, the previous signal mask is restored.

The *SignalSuspend()* and *SignalSuspend_r()* functions are identical, except in the way they indicate errors. See the Returns section for details.

Attempts to block SIGKILL or SIGSTOP are ignored. This is done without causing an error.

If you're using *SignalSuspend()* to synchronously wait for a signal, consider using the more efficient POSIX 1003.1b realtime *sigwaitinfo()* call.

Blocking states

STATE_SIGSUSPEND

The calling thread blocks waiting for a signal.

Returns:

The only difference between these functions is the way they indicate errors.

Since *SignalSuspend()* and *SignalSuspend_r()* block until interrupted, there's no successful return value.

SignalSuspend()

-1 is always returned and *errno* is set.

SignalSuspend_r()

errno is **NOT** set, a value in the Errors section is returned.

If the signal handler calls *longjmp()* or *siglongjmp(), SignalSuspend()* and *SignalSuspend_r()* don't return.

Errors:

EINTR	The call was interrupted by a signal (this is the normal error).
EFAULT	A fault occurred when the kernel tried to access the buffers provided.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

SignalKill()

Select a pending signal

Synopsis:

```
#include <sys/neutrino.h>

int SignalWaitinfo( const sigset_t* set,
                    siginfo_t* info );

int SignalWaitinfo_r( const sigset_t* set,
                      siginfo_t* info );
```

Arguments:

set A pointer to a **sigset_t** object that specifies the signals you want to wait for.

info NULL, or a pointer to a **siginfo_t** structure where the function can store information about the signal.

Library:

libc

Description:

The *SignalWaitinfo()* and *SignalWaitinfo_r()* kernel calls select the pending signal from the set specified by *set*. If no signal in *set* is pending at the time of the call, the thread blocks until one or more signals in *set* become pending or until interrupted by an unblocked, caught signal.

These functions are identical except in the way they indicate errors. See the Returns section for details.

If the *info* argument isn't NULL, information on the selected signal is stored there as follows:

siginfo_t member	Description
si_signo	Selected signal number
si_code	Signal code
si_value	Signal value

If, while *SignalWaitinfo()* is waiting, a caught signal occurs that isn't blocked, the signal handler is invoked and *SignalWaitinfo()* is interrupted with an error of EINTR.

Blocking states

STATE_SIGWAITINFO

The calling thread blocks waiting for a signal.

Returns:

The only difference between these functions is the way they indicate errors:

SignalWaitinfo()

A signal number. If an error occurs, -1 is returned and *errno* is set.

SignalWaitinfo_r()

A signal number. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EINTR	The call was interrupted by a signal.
EFAULT	A fault occurred when the kernel tried to access the buffers provided.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

SignalKill(), SignalKill_r()

significand(), significandf()

Compute the "significant bits" of a floating-point number

Synopsis:

```
#include <math.h>

double significand ( double x );

float significandf ( float x );
```

Arguments:

x A floating-point number.

Library:

libm

Description:

The *significand()* and *significandf()* functions are math functions that compute the "significant bits" of a floating-point number.

When encoding a floating-point number into binary notation, you remove the sign, and then shift the bits to the right or left until the shifted result is in the range [0.5, 1). The negative of the number of positions shifted is the *exponent* of the number, and the shifted result is the *significand*.

If *x* equals sig $\times$ 2^n with 1 **<** sig **<** 2, then **significand(***x***)** returns sig for exercising the fraction-part(F) test vector. The function **significand(***x***)** isn't defined when *x* is one of:

- **0**
- positive or negative infinity
- NAN.

Returns:

scalb (*x*, (**double**) -*ilogb* (*x*))

Since *significand*(*x*) = *scalb*(*x*, -*ilogb*(*x*)) where *ilogb()* returns the exponent part of *x* and *scalb*(*x*, *n*) returns *a*, such that $x = a \times 2^{n}$, then:

When *x* is:	*scalbn*(*x*, *n*) returns:
±infinity	*x*
NAN	NAN

Examples:

```
#include <stdio.h>
#include <errno.h>
#include <inttypes.h>
#include <math.h>
#include <fpstatus.h>

int main(int argc, char** argv)
{
    double a, b, c, d;

    a = 5;
    b = ilogb(d);
    printf("The exponent part of %f is %f \n", a, b);
    c = significand(a);
    printf("%f = %f * (2 ^ %f) \n", a, c, b);

    return(0);
}
```

produces the output:

```
The exponent part of 5.000000 is -895.000000
5.000000 = 1.250000 * (2 ^ -895.000000)
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ilogb(), scalb(), scalbn()

sigpause()

Wait for a signal

Synopsis:

```
#include <signal.h>

int sigpause( int sig );
```

Arguments:

sig A mask containing the signal number that you want to wait for.

Library:

libc

Description:

The *sigpause()* function assigns *sig* to the set of masked signals and then waits for a signal to arrive; on return, the set of masked signals is restored. The *mask* argument is usually 0 to indicate that no signals are now to be blocked. This function always terminates by being interrupted, returning -1, and setting *errno* to EINTR.

In normal usage, a signal is blocked using *sigblock()*. To begin a critical section, variables modified on the occurrence of the signal are examined to determine that there is no work to be done, and the process pauses awaiting work by using *sigpause()* with the mask returned by *sigblock()*.

It isn't possible to block SIGKILL, SIGSTOP, or SIGCONT; this restriction is silently imposed by the system.

Returns:

-1; *errno* is set to EINTR.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Use of these interfaces should be restricted to only applications written on BSD platforms. Use of these interfaces with any of the system libraries or in multithreaded applications is unsupported.

See also:

kill(), sigaction(), sigblock(), sigmask(), signal(), sigsetmask(), sigsuspend(), sigunblock()

sigpending()

Examine the set of pending, masked signals for a process

Synopsis:

```
#include <signal.h>

int sigpending( sigset_t *set );
```

Arguments:

set A pointer to a **sigset_t** object that the function sets to indicate the pending, masked signals.

Library:

libc

Description:

The *sigpending()* function is used to examine the set of pending signals that are masked (blocked) from delivery to the calling thread and that are pending on the calling process or thread. They're saved in the signal set pointed to by *set*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EFAULT A fault occurred while accessing the buffer pointed to by *set*.

Examples:

See *sigprocmask()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

kill(), raise(), sigaction(), sigaddset(), sigdelset(), sigemptyset(), sigfillset(), sigismember(), signal(), sigprocmask()

sigprocmask()

Examine or change the signal mask for a thread

Synopsis:

```
#include <signal.h>

int sigprocmask( int how,
                 const sigset_t *set,
                 sigset_t *oset );
```

Arguments:

how The manner in which you want to change the set:

- SIG_BLOCK — add the signals pointed to by *set* to the thread mask.
- SIG_UNBLOCK — remove the signals pointed to by *set* from the thread mask.
- SIG_SETMASK — set the thread mask to be the signals pointed to by *set*.

set NULL, or a pointer to a **sigset_t** object that defines the signals that you want to change in the thread's signal mask. If this argument is NULL, the *how* argument is ignored.

oset NULL, or a pointer to a **sigset_t** object that the function sets to indicate the thread's current signal mask.

Library:

libc

Description:

The *sigprocmask()* function is used to examine or change (or both) the signal mask for the calling thread. If the value of *set* isn't NULL, it points to a set of signals to be used to change the currently blocked set.

The *set* argument isn't changed. The resulting set is maintained in the process table of the calling thread. If a signal occurs on a signal that's

masked, it becomes pending, but doesn't affect the execution of the process. You can examine pending signals by calling *sigpending()*. When a pending signal is unmasked, it's acted upon immediately, before this function returns.

When a signal handler is invoked, the signal responsible is automatically masked before its handler is called. If the handler returns normally, the operating system restores the signal mask present just before the handler was called as an atomic operation. Changes made using *sigprocmask()* in the handler are undone.

The *sigaction()* function lets you specify any mask that's applied before a handler is invoked. This can simplify multiple signal handler design.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EAGAIN Insufficient system resources are available to mask the signals.

EFAULT A fault occurred trying to access the buffers provided.

EINVAL The value of *how* is invalid, or you tried to set SIGKILL or SIGSTOP to something other than SIG_DFL.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>

int main( void )
  {
    sigset_t set, oset, pset;

    sigemptyset( &set );
```

```
    sigaddset( &set, SIGINT );
    sigprocmask( SIG_BLOCK, &set, &oset );
    printf( "Old set was %8.8ld.\n", oset );

    sigpending( &pset );
    printf( "Pending set is %8.8ld.\n", pset );

    kill( getpid(), SIGINT );

    sigpending( &pset );
    printf( "Pending set is %8.8ld.\n", pset );

    sigprocmask( SIG_UNBLOCK, &set, &oset );

    /* The program terminates with a SIGINT */
    return( EXIT_SUCCESS );
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

kill(), raise(), sigaction(), sigaddset(), sigdelset(), sigemptyset(), sigfillset(), sigismember(), signal(), SignalProcmask(), sigpending()

sigqueue()

Queue a signal to a process

Synopsis:

```
#include <signal.h>

int sigqueue ( pid_t pid,
               int signo,
               const union sigval value );
```

Arguments:

pid The ID of the process that you want to signal.

signo Zero, or the number of the signal that you want to queue for the process. For more information, see "POSIX signals" in the documentation for *SignalAction()*.

value The value to queue with the signal.

Library:

libc

Description:

The *sigqueue()* function causes the signal, *signo* to be sent with the specified value to the process, *pid*. If *signo* is zero, error checking is performed, but no signal is actually sent. This is one way of checking to see if *pid* is valid.

The condition required for a process to have permission to queue a signal to another process is the same as for the *kill()* function — the real or effective user ID of the sending process must match the real or effective user ID of the receiving process.

The *sigqueue()* function returns immediately. If SA_SIGINFO is set for *signo* and if the resources are available to queue the signal, the signal is queued and sent to the receiving process. If SA_SIGINFO isn't set for the *signo*, then *signo* is sent to the receiving process if the signal isn't already pending.

If *pid* causes *signo* to be generated for the sending process, and if *signo* isn't blocked for the calling thread and if no other thread has *signo* unblocked or is waiting in a *sigwait()* function for *signo*, then either *signo* or at least one pending unblocked signal is delivered to the calling thread before *sigqueue()* returns.

Should any of multiple pending signals in the range SIGRTMIN to SIGRTMAX be selected for delivery, the lowest numbered one is delivered. The selection order between realtime and nonrealtime signals, or between multiple pending nonrealtime signals, is unspecified.

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Errors:

EAGAIN No resources were available to queue the signal. The process has already queued the maximum number of signals as returned by:

sysconf(_SC_SIGQUEUE_MAX)

that are still pending at the receiver(s), or a system-wide resource limit has been exceeded.

EINVAL The value of the *signo* argument is an invalid or unsupported signal number.

ENOSYS The function *sigqueue()* isn't supported by this implementation.

EPERM The process doesn't have the appropriate privilege to send the signal to the receiving process.

ESRCH The process *pid* doesn't exist.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

kill(), signal()

sigsetjmp()

Save the environment, including the signal mask

Synopsis:

```
#include <setjmp.h>

int sigsetjmp( sigjmp_buf env,
               int savemask );
```

Arguments:

env	A buffer where the function can save the calling environment.
savemask	Nonzero if you want to save the process's current signal mask, otherwise 0.

Library:

libc

Description:

The *sigsetjmp()* function behaves in the same way as the *setjmp()* function when *savemask* is zero. If *savemask* is nonzero, then *sigsetjmp()* also saves the thread's current signal mask as part of the calling environment.

WARNING: *Don't* use *longjmp()* or *siglongjmp()* to restore an environment saved by a call to *setjmp()* or *sigsetjmp()* in another thread. If you're lucky, your application will crash; if not, it'll look as if it works for a while, until random scribbling on the stack causes it to crash.

Returns:

Zero on the first call, or nonzero if the return is the result of a call to *siglongjmp()*.

Examples:

See *setjmp()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

setjmp(), sigaction(), sigprocmask(), sigsuspend()

sigsetmask()

Set the mask of signals to block

Synopsis:

```
#include <unix.h>

int sigsetmask( int mask );
```

Arguments:

mask A bitmask of the signals that you want to block.

Library:

libc

Description:

The *sigsetmask()* function sets the current signal mask (those signals that are blocked from delivery). Signals are blocked if the corresponding bit in *mask* is a 1; the macro *sigmask()* is provided to construct the mask for a given signum.

In normal usage, a signal is blocked using *sigblock()*. To begin a critical section, variables modified on the occurrence of the signal are examined to determine that there is no work to be done, and the process pauses awaiting work by using *sigpause()* with the mask returned by *sigblock()*.

It isn't possible to block SIGKILL, SIGSTOP, or SIGCONT; this restriction is silently imposed by the system.

Returns:

The previous set of masked signals.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Use of these interfaces should be restricted to only applications written on BSD platforms. Use of these interfaces with any of the system libraries or in multithreaded applications is unsupported.

See also:

kill(), sigaction(), sigblock(), sigmask(), signal(), sigpause(), sigprocmask(), sigunblock()

sigsuspend()

Replace the signal mask, and then suspend the thread

Synopsis:

```
#include <signal.h>

int sigsuspend( const sigset_t *sigmask );
```

Arguments:

sigmask A pointer to a **sigset_t** object that specifies the signals that you want in the thread's signal mask.

Library:

libc

Description:

The *sigsuspend()* function replaces the thread's signal mask with the set of signals pointed to by *sigmask* and then suspends the thread until delivery of a signal whose action is either to execute a signal-catching function (then return), or to terminate the thread.

Returns:

-1 (if the function returns); *errno* is set.

Errors:

EFAULT A fault occurred trying to access the buffers provided.

EINTR A signal was caught by the calling thread, and control is returned from the signal-catching function.

Examples:

```
/*
 * This program pauses until a signal other than
 * a SIGINT occurs. In this case a SIGALRM.
 */
#include <stdio.h>
#include <signal.h>
```

```
#include <stdlib.h>
#include <unistd.h>

sigset_t    set;

int main( void )
  {
    sigemptyset( &set );
    sigaddset( &set, SIGINT );

    printf( "Program suspended and immune to breaks.\n" );
    printf( "A SIGALRM will terminate the program"
        " in 10 seconds.\n" );
    alarm( 10 );
    sigsuspend( &set );
    return( EXIT_SUCCESS );
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pause(), sigaction(), sigpending(), sigprocmask()

sigtimedwait()

Wait for a signal or a timeout

Synopsis:

```
#include <signal.h>

int sigtimedwait( const sigset_t *set,
                  siginfo_t *info,
                  const struct timespec *timeout );
```

Arguments:

set A set of signals from which the function selects a pending signal.

info If this argument is NULL, the selected signal is returned by *sigwaitinfo()*; otherwise, the selected signal is stored in the *si_signo* member of *info*, and the cause of the signal is stored in the *si_code* member.

timeout NULL, or a pointer to a **timespec** structure that specifies the maximum time to wait for a pending signal.

Library:

libc

Description:

The *sigtimedwait()* function selects a pending signal from *set*, atomically clears it from the set of pending signals in the process, and returns that signal number.

If any value is queued to the selected signal, the first queued value is dequeued and, if the *info* argument is non-NULL, the value is stored in the *si_value* member of *info*. The system resources used to queue the signal are released and made available to queue other signals. If no value is queued, the content of the *si_value* member is undefined.

If no further signals are queued for the selected signal, the pending indication for that signal is reset.

If none of the signals specified by *set* are pending, *sigtimedwait()* waits for the time interval specified by the **timespec** structure *timeout*. If *timeout* is zero and if none of the signals specified by *set* are pending, then *sigtimedwait()* returns immediately with an error. If *timeout* is NULL, *sigtimedwait()* behaves the same as *sigwaitinfo()*.

Returns:

The selected signal number, or -1 if an error occurred (*errno* is set).

Errors:

EAGAIN	The *timeout* expired before a signal specified in *set* was generated, or all kernel timers are in use.
EFAULT	A fault occurred while accessing the provided buffers.
EINTR	The wait was interrupted by an unblocked, caught signal.
EINVAL	The *timeout* argument specified a *tv_nsec* value less than zero or greater than or equal to 1000 million or *set* contains an invalid or unsupported signal number.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pause(), *pthread_sigmask()*, *sigaction()*, *SignalWaitinfo()*, *sigpending()*, *sigsuspend()*, *sigwaitinfo()*, **`timespec`**

sigunblock()

Unblock signals

Synopsis:

```
#include <unix.h>

int sigunblock( int mask );
```

Arguments:

mask A bitmask of the signals that you want to unblock.

Library:

libc

Description:

The *sigunblock()* function removes the signals specified in *mask* from the set of signals currently being blocked from delivery. Signals are unblocked if the appropriate bit in *mask* is a 1; the macro *sigmask()* is provided to construct the mask for a given signum. The *sigunblock()* returns the previous mask. You can restore the previous mask by calling *sigsetmask()*.

In normal usage, a signal is blocked using *sigblock()*. To begin a critical section, variables modified on the occurrence of the signal are examined to determine that there is no work to be done, and the process pauses awaiting work by using *sigpause()* with the mask returned by *sigblock()*.

It isn't possible to block SIGKILL, SIGSTOP, or SIGCONT; this restriction is silently imposed by the system.

Returns:

The previous set of masked signals.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Use of these interfaces should be restricted to only applications written on BSD platforms. Use of these interfaces with any of the system libraries or in multithreaded applications is unsupported.

See also:

kill(), sigaction(), sigblock(), sigmask(), signal(), sigpause(), sigprocmask(), sigsetmask()

Synopsis:

```
#include <signal.h>

int sigwait( const sigset_t *set,
             int *sig );
```

Arguments:

set A pointer to a **sigset_t** object that specifies the signals you want to wait for.

sig A pointer to a location where the function can store the signal that it cleared.

Library:

libc

Description:

The *sigwait()* function selects a pending signal from *set*, atomically clears it from the set of pending signals in the system, and returns that signal number in *sig*. If there are multiple signals queued for the signal number selected, the first signal causes a return from *sigwait()* and the rest remain queued. If no signal in *set* is pending at the time of the call, the thread is suspended until one or more becomes pending.

The signals defined by *set* must be blocked before you call *sigwait()*; otherwise, the behavior is undefined. The effect of *sigwait()* on the signal actions for the signals in *set* is unspecified.

If more than one thread is using *sigwait()* to wait for the same signal, only one of the threads returns from *sigwait()* with the signal number — which one is unspecified.

Returns:

0	Success (that is, one of the signals specified by set is pending or has been generated).
EINTR	The *sigwait()* function was interrupted by a signal.
EINVAL	The *set* argument contains an invalid or unsupported signal number.
EFAULT	A fault occurred while accessing the provided buffers.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pause(), *pthread_sigmask()*, *sigaction()*, *sigpending()*, *sigsuspend()*

sigwaitinfo()

Wait for a pending signal and get its information

Synopsis:

```
#include <signal.h>

int sigwaitinfo ( const sigset_t *set,
                  siginfo_t *info );
```

Arguments:

set A pointer to a **sigset_t** object that specifies the signals you want to wait for.

info NULL, or a pointer to a **siginfo_t** structure where the function can store information about the signal.

Library:

libc

Description:

The *sigwaitinfo()* function selects a pending signal from *set*, atomically clears it from the set of pending signals in the system, and returns that signal number.

If *info* is NULL, the selected signal is returned by *sigwaitinfo()*; otherwise, the selected signal is stored in the *si_signo* member of *info* and the cause of the signal is stored in the *si_code* member.

If any value is queued to the selected signal, the first queued value is dequeued and, if the *info* argument is non-NULL, the value is stored in the *si_value* member of *info*. The system resources used to queue the signal are released and made available to queue other signals. If no value is queued, the content of the *si_value* member is undefined.

If no further signals are queued for the selected signal, the pending indication for that signal is reset.

Returns:

A signal number, or -1 if an error occurred (*errno* is set).

Errors:

EFAULT A fault occurred while accessing the buffers.

EINTR The wait was interrupted by an unblocked, caught signal.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pause(), pthread_sigmask(), sigaction(), SignalWaitinfo(), sigpending(), sigsuspend(), sigtimedwait(), sigwait()

sin(), sinf()

Calculate the sine of an angle

Synopsis:

```
#include <math.h>

double sin( double x );

float sinf( float x );
```

Arguments:

x The angle, in radians, for which you want to compute the sine.

Library:

libm

Description:

The *sin()* and *sinf()* functions compute the sine (specified in radians) of *x*. An argument with a large magnitude may yield a result with little or no significance.

Returns:

The sine value.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
  {
    printf( "%f\n", sin(.5) );
```

```
    return( EXIT_SUCCESS );
}
```

produces the output:

```
0.479426
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

acos(), asin(), atan(), atan2(), cos(), tan()

sinh(), sinhf()

Compute the hyperbolic sine

Synopsis:

```
#include <math.h>

double sinh( double x );

float sinhf( float x );
```

Arguments:

x The angle, in radians, for which you want to compute the hyperbolic sine.

Library:

libm

Description:

The *sinh()* and *sinhf()* functions compute the hyperbolic sine (specified in radians) of *x*. A range error occurs if the magnitude of *x* is too large.

Returns:

The hyperbolic sine value.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
  {
    printf( "%f\n", sinh(.5) );
```

```
    return( EXIT_SUCCESS );
}
```

produces the output:

```
0.521095
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

cosh(), errno, tanh()

sleep()

Suspend a thread for a given length of time

Synopsis:

```
#include <unistd.h>

unsigned int sleep( unsigned int seconds );
```

Arguments:

seconds The number of realtime seconds that you want to suspend the thread for.

Library:

libc

Description:

The *sleep()* function suspends the calling thread until the number of realtime seconds specified by the *seconds* argument have elapsed, or the thread receives a signal whose action is either to terminate the process or to call a signal handler. The suspension time may be greater than the requested amount, due to the scheduling of other, higher priority threads by the system.

Returns:

0 if the full time specified was completed; otherwise, the number of seconds unslept if interrupted by a signal.

Errors:

EAGAIN No timer resources were available to satisfy the request.

Examples:

```
/*
 * The following program sleeps for the
 * number of seconds specified in argv[1].
 */
#include <stdlib.h>
#include <unistd.h>
```

```
int main( int argc, char **argv )
{
    unsigned seconds;

    seconds = (unsigned) strtol( argv[1], NULL, 0 );
    sleep( seconds );

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

alarm(), *delay()*, *errno*, *nanosleep()*, *timer_create()*, *timer_gettime()*, *timer_settime()*, *usleep()*

_sleepon_broadcast()

Wake up multiple threads

Synopsis:

```
#include <pthread.h>

int _sleepon_broadcast( sleepon_t * l,
                        const volatile void * addr );
```

Arguments:

l A pointer to a **sleepon_t** that you created by calling *_sleepon_init()*.

addr The handle that the threads are waiting on. The value of *addr* is typically a data structure that controls a resource.

Library:

libc

Description:

The *_sleepon_signal()* and *_sleepon_broadcast()* functions are very similar:

- *_sleepon_signal()* wakes up a single thread that's waiting on the key, *addr*.
- *_sleepon_broadcast()* wakes up all threads that are waiting on the key, *addr*.

The waiting threads must have used the same sleepon, *l* and key, *addr*, in order to be woken up.

To be woken up, the calling threads must have been locked by *_sleepon_lock()*.

Returns:

0 Success.

≠0 Failure.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

pthread_sleepon_broadcast(), pthread_sleepon_signal(), _sleepon_destroy(), _sleepon_init(), _sleepon_lock(), _sleepon_signal(), _sleepon_unlock()

_sleepon_destroy()

Destroy a sleepon

Synopsis:

```
#include <pthread.h>

int _sleepon_destroy( sleepon_t * l );
```

Arguments:

l A pointer to a **sleepon_t** that you created by calling *_sleepon_init()*.

Library:

libc

Description:

The *_sleepon_destroy()* function destroys a **sleepon_t** structure, *l*, that has been previously initialized by *_sleepon_init()*.

If *l* hasn't been locked by *_sleepon_lock()*, *_sleepon_destroy()* locks it before destroying it.

The sleepon structure is reference-counted such that, if other threads are blocked waiting for a condition, they're be signaled to wake up, and the last one to wake up frees the memory allocated to the sleepon.

Returns:

0 Success.

≠0 Failure

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

_sleepon_broadcast(), *_sleepon_init()*, *_sleepon_lock()*, *_sleepon_signal()*, *_sleepon_unlock()*

Synopsis:

```
#include <pthread.h>

int _sleepon_init( sleepon_t ** pl,
                   unsigned flags);
```

Arguments:

pl The address of a location where the function can store a pointer to the **sleepon_t** object that it creates.

flags There are currently no flags defined; pass zero for this argument.

Library:

libc

Description:

The *_sleepon_init()* function allocates a **sleepon_t** object (which is an opaque data structure) and stores a pointer to it in the location that *pl* points to.

Returns:

0 Success.

≠0 Failure.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

_sleepon_broadcast(), *_sleepon_destroy()*, *_sleepon_lock()*, *_sleepon_signal()*, *_sleepon_unlock()*

_sleepon_lock()

Lock a sleepon

Synopsis:

```
#include <pthread.h>

int _sleepon_lock( sleepon_t * l );
```

Arguments:

l A pointer to a **sleepon_t** that you created by calling *_sleepon_init()*.

Library:

libc

Description:

The *_sleepon_lock()* function locks the mutex associated with the sleepon structure, *l*.

You must call this function before calling *_sleepon_wait()*, *_sleepon_signal()*, or *_sleepon_broadcast()*.

Returns:

EOK	Success.
EAGAIN	Insufficient system resources were available to lock the mutex.
EDEADLK	The calling thread already owns *mutex*, and the mutex doesn't allow recursive behavior.
EINVAL	Invalid mutex.

The *_sleepon_lock()* function returns the same values as *pthread_mutex_lock()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

pthread_mutex_lock(), _sleepon_broadcast(), _sleepon_destroy(), _sleepon_init(), _sleepon_signal(), _sleepon_unlock(), _sleepon_wait()

_sleepon_signal()

Wake up a single thread

Synopsis:

```
#include <pthread.h>

int _sleepon_signal( sleepon_t * l,
                     const volatile void * addr );
```

Arguments:

l	A pointer to a **sleepon_t** that you created by calling *_sleepon_init()*.
addr	The handle that the thread is waiting on. The value of *addr* is typically a data structure that controls a resource.

Library:

libc

Description:

The *_sleepon_signal()* and *_sleepon_broadcast()* functions are very similar:

- *_sleepon_signal()* wakes up a single thread that's waiting on the key, *addr*.
- *_sleepon_broadcast()* wakes up all threads that are waiting on the key, *addr*.

The waiting threads must have used the same sleepon, *l* and key, *addr*, in order to be woken up.

To be woken up, the calling threads must have been locked by *_sleepon_lock()*.

Returns:

0	Success.
≠0	Failure.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

pthread_sleepon_broadcast(), pthread_sleepon_signal(), _sleepon_broadcast(), _sleepon_destroy(), _sleepon_init(), _sleepon_lock(), _sleepon_unlock()

Unlock a sleepon

Synopsis:

```
#include <pthread.h>

int _sleepon_unlock( sleepon_t * l );
```

Arguments:

l A pointer to a **sleepon_t** that you created by calling *_sleepon_init()*.

Library:

libc

Description:

The *_sleepon_unlock()* function unlocks the mutex associated with the sleepon structure, *l*. You must have previously locked the mutex by calling *_sleepon_lock()*.

Returns:

EOK	Success.
EINVAL	Invalid mutex *mutex*.
EPERM	The current thread doesn't own *mutex*.

The *_sleepon_unlock()* function returns the same values as *pthread_mutex_unlock()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

pthread_mutex_unlock(), _sleepon_broadcast(), _sleepon_destroy(), _sleepon_init(), _sleepon_lock()

_sleepon_wait()

Wait on a sleepon lock

Synopsis:

```
#include <pthread.h>

int _sleepon_wait( sleepon_t * l,
                   const volatile void * addr,
                   _uint64 nsec);
```

Arguments:

l A pointer to a **sleepon_t** that you created by calling *_sleepon_init()*.

addr The handle that you want to wait on. The value of *addr* is typically a data structure that controls a resource.

nsec Zero, or the amount of time, in nanoseconds, to wait before the thread wakes up. If this timeout occurs, ETIMEDOUT is returned.

Library:

libc

Description:

The *_sleepon_wait()* function blocks on the sleepon *l* using the key *addr* until woken up by either a *_sleepon_signal()* or a *_sleepon_broadcast()* call that uses the same *addr* key.

The calling thread must first have locked the sleepon by calling *_sleepon_lock()*.

When the thread returns from this function, it must release the sleepon lock by calling *_sleepon_unlock()*.

Returns:

0 Success.

≠0 Failure; a nonzero *errno* value.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

_sleepon_broadcast(), *_sleepon_lock()*, *_sleepon_unlock()*, *_sleepon_signal()*

slogb()

Send a message to the system logger

Synopsis:

```
#include <stdio.h>
#include <sys/slog.h>

int slogb( int code,
           int severity,
           void * data,
           int size );
```

Arguments:

opcode	A combination of a *major* and *minor* code.
severity	The severity of the log message; see "Severity levels," in the documentation for *slogf()*.
data	A block of raw data.
size	The size of the raw data.

Library:

libc

Description:

The *slog*()* functions send log messages to the system logger, **slogger**. To send formatted messages, use *slogf()*. If you have programs that scan log files for specified codes, you can use *slogb()* or *slogi()* to send a block of structures or **int**'s, respectively.

Errors:

Any value from the Errors section in *MsgSend()*, as well as:

EACCES	Insufficient permission to write to the log file.
EINVAL	The size of the data buffer exceeds 255×4 bytes, or an odd number of bytes is being read.

ENOENT	Invalid log file or directory specified, or **slogger** isn't running.

Examples:

See *slogf()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

slogf(), *slogi()*, *vslogf()*

slogger, **sloginfo** in the *Utilities Reference*

Synopsis:

```
#include <stdio.h>
#include <sys/slog.h>

int slogf( int opcode,
           int severity,
           const char * fmt,
           ... );
```

Arguments:

opcode A combination of a *major* and *minor* code. Create the *opcode* using the **_SLOG_SETCODE(***major***,** *minor***)** macro that's defined in **<sys/slog.h>**.

The *major* and *minor* codes are defined in **<sys/slogcodes.h>**.

severity The severity of the log message; see "Severity levels," below.

fmt A standard *printf()* string followed by *printf()* arguments.

The formatting characters that you use in the message determine any additional arguments.

Library:

libc

Description:

The *slog*()* functions send log messages to the system logger, **slogger**. To send formatted messages, use *slogf()*. If you have programs that scan log files for specified codes, you can use *slogb()* or *slogi()* to send a block of structures or **int**'s, respectively.

The *vslogf()* function is an alternate form in which the arguments have already been captured using the variable-length argument facilities of **<stdarg.h>**.

Severity levels

There are eight levels of severity defined. The lowest severity is 7 and the highest is 0. The default is 7.

Manifest Name	Severity value	Description
_SLOG_SHUTDOWN	0	Shut down the system NOW (e.g. for OEM use)
_SLOG_CRITICAL	1	Unexpected unrecoverable error (e.g. hard disk error)
_SLOG_ERROR	2	Unexpected recoverable error (e.g. needed to reset a hardware controller)
_SLOG_WARNING	3	Expected error (e.g. parity error on a serial port)
_SLOG_NOTICE	4	Warnings (e.g. out of paper)
_SLOG_INFO	5	Information (e.g. printing page 3)
_SLOG_DEBUG1	6	Debug messages (normal detail)
_SLOG_DEBUG2	7	Debug messages (fine detail)

Returns:

The size of the message sent to **`slogger`**, or -1 if an error occurs.

Errors:

Any value from the Errors section in *MsgSend()*, as well as:

EACCES	Insufficient permission to write to the log file.
EINVAL	The size of the data buffer exceeds 255×4 bytes, or an odd number of bytes is being read.
ENOENT	Invalid log file or directory specified, or **`slogger`** isn't running.

Examples:

```
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <sys/slog.h>
#include <sys/slogcodes.h>

int main() {
  int i;

  for(i = 0 ; ; i++) {
    switch(rand() % 3) {
    case 0:
      slogb( _SLOG_SETCODE(_SLOGC_TEST, 0),
             _SLOG_DEBUG1, &i, sizeof(i));
      break;

    case 1:
      slogi( _SLOG_SETCODE(_SLOGC_TEST, 1),
             _SLOG_CRITICAL, 1, i);
      break;

    case 2:
      slogf( _SLOG_SETCODE(_SLOGC_TEST, 2),
              _SLOG_ERROR,
             "This is number %d", i);
      break;
    }

    sleep(1);
  }
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

slogb(), slogi(), vslogf()

`slogger`, **`sloginfo`** in the *Utilities Reference*

slogi()

Send a message to the system logger

Synopsis:

```
#include <stdio.h>
#include <sys/slog.h>

int slogi( int code,
           int severity,
           int nargs,
            ... );
```

Arguments:

opcode A combination of a *major* and *minor* code.

severity The severity of the log message; see "Severity levels," in the documentation for *slogf()*.

nargs The number of integers to send. A maximum of 32 integers is allowed.

The additional arguments are the integers that you want to write.

Library:

libc

Description:

The *slog*()* functions send log messages to the system logger, **slogger**. To send formatted messages, use *slogf()*. If you have programs that scan log files for specified codes, you can use *slogb()* or *slogi()* to send a block of structures or **int**'s, respectively.

Errors:

Any value from the Errors section in *MsgSend()*, as well as:

EACCES Insufficient permission to write to the log file.

EINVAL The size of the data buffer exceeded 32 integers.

ENOENT	Invalid log file or directory specified, or **slogger** isn't running.

Examples:

See *slogf()*

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

slogb(), *slogf()*, *slogi()*, *vslogf()*

slogger, **sloginfo** in the *Utilities Reference*

_smalloc()

Allocate memory in blocks

Synopsis:

```
#include <malloc.h>

void* _smalloc( size_t size );
```

Arguments:

size The size of the block to allocate, in bytes.

Library:

libc

Description:

The *_smalloc()* function allocates space for an object of *size* bytes. Nothing is allocated when the *size* argument has a value of zero.

This function allocates memory in blocks of *_amblksiz* bytes; *_amblksiz* is a global variable defined in **<stdlib.h>**.

You must use *_sfree()* to deallocate the memory allocated by *_smalloc()*.

Returns:

A pointer to the start of the allocated memory, or NULL if there's insufficient memory available, or if the requested *size* is zero.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

calloc(), free(), realloc(), _scalloc(), _sfree(), _srealloc()

snmp_close()

Close an SNMP session

Synopsis:

```
#include <sys/types.h>
#include <snmp/asn1.h>
#include <snmp/snmp_api.h>

extern int snmp_errno

int snmp_close( struct snmp_session * session );
```

Arguments:

session A pointer to the **snmp_session** structure that identifies the SNMP session that you want to close. This pointer was returned by a call to *snmp_open()*.

Library:

libsnmp

Description:

The *snmp_close()* function closes the input session, frees any data allocated for it, dequeues any pending requests, and closes any sockets allocated for the session.

Returns:

1 Success.

0 An error occurred (*snmp_errno* is set).

Errors:

If an error occurs, this function sets *snmp_errno* to:

SNMPERR_BAD_SESSION

The specified session wasn't open.

Classification:

SNMP

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

select(), *snmp_free_pdu()*, *snmp_open()*, **snmp_pdu**, *snmp_pdu_create()*, *snmp_read()*, *snmp_select_info()*, *snmp_send()*, **snmp_session**, *snmp_timeout()*

RFC 1157, FAQ in Internet newsgroup **comp.protocols.snmp**

Marshall T. Rose, *The Simple Book: An Introduction to Internet Management*, Revised 2nd ed. (Prentice-Hall, 1996, ISBN 0-13-451659-1)

snmp_free_pdu()

Free an SNMP Protocol Data Unit message structure

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <snmp/asn1.h>
#include <snmp/snmp_api.h>

void snmp_free_pdu( struct snmp_pdu * pdu );
```

Arguments:

pdu A pointer to the **snmp_pdu** structure that you want to free.

Library:

libsnmp

Description:

The *snmp_free_pdu()* function frees the **snmp_pdu** structure pointed to by *pdu*, and any data that it contains that was allocated with *malloc()*.

Classification:

SNMP

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

select(), *snmp_close()*, *snmp_open()*, **snmp_pdu**, *snmp_read()*, *snmp_select_info()*, *snmp_send()*, **snmp_session**, *snmp_timeout()*

RFC 1157, FAQ in Internet newsgroup **comp.protocols.snmp**

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snmp_open()

Open an SNMP session

Synopsis:

```
#include <sys/types.h>
#include <snmp/asn1.h>
#include <snmp/snmp_api.h>

extern int snmp_errno;

struct snmp_session * snmp_open(
            struct snmp_session * session );
```

Arguments:

session A pointer to a **snmp_session** structure that defines the SNMP session that you want to open.

Library:

libsnmp

Description:

The *snmp_open()* function sets up an SNMP session with the information supplied by the application in the **snmp_session** structure pointed to by *session*. Next, *snmp_open()* opens and binds the necessary UDP port.

Returns:

A pointer to a **snmp_session** structure for the created session (which is different from the pointer passed to the function), or NULL if an error occurs (*snmp_errno* is set).

Errors:

If an error occurs, this function sets *snmp_errno* to one of:

SNMPERR_BAD_ADDRESS

Unknown host.

SNMPERR_BAD_LOCPORT

Couldn't bind to the specified port.

SNMPERR_GENERR

Couldn't open the socket.

Classification:

SNMP

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

read_main_config_file(), *select()*, *snmp_close()*, *snmp_free_pdu()*, **snmp_pdu**, *snmp_pdu_create()*, *snmp_read()*, *snmp_select_info()*, *snmp_send()*, **snmp_session**, *snmp_timeout()*

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Synopsis:

```
#include <snmp/snmp_api.h>

struct snmp_pdu {
    int version;
    ipaddr address;
    oid * srcParty;
    int srcPartyLen;
    oid * dstParty;
    int dstPartyLen;
    oid * context;
    int contextLen;
    u_char * community;
    int community_len;
    int command;
    long reqid;
    long errstat;
    long errindex;

    /* Trap information */
    oid * enterprise;
    int enterprise_length;
    ipaddr agent_addr;
    int trap_type;
    int specific_type;
    u_long time;

    struct variable_list * variables;
};
```

Description:

The **snmp_pdu** structure describes a *Protocol Data Unit* (PDU), a transaction that's performed over an open session. It contains the headers and variables of an SNMP packet. The structure includes the following members:

version The version of SNMP: either SNMP_VERSION_1 or SNMP_VERSION_2.

address	The destination IP address.
srcParty	The source party being used.
srcPartyLen	The number of object identifier (OID) elements in *srcParty*. For example, if *srcParty* is `.1.3.6`, the length is 3.
dstParty	The destination party being used.
dstPartyLen	The number of OID elements in *dstParty*.
context	The context being used.
contextLen	The number of OID elements in *context*.
community	The community for outgoing requests.
community_len	The length of the community name.
command	The type of this PDU.
reqid	The request ID. The default is SNMP_DEFAULT_REQID (0).
errstat	The error status (non_repeaters in GetBulk). The default is SNMP_DEFAULT_ERRSTAT (-1).
errindex	The error index (max_repetitions in GetBulk). The default is SNMP_DEFAULT_ERRINDEX (-1).
enterprise	The system OID.
enterprise_length	The number of OID elements in *enterprise*. The default is SNMP_DEFAULT_ENTERPRISE_LENGTH (0).
agent_addr	The address of the object generating the trap.
trap_type	The trap type.
specific_type	The specific type.

time The up time. The default is SNMP_DEFAULT_TIME (0).

variables A linked list of variables, of type **variable_list**.

The **variable_list** structure is defined as:

```
typedef    struct    sockaddr_in ipaddr;

struct variable_list {
    struct variable_list* next_variable;
    oid*        name;
    int         name_length;
    u_char      type;
    union {
        long*     integer;
        u_char*   string;
        oid*      objid;
        u_char*   bitstring;
        struct counter64* counter64;
    } val;
    int         val_len;
};
```

The members are:

next_variable A pointer to the next variable. This is NULL for the last variable in the list.

name The object identifier of the variable.

name_length The number of sub IDs in *name*.

type The ASN type of variable.

val.integer The value of the variable if it's an integer.

val.string The value of the variable if it's a string.

val.objid The value of the variable if it's an object ID.

bitstring The value of the variable if it's a bitstring.

counter64 The value of the variable if it's a counter64.

val_len The length of the value.

Classification:

SNMP

See also:

snmp_close(), *snmp_free_pdu()*, *snmp_open()*, *snmp_pdu_create()*, *snmp_read()*, *snmp_send()*, **snmp_session**

RFC 1157, FAQ in Internet newsgroup **comp.protocols.snmp**

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snmp_pdu_create()

Create an SNMP Protocol Data Unit message structure

Synopsis:

```
#include <sys/types.h>
#include <netinet/in.h>
#include <snmp/snmp.h>
#include <snmp/asn1.h>
#include <snmp/snmp_api.h>
#include <snmp/snmp_client.h>

extern int snmp_errno;

struct snmp_pdu * snmp_pdu_create (int command );
```

Arguments:

command The type of message that the PDU represents:

- BULK_REQ_MSG
- GET_REQ_MSG
- GET_RSP_MSG
- GETNEXT_REQ_MSG
- INFORM_REQ_MSG
- SET_REQ_MSG
- TRP_REQ_MSG
- TRP2_REQ_MSG

as defined in **<snmp/snmp.h>**.

Library:

libsnmp

Description:

The *snmp_pdu_create()* function allocates memory for a *Protocol Data Unit* (PDU) structure for SNMP message passing. The PDU structure is initialized with default values; see the documentation for **snmp_pdu**.

Returns:

A pointer to the PDU structure created, or NULL if an error occurs (*snmp_errno* is set).

Errors:

If an error occurs, this function sets *snmp_errno* to:

SNMPERR_GENERR
: Not enough memory to create the **snmp_pdu** structure.

Classification:

SNMP

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

snmp_free_pdu(), **snmp_pdu**, *snmp_read()*, *snmp_send()*

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snmp_read()

Read an SNMP message

Synopsis:

```
#include <sys/select.h>
#include <snmp/snmp_impl.h>

void snmp_read( struct fd_set * fdset );
```

Arguments:

fdset A pointer to a **fd_set** structure that contains all the file descriptors that you want to read from.

Library:

libsnmp

Description:

The *snmp_read()* function reads a packet from each socket and its set of file descriptors and parses the packet. The resulting Protocol Data Unit (PDU) is passed to the callback routine for the session (see **snmp_session**); if the callback returns successfully, the PDU and its request are deleted.

For information on asynchronous SNMP transactions, see *snmp_select_info()*.

Classification:

SNMP

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

select(), *snmp_close()*, *snmp_open()*, **snmp_pdu**, *snmp_read()*, *snmp_select_info()*, *snmp_send()*, **snmp_session**, *snmp_timeout()*

RFC 1157, FAQ in Internet newsgroup **comp.protocols.snmp**

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snmp_select_info()

Get information that select() needs for SNMP

Synopsis:

```
#include <sys/types.h>
#include <sys/select.h>
#include <sys/time.h>
#include <snmp/snmp_api.h>

int snmp_select_info( int * numfds,
                      struct fd_set * fdset,
                      struct timeval * timeout,
                      int * block );
```

Arguments:

numfds The number of significant file descriptors in *fdset*.

fdset A pointer to a set of file descriptors that contains all of the file descriptors that you've opened for SNMP. If activity occurs on any of these file descriptors, you should call *snmp_read()* with that file-descriptor set.

timeout A pointer to a **timeval** structure that defines the longest time that SNMP can wait for a timeout. You should call *select()* with the minimum time between *timeout* and any other timeouts necessary. You should check this on each invocation of *select()*. If a timeout is received, you should call *snmp_timeout()* to see if the timeout was for SNMP. (The *snmp_timeout()* function is idempotent.)

You must provide the *timeout*, even if *block* is 1 (see below).

block Governs the behavior of *select()*:

- If *block* is 0, *select()* is requested to time out.
- If *block* is 1, *select()* is requested to block indefinitely. The timeout value is treated as undefined, although you must provide it. On return, if *block* is nonzero, the value of *timeout* is undefined.

Library:

libsnmp

Description:

The *snmp_select_info()* function is used to return information about what SNMP requires from a *select()* call.

Asynchronous SNMP transactions:

To have SNMP transactions occur asynchronously, you can invoke the functions *snmp_select_info()*, *snmp_timeout()*, and *snmp_read()* in conjunction with the system call *select()*. For more information, see *select()*.

For asynchronous transactions, invoke *snmp_select_info()* with the information you would have passed to *select()* in the absence of SNMP. The *snmp_select_info()* function modifies the information, which is subsequently passed to *select()*.

Parameters to *select()*:	**Corresponding parameters to *snmp_select_info()*:**
nfds	*numfds*
readfds	*fdset*
timeout	*timeout* — must point to an allocated (but not necessarily initialized) **timeval** structure.

The following code segment shows how to use these SNMP functions in conjunction with *select()*:

```
FD_ZERO(&fdset);
numfds=sd+1;
FD_SET(sd,&fdset);
block=0;
tvp=&timeout;
timerclear(tvp);
tvp->tv_sec = 5;
```

```
snmp_select_info(&numfds, &fdset, tvp, &block);

if(block==1)
{
  tvp = NULL;
}
count = select(numfds, &fdset, 0, 0, tvp);

if(count==0)
  snmp_timeout();
if(count>0)
  snmp_read(&fdset);
```

Returns:

The number of open sockets (i.e. the number of open sessions).

Classification:

SNMP

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

select(), *snmp_close()*, *snmp_open()*, **snmp_pdu**, *snmp_read()*, *snmp_select_info()*, *snmp_send()*, **snmp_session**, *snmp_timeout()*

RFC 1157, FAQ in Internet newsgroup **comp.protocols.snmp**

Marshall T. Rose, *The Simple Book: An Introduction to Internet Management*, Revised 2nd ed. (Prentice-Hall, 1996, ISBN 0-13-451659-1)

snmp_send()

Send SNMP messages

Synopsis:

```
#include <sys/types.h>
#include <snmp/asn1.h>
#include <netinet/in.h>
#include <snmp/snmp_api.h>

extern int snmp_errno

int snmp_send( struct snmp_session * session,
               struct snmp_pdu * pdu );
```

Arguments:

session A pointer to the **snmp_session** structure that identifies the SNMP session that you want to send the message on. This pointer was returned by a call to *snmp_open()*.

pdu A pointer to the **snmp_pdu** structure that defines the Protocol Data Unit that you want to send. Create this structure by calling *snmp_pdu_create()*.

Library:

libsnmp

Description:

The *snmp_send()* function sends the PDU on the session provided. If necessary, some of the **snmp_pdu** structure data is set from the session defaults. A request corresponding to this PDU is added to the list of outstanding requests on this session and then the packet is sent.

This function frees *pdu* unless an error occurs.

Returns:

The request ID of the generated packet, if applicable, 1 if not applicable, or 0 if an error occurs (*snmp_errno* is set).

Errors:

If an error occurs, this function sets *snmp_errno* to one of:

SNMPERR_BAD_ADDRESS

A necessary entity in the *pdu* structure was omitted. These include:

- *version*
- *address* and the **snmp_session** *peername* member
- *srcParty* (SNMP version 2 only)
- *dstParty* (SNMP version 2 only)
- *context* (SNMP version 2 only)
- *community_len* (SNMP version 1 only)

SNMPERR_BAD_SESSION

The specified session wasn't open.

SNMPERR_GENERR

An error occurred forming the packet.

Classification:

SNMP

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

select(), *snmp_close()*, *snmp_open()*, **snmp_pdu**, *snmp_pdu_create()*, *snmp_read()*, *snmp_select_info()*, *snmp_send()*, **snmp_session**, *snmp_timeout()*

RFC 1157, FAQ in Internet newsgroup **comp.protocols.snmp**

Marshall T. Rose, *The Simple Book: An Introduction to Internet Management*, Revised 2nd ed. (Prentice-Hall, 1996, ISBN 0-13-451659-1)

Structure that defines a set of transactions with similar transport characteristics

Synopsis:

```
#include <snmp/snmp_api.h>

struct snmp_session {
    u_char * community;
    int community_len;
    int retries;
    long timeout;
    char * peername;
    u_short remote_port;
    u_short local_port;
    u_char * ( *authenticator )();
    int ( * callback )();
    void * callback_magic;
    int version;
    oid * srcParty;
    int srcPartyLen;
    oid * dstParty;
    int dstPartyLen;
    oid * context;
    int contextLen;
};
```

Description:

The **snmp_session** structure describes a set of transactions sharing similar transport characteristics. It includes the following members:

community	The community for outgoing requests. The default is 0.
community_len	The length of the community name. The default is SNMP_DEFAULT_COMMUNITY_LEN (0).
retries	The number of retries before timing out. The default is SNMP_DEFAULT_RETRIES (-1).
timeout	The number of microseconds until the first timeout. Subsequent timeouts increase exponentially. The default is SNMP_DEFAULT_TIMEOUT (-1).

peername The domain name or dotted IP address of the default peer. The default is SNMP_DEFAULT_PEERNAME (NULL).

remote_port The UDP port number of the peer. The default is SNMP_DEFAULT_REMPORT (0).

local_port My UDP port number. The default is SNMP_DEFAULT_ADDRESS (0), for picked randomly.

authenticator The authentication function, or NULL if null authentication is used. If your application is using version 1 of SNMP, you must supply this member.

The *authenticator()* function is defined as:

```
u_char* authenticator( u_char* pdu,
                       int* length,
                       u_char* community,
                       int community_len)
```

The arguments are:

- *pdu* — the rest of the PDU to be authenticated.
- *length* — the length of the remaining data in the PDU, updated by *authenticator()*.
- *community* — the community name for authentication.
- *community_len* — the length of the community name.

To specify null authentication, set the *authenticator* field in **snmp_session** to NULL.

The *authenticator()* function returns an authenticated PDU, or NULL if an error occurs.

callback A function used to extract the data from the received packet (the **snmp_pdu** structure passed to

the callback). The application must supply this member.

The *callback()* function is defined as:

```
int callback( int operation,
              struct snmp_session* session,
              int reqid,
              struct snmp_pdu* pdu,
              void* magic );
```

The arguments are:

- *operation* — the possible operations are RECEIVED_MESSAGE and TIMED_OUT.
- *session* — the session that was authenticated using *community*.
- *reqid* — the request ID identifying the transaction within this session. Use 0 for traps.
- *pdu* — A pointer to PDU information. You must copy the information because it will be freed elsewhere.
- *magic* — a pointer to the data for *callback()*.

The callback should return 1 on successful completion, or 0 if it should be kept pending.

callback_magic — A pointer to data that the callback function may consider important.

version — The version of SNMP: either SNMP_VERSION_1 or SNMP_VERSION_2.

srcParty — The source party being used for this session.

srcPartyLen — The number of object identifier (OID) elements in *srcParty*. For example, if *srcParty* is `.1.3.6`, the length is 3.

dstParty — The destination party being used for this session.

dstPartyLen	The number of OID elements in *dstParty*.
context	The context being used for this session.
contextLen	The number of OID elements in *context*.

Classification:

SNMP

See also:

snmp_close(), *snmp_free_pdu()*, *snmp_open()*, **snmp_pdu**, *snmp_send()*

RFC 1157, FAQ in Internet newsgroup **comp.protocols.snmp**

Marshall T. Rose, *The Simple Book: An Introduction to Internet Management*, Revised 2nd ed. (Prentice-Hall, 1996, ISBN 0-13-451659-1)

snmp_timeout()

Timeout during an SNMP session

Synopsis:

```
#include <snmp/snmp_api.h>

void snmp_timeout( void );
```

Library:

libsnmp

Description:

The *snmp_timeout()* function handles any outstanding SNMP requests. It should be called whenever the timeout from *snmp_select_info()* expires. The *snmp_timeout()* function checks to see if any of the sessions has an outstanding request that has timed out.

If it finds one or more, and that PDU has more retries available, a new packet is formed from the PDU and is resent. If there are no more retries available, the callback for the session is used to alert the user of the timeout by setting the callback's *operation* argument to TIMED_OUT (2).

For information on asynchronous SNMP transactions, see *snmp_select_info()*.

Classification:

SNMP

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

select(), *snmp_close()*, *snmp_open()*, **snmp_pdu**, *snmp_read()*, *snmp_select_info()*, *snmp_send()*, **snmp_session**, *snmp_timeout()*

RFC 1157, FAQ in Internet newsgroup **comp.protocols.snmp**

Marshall T. Rose, *The Simple Book: An Introduction to Internet Management*, Revised 2nd ed. (Prentice-Hall, 1996, ISBN 0-13-451659-1)

Write formatted output to a character array, up to a given maximum number of characters

Synopsis:

```
#include <stdio.h>

int snprintf( char* buf,
              size_t count,
              const char* format,
              ... );
```

Arguments:

buf	A pointer to the buffer where you want to function to store the formatted string.
count	The maximum number of characters to store in the buffer, including a terminating null character.
format	A string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.

Library:

libc

Description:

The *snprintf()* function is similar to *fprintf()*, except that *snprintf()* places the generated output into the character array pointed to by *buf*, instead of writing it to a file. A null character is placed at the end of the generated character string.

Returns:

The number of characters that would have been written into the array, not counting the terminating null character, had *count* been large enough. It does this even if *count* is zero; in this case *buf* can be NULL.

If an error occurred, *snprintf()* returns a negative value and sets *errno*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

/* Create temporary file names using a counter */

char namebuf[13];
int  TempCount = 0;

char *make_temp_name( void )
{
    snprintf( namebuf, 13, "ZZ%.6o.TMP",
              TempCount++ );
    return( namebuf );
}

int main( void )
{
    FILE *tf1, *tf2;

    tf1 = fopen( make_temp_name(), "w" );
    tf2 = fopen( make_temp_name(), "w" );
    fputs( "temp file 1", tf1 );
    fputs( "temp file 2", tf2 );
    fclose( tf1 );
    fclose( tf2 );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

Be careful if you're using *snprintf()* to build a string one piece at a time. For example, this code:

```
len += snprintf(&buf[len], RECSIZE - 1 - len, ...);
```

could have a problem if *snprintf()* truncates the string. Without a separate test to compare *len* with RECSIZE, this code doesn't protect against a buffer overflow. After the call that truncates the output, *len* is larger than RECSIZE, and **`RECSIZE - 1 - len`** is a very large (unsigned) number; the next call generates unlimited output somewhere beyond the buffer.

See also:

errno, *fprintf()*, *fwprintf()*, *printf()*, *sprintf()*, *swprintf()*, *vfprintf()*, *vfwprintf()*, *vprintf()*, *vsnprintf()*, *vsprintf()*, *vswprintf()*, *vwprintf()*, *wprintf()*

sockatmark()

Determine whether a socket is at the out-of-band mark

Synopsis:

```
#include <sys/socket.h>

int sockatmark( int s );
```

Arguments:

s The file descriptor of the socket that you want to check, as returned by *socket()*.

Library:

libsocket

Description:

The *sockatmark()* function determines whether the socket specified by *s* is at the out-of-band data mark. If the protocol for the socket supports out-of-band data by marking the stream with an out-of-band data mark, *sockatmark()* returns 1 when all data preceding the mark has been read and the out-of-band data mark is the first element in the receive queue.

The *sockatmark()* function doesn't remove the out-of-band data mark from the stream.

Using this function between receive operations lets an application determine which data comes before and after out-of-band data.

Returns:

0 The socket isn't at the out-of-band data mark.

1 The socket is at the out-of-band data mark.

-1 An error occurred (*errno* is set).

Errors:

EBADF	Invalid file descriptor *s*.
ENOTTY	The *s* argument isn't the file descriptor of a valid socket.

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

recv(), recvmsg()

socket()

Create an endpoint for communication

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

int socket( int domain,
            int type,
            int protocol );
```

Arguments:

domain The communications domain that you want to use. This selects the protocol family that should be used. These families are defined in **<sys/socket.h>**.

type The type of socket you want to create. This determines the semantics of communication. Here are the currently defined types:

- SOCK_STREAM — provides sequenced, reliable, two-way, connection-based byte streams. An out-of-band data transmission mechanism may be supported.
- SOCK_DGRAM — supports datagrams, which are connectionless, unreliable messages of a fixed (typically small) maximum length.
- SOCK_RAW — provides access to internal network protocols and interfaces. Available only to the superuser, this type isn't described here.

For more information, see below.

protocol The particular protocol that you want to use with the socket. Normally, only a single protocol exists to support a particular socket type within a given protocol family. But if many protocols exist, you must specify one. The protocol number you give is particular to the communication domain where communication is to take place (see **/etc/protocols** in the *Utilities Reference*).

Library:

libsocket

Description:

The *socket()* function creates an endpoint for communication and returns a descriptor.

SOCK_STREAM sockets

SOCK_STREAM sockets are full-duplex byte streams, similar to pipes. A stream socket must be in a *connected* state before any data may be sent or received on it. To create a connection to another socket, call *connect()* call.

Once the socket is connected, you can transfer data by using *read()* and *write()* or some variant of *send()* and *recv()*. When a session has been completed, a *close()* may be performed. Out-of-band data may also be transmitted (as described in *send()*) and received (as described in *recv()*).

The communications protocols used to implement a SOCK_STREAM socket ensure that data isn't lost or duplicated. If a piece of data that the peer protocol has buffer space for can't be successfully transmitted within a reasonable length of time, the connection is considered broken and calls will indicate an error by returning -1 and setting *errno* to ETIMEDOUT.

SOCK_DGRAM and SOCK_RAW sockets

With SOCK_DGRAM and SOCK_RAW sockets, datagrams can be sent to correspondents named in *send()* calls. Datagrams are generally received with *recvfrom(),* which returns the next datagram with its return address.

Using the *ioctl()* call

You can use the *ioctl()* call to specify a process group to receive a SIGURG signal when the out-of-band data arrives. The call may also enable nonblocking I/O and asynchronous notification of I/O events via SIGIO.

Socket-level options

The operation of sockets is controlled by socket-level options. These options are defined in the file **<sys/socket.h>**. Use *setsockopt()* and *getsockopt()* to set and get options.

Returns:

A descriptor referencing the socket, or -1 if an error occurs (*errno* is set).

Errors:

EACCES — Permission to create a socket of the specified type and/or protocol is denied.

EMFILE — The per-process descriptor table is full.

ENFILE — The system file table is full.

ENOBUFS — Insufficient buffer space available. The socket can't be created until sufficient resources are freed.

ENOMEM — Not enough memory.

EPROTONOSUPPORT — The protocol type or the specified protocol isn't supported within this domain.

Classification:

Standard Unix, POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

By default, *socket()* communicates with the TCP/IP stack managing the **/dev/socket** portion of the namespace. This behavior can be controlled via the SOCK environmental variable. See the examples in the **npm-tcpip.so** utility.

See also:

ICMP6, ICMP, INET6, IPv6, IP, IPsec, ROUTE, TCP, UDP, UNIX protocols

accept(), *bind()*, *close()*, *connect()*, *getprotobyname()*, *getsockname()*, *getsockopt()*, *ioctl()*, *listen()*, *read()*, *recv()*, *select()*, *send()*, *shutdown()*, *socketpair()*, *write()*

socketpair()

Create a pair of connected sockets

Synopsis:

```
#include <sys/types.h>
#include <sys/socket.h>

int socketpair( int domain,
                int type,
                int protocol,
                int * fd[2] );
```

Arguments:

domain	The communications domain where the sockets are to be created.
type	The type of sockets to create.
protocol	The protocol to use with the sockets. A protocol of 0 causes *socketpair()* to use an unspecified default protocol appropriate for the requested socket type.
fd[2]	The 2-digit integer array where the file descriptors of the created socket pair are to be held.

Library:

libsocket

Description:

The *socketpair()* call creates an unnamed pair of connected sockets in the specified *domain*, of the specified *type*, using the optionally specified *protocol* argument. The file descriptors are returned in the vector *fd* and are identical.

Valid types are described in *socket()*.

If the *protocol* argument is nonzero, it must be a protocol that's understood by the address family. No such protocols are defined at this time.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EAFNOSUPPORT
: The specified address family isn't supported on this machine.

EFAULT
: The address *sv* doesn't specify a valid part of the process address space.

EMFILE
: Too many descriptors are in use by this process.

EOPNOTSUPP
: The specified protocol doesn't support creation of socket pairs.

EPROTONOSUPPORT
: The specified protocol isn't supported on this machine.

Examples:

```
#include <stdio.h>
#include <sys/socket.h>

#define CHAR_BUFSIZE 20
int main(int argc, char **argv) {
int fd[2], len;
char message[CHAR_BUFSIZE];

if(socketpair(AF_LOCAL, SOCK_STREAM, 0, fd) == -1) {
return 1;
}

/* Print a message into one end of the socket */
snprintf(message, CHAR_BUFSIZE, "First message");
write(fd[0], message, strlen(message) + 1);

/* Print a message into the other end of the socket */
snprintf(message, CHAR_BUFSIZE, "Second message");
```

```
write(fd[1], message, strlen(message) + 1);

/* Read back the data written to the first socket */
len = read(fd[0], message, CHAR_BUFSIZE-1);
message[len] = '\0';
printf("Read [%s] from first fd \n", message);

/* Read back the data written to the second socket */
len = read(fd[1], message, CHAR_BUFSIZE-1);
message[len] = '\0';
printf("Read [%s] from second fd \n", message);

close(fd[0]);
close(fd[1]);

return 0;
}
```

Classification:

POSIX 1003.1-2001

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

read(), socket(), write()

SOCKSinit()

Initialize a connection with a SOCKS server

Synopsis:

```
#include <sys/select.h>

int SOCKSinit( char * progname );
```

Arguments:

progname The name that you want to associate with the your program. The default is **SOCKSclient**.

Library:

libsocks

Description:

The *SOCKSinit()* function initializes some defaults for the SOCKS library and also sets the program name that appears in the **syslog** output.

You don't have to call this function before making a SOCKS library call (but if you don't, a generic "SOCKSclient" appears instead of the program name).

For more information about SOCKS and its libraries, see the appendix, SOCKS — A Basic Firewall.

Returns:

0 Success.

1 An error occurred (*errno* is set).

Classification:

SOCKS

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

Raccept(), *Rbind()*, *Rconnect()*, *Rgetsockname()*, *Rlisten()*, *Rrcmd()*, *Rselect()*

SOCKS — A Basic Firewall

Synopsis:

```
#include <unistd.h>
#include <fcntl.h>
#include <sys/stat.h>
#include <sys/types.h>
#include <share.h>

int sopen( const char* filename,
           int oflag,
           int share,
           ... );
```

Arguments:

filename The path name of the file that you want to open.

oflag Flags that specify the status and access modes of the file. This argument is a combination of the following bits (defined in **<fcntl.h>**):

- O_RDONLY — permit the file to be only read.
- O_WRONLY — permit the file to be only written.
- O_RDWR — permit the file to be both read and written.
- O_APPEND — cause each record that's written to be written at the end of the file.
- O_CREAT — create the file if it doesn't exist. This bit has no effect if the file already exists.
- O_TRUNC — truncate the file to contain no data if the file exists; this bit has no effect if the file doesn't exist.
- O_EXCL — open the file for exclusive access. If the file exists and you also specify O_CREAT, the open fails (that is, use O_EXCL to ensure that the file doesn't already exist).

share The shared access for the file. This is a combination of the following bits (defined in **<share.h>**):

- SH_COMPAT — set compatibility mode.
- SH_DENYRW — prevent read or write access to the file.
- SH_DENYWR — prevent write access to the file.
- SH_DENYRD — prevent read access to the file.
- SH_DENYNO — permit both read and write access to the file.

If you set O_CREAT in *oflag*, you must also specify the following argument:

mode An object of type **mode_t** that specifies the access mode that you want to use for a newly created file. For more information, see "Access permissions" in the documentation for *stat()*.

Library:

libc

Description:

The *sopen()* function opens a file at the operating system level for shared access. The name of the file to be opened is given by *filename*.

The file is accessed according to the access mode specified by *oflag*. You must specify O_CREAT if the file doesn't exist.

The sharing mode of the file is given by the *share* argument. The optional argument is the file permissions to be used when O_CREAT flag is on in the *oflag* mode; you must provide this when the file is to be created.

The *sopen()* function applies the current file permission mask to the specified permissions (see *umask()*).

Note that

```
open( path, oflag, ... );
```

is the same as:

```
sopen( path, oflag, SH_COMPAT, ... );
```

The *sopen()* function ignores advisory locks that you may have set by calling *fcntl()*.

Returns:

A descriptor for the file, or -1 if an error occurs while opening the file (*errno* is set).

Errors:

EACCES	Search permission is denied on a component of the path prefix, or the file exists and the permissions specified by *oflag* are denied, or the file doesn't exist and write permission is denied for the parent directory of the file to be created.
EBUSY	Sharing mode (*share*) was denied due to a conflicting open.
EISDIR	The named file is a directory, and the *oflag* argument specifies write-only or read/write access.
ELOOP	Too many levels of symbolic links or prefixes.
EMFILE	No more descriptors available (too many open files).
ENOENT	Path or file not found.
ENOSYS	The *sopen()* function isn't implemented for the filesystem specified in *path*.

Examples:

```
#include <stdlib.h>
#include <sys/stat.h>
#include <sys/types.h>
#include <fcntl.h>
#include <share.h>

int main( void )
  {
    int filedes ;

    /* open a file for output                  */
    /* replace existing file if it exists      */

    filedes = sopen( "file",
        O_WRONLY | O_CREAT | O_TRUNC,
        SH_DENYWR,
        S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP );

    /* read a file which is assumed to exist   */

    filedes = sopen( "file", O_RDONLY, SH_DENYWR );

    /* append to the end of an existing file   */
    /* write a new file if file doesn't exist */

    filedes = sopen( "file",
        O_WRONLY | O_CREAT | O_APPEND,
        SH_DENYWR,
        S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP );
    return EXIT_SUCCESS;
  }
```

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No

continued...

Safety	
Thread	Yes

See also:

chsize(), *close()*, *creat()*, *dup()*, *dup2()*, *eof()*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *fcntl()*, *fileno()*, *fstat()*, *isatty()*, *lseek()*, *open()*, *read()*, *stat()*, *tell()*, *umask()*, *write()*

sopenfd()

Open for shared access a file associated with a given descriptor

Synopsis:

```
#include <unistd.h>

int sopenfd( int fd,
             int oflag,
             int sflag );
```

Arguments:

fd A file descriptor associated with the file that you want to open.

oflag How you want to open the file; a combination of the following bits:

- O_RDONLY — permit the file to be only read.
- O_WRONLY — permit the file to be only written.
- O_RDWR — permit the file to be both read and written.
- O_APPEND — cause each record that's written to be written at the end of the file.
- O_TRUNC — if the file exists, truncate it to contain no data. This flag has no effect if the file doesn't exist.

sflag How you want the file to be shared; a combination of the following bits:

- SH_COMPAT — set compatibility mode.
- SH_DENYRW — prevent read or write access to the file.
- SH_DENYWR — prevent write access to the file.
- SH_DENYRD — prevent read access to the file.
- SH_DENYNO — permit both read and write access to the file.

Library:

libc

Description:

The *sopenfd()* function opens for shared access the file associated with the file descriptor, *fd*. The access mode, *oflag*, must be equal to or more restrictive than the access mode of the source *fd*.

Note that:

```
openfd( fd, oflag );
```

is the same as:

```
sopenfd( fd, oflag, SH_DENYNO );
```

Returns:

The file descriptor, or -1 if an error occurs (*errno* is set).

Errors:

EBADF	Invalid file descriptor *fd*.
EACCES	The access mode specified by *oflag* isn't equal to or more restrictive than the access mode of the source *fd*.
EBUSY	Sharing mode (*sflag*) was denied due to a conflicting open.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

openfd()

Synopsis:

```
#include <spawn.h>

pid_t spawn( const char * path,
             int fd_count,
             const int fd_map[ ],
             const struct inheritance * inherit,
             char * const argv[ ],
             char * const envp[ ] );
```

Arguments:

path The full path name of the executable.

fd_count The number of entries in the *fd_map* array.

fd_map An array of file descriptors that you want the child process to inherit. If *fd_count* isn't 0, *fd_map* must contain at least *fd_count* file descriptors, up to OPEN_MAX FDs. If *fd_count* is 0, *fd_map* is ignored.

When *fdmap[X]* has the value of SPAWN_FDCLOSED instead of a valid file descriptor, the file descriptor *X* will be closed in the child process.

If *fd_count* is 0, all file descriptors (except for the ones created with *fcntl()*'s FD_CLOEXEC flag) are inherited by the child process.

inherit A structure, of type **`struct inheritance`**, that indicates what you want the child process to inherit from the parent. This structure contains at least these members:

`unsigned long` *flags*

One or more of the following bits:

- SPAWN_CHECK_SCRIPT — let *spawn()* start a shell, passing *path* as a script.

- SPAWN_SEARCH_PATH — search the **PATH** environment variable for the executable.
- SPAWN_SETGROUP — set the child's process group to the value in the *pgroup* member. If this flag isn't set, the child process is part of the current process group.
- SPAWN_SETND — spawn the child process on the node specified by the *nd* member.
- SPAWN_SETSIGDEF — use the *sigdefault* member to specify the child process's set of defaulted signals. If this flag isn't specified, the child process inherits the parent process's signal actions.
- SPAWN_SETSIGMASK — use the *sigmask* member to specify the child process's signal mask.

`pid_t` *pgroup* The child process's group if SPAWN_SETGROUP is specified in the *flags* member.

If SPAWN_SETGROUP is set in *inherit.flags* and *inherit.pgroup* is set to SPAWN_NEWPGROUP, the child process starts a new process group with the process group ID set to its process ID.

`sigset_t` *sigmask*

The child process's signal mask if SPAWN_SETSIGMASK is specified in the *flags* member.

sigset_t *sigdefault*

The child process's set of defaulted signals if SPAWN_SETSIGDEF is specified in the *flags* member.

uint32_t *nd* The node descriptor of the remote node on which to spawn the child process. This member is used only if SPAWN_SETND is set in the *flags* member.

argv A pointer to an argument vector. The value in *argv[0]* should point to the filename of program being loaded, but can be NULL if no arguments are being passed. The last member of *argv must* be a NULL pointer. The value of *argv* can't be NULL.

envp A pointer to an array of character pointers, each pointing to a string defining an environment variable. The array is terminated with a NULL pointer. Each pointer points to a character string of the form:

variable=*value*

that's used to define an environment variable. If the value of *envp* is NULL, then the child process inherits the environment of the parent process.

Library:

libc

Description:

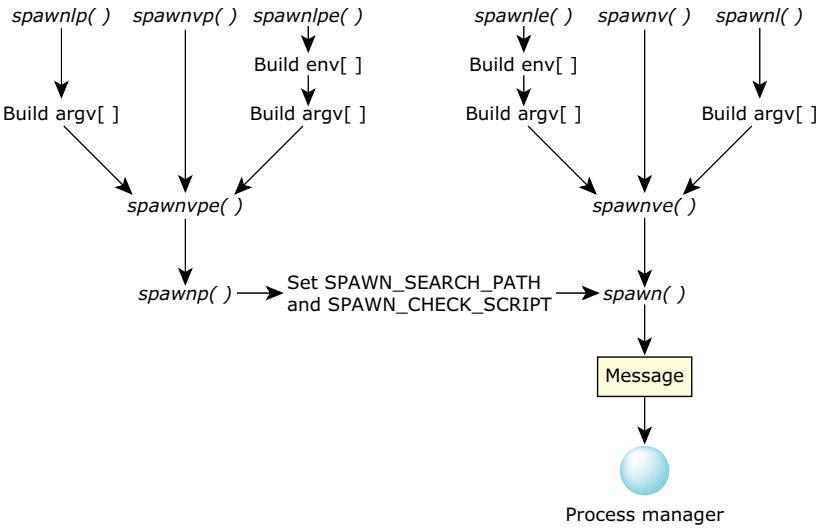
The *spawn()* function creates and executes a new child process, named in *path*.

If the child process is a shell script, the first line must start with `#!`, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawn()* function is a QNX Neutrino function (based on the POSIX 1003.1d *draft standard*). The C library also includes several specialized *spawn*()* functions. Their names consist of **`spawn`** followed by several letters:

This suffix:	Indicates the function takes these arguments:
`e`	An array of environment variables.
`l`	A NULL-terminated list of arguments to the program.
`p`	A relative path. If the path doesn't contain a slash, the **PATH** environment variable is searched for the program.
`v`	A vector of arguments to the program.

As shown below, these functions eventually call *spawn()*, which in turn sends a message to the process manager.



Most of the spawn() functions do a lot of work before a message is sent to* **procnto**.

The child process inherits the following attributes of the parent process:

- Process group ID (unless SPAWN_SETGROUP is set in *inherit.flags*)
- Session membership
- Real user ID and real group ID
- Supplementary group IDs
- Priority and scheduling policy
- Current working directory and root directory
- File creation mask
- Signal mask (unless SPAWN_SETSIGMASK is set in *inherit.flags*)
- Signal actions specified as SIG_DFL

- Signal actions specified as SIG_IGN (except the ones modified by *inherit.sigdefault* when SPAWN_SETSIGDEF is set in *inherit.flags*)

The child process has several differences from the parent process:

- Signals set to be caught by the parent process are set to the default action (SIG_DFL).
- The child process's *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* are tracked separately from the parent's.
- The number of seconds left until a SIGALRM signal would be generated is set to zero for the child process.
- The set of pending signals for the child process is empty.
- File locks set by the parent aren't inherited.
- Per-process timers created by the parent aren't inherited.
- Memory locks and mappings set by the parent aren't inherited.

If the child process is spawned on a remote node, the process group ID and the session membership aren't set; the child process is put into a new session and a new process group.

The child process can access the parent process's environment by using the *environ* global variable (found in **<unistd.h>**).

If the *path* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the child process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the child process is set to the owner ID of *path*. Similarly, if the set-group ID mode bit is set, the effective group ID of the child process is set to the group ID of *path*.

The real user ID, real group ID and supplementary group IDs of the child process remain the same as those of the parent process. The effective user ID and effective group ID of the child process are saved as the saved set-user ID and the saved set-group ID used by the *setuid()*.

☞ A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The process ID of the child process, or -1 if an error occurs (*errno* is set).

Errors:

E2BIG — The number of bytes used by the argument list and environment list of the new child process is greater than ARG_MAX bytes.

EACCESS — Search permission is denied for a directory listed in the path prefix of the new child process or the child process's file doesn't have the execute bit set or *path*'s filesystem was mounted with the ST_NOEXEC flag.

EAGAIN — Insufficient resources available to create the child process.

EBADF — An entry in *fd_map* refers to an invalid file descriptor.

EFAULT — One of the buffers specified in the function call is invalid.

ELOOP — Too many levels of symbolic links or prefixes.

EMFILE — Insufficient resources available to remap file descriptors in the child process.

ENAMETOOLONG — The length of *path* exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT — The file identified by the *path* argument is empty, or one or more components of the pathname of the child process don't exist.

ENOEXEC	The child process's file has the correct permissions, but isn't in the correct format for an executable. (This error doesn't occur if SPAWN_CHECK_SCRIPT is set in the *flags* member of the **`inheritance`** structure.)
ENOMEM	Insufficient memory available to create the child process.
ENOSYS	The *spawn()* function isn't implemented for the filesystem specified in *path*.
ENOTDIR	A component of the path prefix of the child process isn't a directory.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *setenv()*, *sigaddset()*, *sigdelset()*, *sigemptyset()*, *sigfillset()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *wait()*, *waitpid()*

Synopsis:

```
#include <process.h>

int spawnl( int mode,
            const char * path,
            const char * arg0,
            const char * arg1...,
            const char * argn,
            NULL );
```

Arguments:

mode How you want to load the child process, and how you want the parent program to behave after the child program is initiated:

- P_WAIT — load the child program into available memory, execute it, and make the parent program resume execution after the child process ends.
- P_NOWAIT — execute the parent program concurrently with the new child process.
- P_NOWAITO — execute the parent program concurrently with the new child process. You can't use *wait()* to obtain the exit code.
- P_OVERLAY — replace the parent program with the child program in memory and execute the child. No return is made to the parent program. This is equivalent to calling the appropriate *exec*()* function.

path The full path name of the executable.

arg0, *argn*, NULL

The arguments that you want to pass to the new process. You must terminate the list with an argument of NULL.

Library:

libc

Description:

The *spawnl()* function creates and executes a new child process, named in *path* with a NULL-terminated list of arguments in *arg0 . . . argn*.

If the new child process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawnl()* function *isn't* a POSIX 1003.1 function, and isn't guaranteed to behave the same on all operating systems. It builds an *argv*[ ] array before calling *spawn()*.

For a diagram of how the *spawn** functions are related, see the description of *spawn()*.

Arguments are passed to the child process by supplying one or more pointers to character strings as arguments. These character strings are concatenated with spaces inserted to separate the arguments to form one argument string for the child process. At least one argument, *arg0*, must be passed to the child process. By convention, this first argument is a pointer to the name of the new child process.

The child process inherits the parent's environment. The environment is the collection of environment variables whose values that have been defined with the **export** shell command, the **env** utility, or by the successful execution of the *putenv()* or *setenv()* function. A program may read these values with the *getenv()* function.

A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The *spawnl()* function's return value depends on the *mode* argument:

mode	Return value
P_WAIT	The exit status of the child process.
P_NOWAIT	The process ID of the child process. To get the exit status for a P_NOWAIT process, you must use the *waitpid()* function, giving it this process ID.
P_NOWAITO	The process ID of the child process, or 0 if the process is being started on a remote node. You can't get the exit status of a P_NOWAITO process.

If an error occurs, -1 is returned (*errno* is set).

Errors:

E2BIG
: The number of bytes used by the argument list of the new child process is greater than ARG_MAX bytes.

EACCESS
: Search permission is denied for a directory listed in the path prefix of the new child process or the new child process's file doesn't have the execute bit set.

EAGAIN
: Insufficient resources available to create the child process.

EFAULT
: One of the buffers specified in the function call is invalid.

ELOOP
: Too many levels of symbolic links or prefixes.

ENAMETOOLONG
: The length of *path* exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT	The file identified by the *path* argument is empty, or one or more components of the pathname of the child process don't exist.
ENOEXEC	The child process's file has the correct permissions, but isn't in the correct format for an executable.
ENOMEM	Insufficient memory available to create the child process.
ENOSYS	The *spawnl()* function isn't implemented for the filesystem specified in *path*.
ENOTDIR	A component of the path prefix of the child process isn't a directory.

Examples:

Run **myprog** as if the user had typed:

```
myprog ARG1 ARG2
```

at the command-line:

```
#include <stddef.h>
#include <process.h>

int exit_val;
...
exit_val = spawnl( P_WAIT, "myprog",
                   "myprog", "ARG1", "ARG2", NULL );
...
```

The program is found if **myprog** is in the current working directory.

Classification:

QNX 4

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *mode* is P_WAIT, this function is a cancellation point.

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *setenv()*, *spawn()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *wait()*, *waitpid()*

spawnle()

Spawn a child process, given a list of arguments and an environment

Synopsis:

```
#include <process.h>

int spawnle( int mode,
             const char * path,
             const char * arg0,
             const char * arg1...,
             const char * argn,
             NULL,
             const char * envp[] );
```

Arguments:

mode How you want to load the child process, and how you want the parent program to behave after the child program is initiated:

- P_WAIT — load the child program into available memory, execute it, and make the parent program resume execution after the child process ends.
- P_NOWAIT — execute the parent program concurrently with the new child process.
- P_NOWAITO — execute the parent program concurrently with the new child process. You can't use *wait()* to obtain the exit code.
- P_OVERLAY — replace the parent program with the child program in memory and execute the child. No return is made to the parent program. This is equivalent to calling the appropriate *exec*()* function.

path The full path name of the executable.

arg0, *argn*, NULL

The arguments that you want to pass to the new process. You must terminate the list with an argument of NULL.

envp NULL, or a pointer to an array of character pointers, each pointing to a string that defines an environment variable.

The array is terminated with a NULL pointer. Each pointer points to a character string of the form:

variable=*value*

that's used to define an environment variable.

Library:

libc

Description:

The *spawnle()* function creates and executes a new child process, named in *path* with NULL-terminated list of arguments in *arg0* ... *argn* and with the environment specified in *envp*.

If the new child process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawnle()* function *isn't* a POSIX 1003.1 function, and isn't guaranteed to behave the same on all operating systems. It builds *argv*[ ] and *envp*[ ] arrays before calling *spawn()*.

For a diagram of how the *spawn** functions are related, see the description of *spawn()*.

Arguments are passed to the child process by supplying one or more pointers to character strings as arguments. These character strings are concatenated with spaces inserted to separate the arguments to form one argument string for the child process. At least one argument, *arg0*, must be passed to the child process. By convention, this first argument is a pointer to the name of the new child process.

If *envp* is NULL, the child process inherits the environment of the parent process. The new process can access the calling process environment by using the *environ* global variable (found in **<unistd.h>**).

☞ A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The *spawnle()* function's return value depends on the *mode* argument:

mode	Return value
P_WAIT	The exit status of the child process.
P_NOWAIT	The process ID of the child process. To get the exit status for a P_NOWAIT process, you must use the *waitpid()* function, giving it this process ID.
P_NOWAITO	The process ID of the child process, or 0 if the process is being started on a remote node. You can't get the exit status of a P_NOWAITO process.

If an error occurs, -1 is returned (*errno* is set).

Errors:

E2BIG	The number of bytes used by the argument list or environment list of the new child process is greater than ARG_MAX bytes.
EACCESS	Search permission is denied for a directory listed in the path prefix of the new child process or the new child process's file doesn't have the execute bit set.
EAGAIN	Insufficient resources available to create the child process.
EFAULT	One of the buffers specified in the function call is invalid.
ELOOP	Too many levels of symbolic links or prefixes.

ENAMETOOLONG
: The length of *path* exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT
: The file identified by the *path* argument is empty, or one or more components of the pathname of the child process don't exist.

ENOEXEC
: The child process's file has the correct permissions, but isn't in the correct format for an executable.

ENOMEM
: Insufficient memory available to create the child process.

ENOSYS
: The *spawnle()* function isn't implemented for the filesystem specified in *path*.

ENOTDIR
: A component of the path prefix of the child process isn't a directory.

Examples:

Run **myprog** as if the user had typed:

```
myprog ARG1 ARG2
```

at the command-line:

```
#include <stddef.h>
#include <process.h>

char *env_list[] = { "SOURCE=MYDATA",
             "TARGET=OUTPUT",
             "lines=65",
             NULL
            };

spawnle( P_WAIT, "myprog",
    "myprog", "ARG1", "ARG2", NULL,
     env_list );
```

The program is found if **myprog** is in the current working directory. The environment for the child program consists of the three environment variables **SOURCE**, **TARGET** and **lines**.

Classification:

QNX 4

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *mode* is P_WAIT, this function is a cancellation point.

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *setenv()*, *spawn()*, *spawnl()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *wait()*, *waitpid()*

Spawn a child process, given a list of arguments and a relative path

Synopsis:

```
#include <process.h>

int spawnlp( int mode,
             const char * file,
             const char * arg0,
             const char * arg1...,
             const char * argn,
             NULL );
```

Arguments:

mode How you want to load the child process, and how you want the parent program to behave after the child program is initiated:

- P_WAIT — load the child program into available memory, execute it, and make the parent program resume execution after the child process ends.
- P_NOWAIT — execute the parent program concurrently with the new child process.
- P_NOWAITO — execute the parent program concurrently with the new child process. You can't use *wait()* to obtain the exit code.
- P_OVERLAY — replace the parent program with the child program in memory and execute the child. No return is made to the parent program. This is equivalent to calling the appropriate *exec*()* function.

file The name of the executable file. If this argument contains a slash, it's used as the pathname of the executable; otherwise, the function searches for *file* in the directories listed in the **PATH** environment variable.

arg0, *argn*, NULL

The arguments that you want to pass to the new process. You must terminate the list with an argument of NULL.

Library:

libc

Description:

The *spawnlp()* function creates and executes a new child process, named in *file* with NULL-terminated list of arguments in *arg0 . . . argn*.

If the new child process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawnlp()* function *isn't* a POSIX 1003.1 function, and isn't guaranteed to behave the same on all operating systems. It builds an *argv*[ ] array before calling *spawnp()*.

For a diagram of how the *spawn** functions are related, see the description of *spawn()*.

Arguments are passed to the child process by supplying one or more pointers to character strings as arguments. These character strings are concatenated with spaces inserted to separate the arguments to form one argument string for the child process. At least one argument, *arg0*, must be passed to the child process. By convention, this first argument is a pointer to the name of the new child process.

The child process inherits the parent's environment. The environment is the collection of environment variables whose values that have been defined with the **export** shell command, the **env** utility, or by the successful execution of the *putenv()* or *setenv()* function. A program may read these values with the *getenv()* function.

A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The *spawnlp()* function's return value depends on the *mode* argument:

mode	Return value
P_WAIT	The exit status of the child process.
P_NOWAIT	The process ID of the child process. To get the exit status for a P_NOWAIT process, you must use the *waitpid()* function, giving it this process ID.
P_NOWAITO	The process ID of the child process, or 0 if the process is being started on a remote node. You can't get the exit status of a P_NOWAITO process.

If an error occurs, -1 is returned (*errno* is set).

Errors:

E2BIG
: The number of bytes used by the argument list of the new child process is greater than ARG_MAX bytes.

EACCESS
: Search permission is denied for a directory listed in the path prefix of the new child process or the new child process's file doesn't have the execute bit set.

EAGAIN
: Insufficient resources available to create the child process.

EFAULT
: One of the buffers specified in the function call is invalid.

ELOOP
: Too many levels of symbolic links or prefixes.

ENAMETOOLONG
: The length of *file* exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT	The file identified by the *file* argument is empty, or one or more components of the pathname of the child process don't exist.
ENOEXEC	The child process's file has the correct permissions, but isn't in the correct format for an executable.
ENOMEM	Insufficient memory available to create the child process.
ENOSYS	The *spawnlp()* function isn't implemented for the filesystem specified in *file*.
ENOTDIR	A component of the path prefix of the child process isn't a directory.

Classification:

QNX 4

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *mode* is P_WAIT, this function is a cancellation point.

See also:

execl(), execle(), execlp(), execlpe(), execv(), execve(), execvp(), execvpe(), getenv(), putenv(), setenv(), spawn(), spawnl(), spawnle(), spawnlpe(), spawnp(), spawnv(), spawnve(), spawnvp(), spawnvpe(), wait(), waitpid()

Spawn a child process, given a list of arguments, an environment, and a relative path

Synopsis:

```
#include <process.h>

int spawnlpe( int mode,
              const char * file,
              const char * arg0,
              const char * arg1...,
              const char * argn,
              NULL,
              const char * envp[] );
```

Arguments:

mode How you want to load the child process, and how you want the parent program to behave after the child program is initiated:

- P_WAIT — load the child program into available memory, execute it, and make the parent program resume execution after the child process ends.
- P_NOWAIT — execute the parent program concurrently with the new child process.
- P_NOWAITO — execute the parent program concurrently with the new child process. You can't use *wait()* to obtain the exit code.
- P_OVERLAY — replace the parent program with the child program in memory and execute the child. No return is made to the parent program. This is equivalent to calling the appropriate *exec*()* function.

file The name of the executable file. If this argument contains a slash, it's used as the pathname of the executable; otherwise, the function searches for *file* in the directories listed in the **PATH** environment variable.

arg0, *argn*, NULL

The arguments that you want to pass to the new process. You must terminate the list with an argument of NULL.

envp NULL, or a pointer to an array of character pointers, each pointing to a string that defines an environment variable. The array is terminated with a NULL pointer. Each pointer points to a character string of the form:

variable=*value*

that's used to define an environment variable.

Library:

libc

Description:

The *spawnlpe()* function creates and executes a new child process, named in *file* with NULL-terminated list of arguments in *arg0* . . . *argn* and with the environment specified in *envp*.

If the new child process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawnlpe()* function *isn't* a POSIX 1003.1 function, and isn't guaranteed to behave the same on all operating systems. It builds *argv*[ ] and *envp*[ ] arrays before calling *spawnp()*.

For a diagram of how the *spawn** functions are related, see the description of *spawn()*.

Arguments are passed to the child process by supplying one or more pointers to character strings as arguments. These character strings are concatenated with spaces inserted to separate the arguments to form one argument string for the child process. At least one argument, *arg0*, must be passed to the child process. By convention, this first argument is a pointer to the name of the new child process.

If the value of *envp* is NULL, then the child process inherits the environment of the parent process. The new process can access the

calling process environment by using the *environ* global variable (found in **<unistd.h>**).

☞ A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The *spawnlpe()* function's return value depends on the *mode* argument:

mode	Return value
P_WAIT	The exit status of the child process.
P_NOWAIT	The process ID of the child process. To get the exit status for a P_NOWAIT process, you must use the *waitpid()* function, giving it this process ID.
P_NOWAITO	The process ID of the child process, or 0 if the process is being started on a remote node. You can't get the exit status of a P_NOWAITO process.

If an error occurs, -1 is returned (*errno* is set).

Errors:

E2BIG	The number of bytes used by the argument list or environment list of the new child process is greater than ARG_MAX bytes.
EACCESS	Search permission is denied for a directory listed in the path prefix of the new child process or the new child process's file doesn't have the execute bit set.
EAGAIN	Insufficient resources available to create the child process.
EFAULT	One of the buffers specified in the function call is invalid.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *file* exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT — The file identified by the *file* argument is empty, or one or more components of the pathname of the child process don't exist.

ENOEXEC — The child process's file has the correct permissions, but isn't in the correct format for an executable.

ENOMEM — Insufficient memory available to create the child process.

ENOSYS — The *spawnlpe()* function isn't implemented for the filesystem specified in *file*.

ENOTDIR — A component of the path prefix of the child process isn't a directory.

Classification:

QNX 4

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *mode* is P_WAIT, this function is a cancellation point.

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *setenv()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *wait()*, *waitpid()*

spawnp()

Create and execute a new child process, given a relative path

Synopsis:

```
#include <spawn.h>

pid_t spawnp( const char * file,
              int fd_count,
              const int fd_map[ ],
              const struct inheritance * inherit,
              char * const argv[ ],
              char * const envp[ ] );
```

Arguments:

file — If this argument contains a slash, it's used as the pathname of the executable; otherwise, the **PATH** environment variable is searched for *file*.

fd_count — The number of entries in the *fd_map* array.

fd_map — An array of file descriptors that you want the child process to inherit. If *fd_count* isn't `0`, *fd_map* must contain at least *fd_count* file descriptors, up to OPEN_MAX FDs. If *fd_count* is `0`, *fd_map* is ignored.

When *fdmap[X]* has the value of SPAWN_FDCLOSED instead of a valid file descriptor, the file descriptor *X* will be closed in the child process.

If *fd_count* is `0`, all file descriptors (except for the ones created with *fcntl()*'s FD_CLOEXEC flag) are inherited by the child process.

inherit — A structure, of type **`struct inheritance`**, that indicates what you want the child process to inherit from the parent. This structure contains at least these members:

`unsigned long` *flags*

One or more of the following bits:

- SPAWN_CHECK_SCRIPT — let *spawn()* start a shell, passing *path* as a script.
- SPAWN_SEARCH_PATH — search the **PATH** environment variable for the executable.
- SPAWN_SETGROUP — set the child process's group to the value in the *pgroup* member. If this flag isn't set, the child process is part of the current process group.
- SPAWN_SETND — spawn the child process on the node specified by the *nd* member.
- SPAWN_SETSIGDEF — use the *sigdefault* member to specify the child process's set of defaulted signals. If this flag isn't specified, the child process inherits the parent process's signal actions.
- SPAWN_SETSIGMASK — use the *sigmask* member to specify the child process's signal mask.

`pid_t` *pgroup* The child process's group if SPAWN_SETGROUP is specified in the *flags* member.

If SPAWN_SETGROUP is set in *inherit.flags* and *inherit.pgroup* is set to SPAWN_NEWPGROUP, the child process starts a new process group with the process group ID set to its process ID.

`sigset_t` *sigmask*

The child process's signal mask if SPAWN_SETSIGMASK is specified in the *flags* member.

sigset_t *sigdefault*
: The child process's set of defaulted signals if SPAWN_SETSIGDEF is specified in the *flags* member.

uint32_t *nd*
: The node descriptor of the remote node on which to spawn the child process. This member is used only if SPAWN_SETND is set in the *flags* member.

argv
: A pointer to an argument vector. The value in *argv[0]* should point to the filename of program being loaded, but can be NULL if no arguments are being passed. The last member of *argv must* be a NULL pointer. The value of *argv* can't be NULL.

envp
: A pointer to an array of character pointers, each pointing to a string defining an environment variable. The array is terminated with a NULL pointer. Each pointer points to a character string of the form:

  variable=*value*

  that's used to define an environment variable. If the value of *envp* is NULL, then the child process inherits the environment of the parent process.

Library:

libc

Description:

The *spawnp()* function creates and executes a new child process, named in *file*. It sets the SPAWN_CHECK_SCRIPT and SPAWN_SEARCH_PATH flags (see below), and calls *spawn()*.

If the new child process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawnp()* function is a QNX function (based on the POSIX 1003.1d *draft standard*). The C library also includes several specialized *spawn*()* functions. Their names consist of **spawn** followed by several letters:

This suffix:	Indicates the function takes these arguments:
e	An array of environment variables.
l	A NULL-terminated list of arguments to the program.
p	A relative path. If the path doesn't contain a slash, the **PATH** environment variable is searched for the program.
v	A vector of arguments to the program.

For a diagram of how the *spawn** functions are related, see the description of *spawn()*.

The child process inherits the following attributes of the parent process:

- Process group ID (unless SPAWN_SETGROUP is set in *inherit.flags*)
- Session membership
- Real user ID and real group ID
- Supplementary group IDs
- Priority and scheduling policy
- Current working directory and root directory

- File creation mask
- Signal mask (unless SPAWN_SETSIGMASK is set in *inherit.flags*)
- Signal actions specified as SIG_DFL
- Signal actions specified as SIG_IGN (except the ones modified by *inherit.sigdefault* when SPAWN_SETSIGDEF is set in *inherit.flags*)

The child process has several differences from the parent process:

- Signals set to be caught by the parent process are set to the default action (SIG_DFL).
- The child process's *tms_utime*, *tms_stime*, *tms_cutime*, and *tms_cstime* are tracked separately from the parent's.
- The number of seconds left until a SIGALRM signal would be generated is set to zero for the child process.
- The set of pending signals for the child process is empty.
- File locks set by the parent aren't inherited.
- Per-process timers created by the parent aren't inherited.
- Memory locks and mappings set by the parent aren't inherited.

If the child process is spawned on a remote node, the process group ID and the session membership aren't set; the child process is put into a new session and a new process group.

The child process can access the parent process's environment by using the *environ* global variable (found in **<unistd.h>**).

If the *file* is on a filesystem mounted with the ST_NOSUID flag set, the effective user ID, effective group ID, saved set-user ID and saved set-group ID are unchanged for the child process. Otherwise, if the set-user ID mode bit is set, the effective user ID of the child process is set to the owner ID of *file*. Similarly, if the set-group ID mode bit is set, the effective group ID of the child process is set to the group ID of *file*. The real user ID, real group ID and supplementary group IDs

of the child process remain the same as those of the parent process. The effective user ID and effective group ID of the child process are saved as the saved set-user ID and the saved set-group ID used by the *setuid()*.

A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The process ID of the child process, or -1 if an error occurs (*errno* is set).

Errors:

E2BIG	The number of bytes used by the argument list and environment list of the new child process is greater than ARG_MAX bytes.
EACCESS	Search permission is denied for a directory listed in the path prefix of the new child process or the new child process's file doesn't have the execute bit set or *file*'s filesystem was mounted with the ST_NOEXEC flag.
EAGAIN	Insufficient resources available to create the child process.
EBADF	An entry in *fd_map* refers to an invalid file descriptor.
EFAULT	One of the buffers specified in the function call is invalid.
ELOOP	Too many levels of symbolic links or prefixes.
EMFILE	Insufficient resources available to remap file descriptors in the child process.

ENAMETOOLONG
: The length of *file* exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT
: The file identified by the *file* argument is empty, or one or more components of the pathname of the child process don't exist.

ENOEXEC
: The child process's file has the correct permissions, but isn't in the correct format for an executable.

ENOMEM
: Insufficient memory available to create the child process.

ENOSYS
: The *spawnp()* function isn't implemented for the filesystem specified in *file*.

ENOTDIR
: A component of the path prefix of the child process isn't a directory.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *setenv()*, *sigaddset()*, *sigdelset()*, *sigemptyset()*, *sigfillset()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*,

spawnlpe(), *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *wait()*, *waitpid()*

spawnv()

Spawn a child process, given a vector of arguments

Synopsis:

```
#include <process.h>

int spawnv( int mode,
            const char * path,
            char * const argv[] );
```

Arguments:

mode How you want to load the child process, and how you want the parent program to behave after the child program is initiated:

- P_WAIT — load the child program into available memory, execute it, and make the parent program resume execution after the child process ends.
- P_NOWAIT — execute the parent program concurrently with the new child process.
- P_NOWAITO — execute the parent program concurrently with the new child process. You can't use *wait()* to obtain the exit code.
- P_OVERLAY — replace the parent program with the child program in memory and execute the child. No return is made to the parent program. This is equivalent to calling the appropriate *exec*()* function.

path The full path name of the executable.

argv A pointer to an argument vector. The value in *argv[0]* should point to a filename that's associated with the program that you're loading. The last member of *argv must* be a NULL pointer. The value of *argv* can't be NULL, and *argv[0]* can't be a NULL pointer, even if you're not passing any argument strings.

Library:

libc

Description:

The *spawnv()* function creates and executes a new child process, named in *path* with the NULL-terminated list of arguments in the *argv* vector.

☞ If the new child process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawnv()* function *isn't* a POSIX 1003.1 function, and isn't guaranteed to behave the same on all operating systems. It calls *spawnve()* before calling *spawn()*.

For a diagram of how the *spawn** functions are related, see the description of *spawn()*.

The child process inherits the parent's environment. The environment is the collection of environment variables whose values that have been defined with the **export** shell command, the **env** utility, or by the successful execution of the *putenv()* or *setenv()* function. A program may read these values with the *getenv()* function.

☞ A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The *spawnv()* function's return value depends on the *mode* argument:

mode	Return value
P_WAIT	The exit status of the child process.
P_NOWAIT	The process ID of the child process. To get the exit status for a P_NOWAIT process, you must use the *waitpid()* function, giving it this process ID.
P_NOWAITO	The process ID of the child process, or 0 if the process is being started on a remote node. You can't get the exit status of a P_NOWAITO process.

If an error occurs, -1 is returned (*errno* is set).

Errors:

E2BIG — The number of bytes used by the argument list of the new child process is greater than ARG_MAX bytes.

EACCESS — Search permission is denied for a directory listed in the path prefix of the new child process or the new child process's file doesn't have the execute bit set.

EAGAIN — Insufficient resources available to create the child process.

EFAULT — One of the buffers specified in the function call is invalid.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *path* exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT — The file identified by the *path* argument is empty, or one or more components of the pathname of the child process don't exist.

ENOEXEC — The child process's file has the correct permissions, but isn't in the correct format for an executable.

ENOMEM	Insufficient memory available to create the child process.
ENOSYS	The *spawnv()* function isn't implemented for the filesystem specified in *path*.
ENOTDIR	A component of the path prefix of the child process isn't a directory.

Examples:

Run **myprog** as if a user had typed:

```
myprog ARG1 ARG2
```

at the command-line:

```
#include <stddef.h>
#include <process.h>

char *arg_list[] = { "myprog", "ARG1", "ARG2", NULL };
⋮
spawnv( P_WAIT, "myprog", arg_list );
```

The program is found if **myprog** is in the current working directory.

Classification:

QNX 4

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *mode* is P_WAIT, this function is a cancellation point.

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *setenv()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *wait()*, *waitpid()*

Spawn a child process, given a vector of arguments and an environment

Synopsis:

```
#include <process.h>

int spawnve( int mode,
             const char * path,
             char * const argv[],
             char * const envp[] );
```

Arguments:

mode How you want to load the child process, and how you want the parent program to behave after the child program is initiated:

- P_WAIT — load the child program into available memory, execute it, and make the parent program resume execution after the child process ends.
- P_NOWAIT — execute the parent program concurrently with the new child process.
- P_NOWAITO — execute the parent program concurrently with the new child process. You can't use *wait()* to obtain the exit code.
- P_OVERLAY — replace the parent program with the child program in memory and execute the child. No return is made to the parent program. This is equivalent to calling the appropriate *exec*()* function.

path The full path name of the executable.

argv A pointer to an argument vector. The value in *argv[0]* should point to a filename that's associated with the program that you're loading. The last member of *argv must* be a NULL pointer. The value of *argv* can't be NULL, and *argv[0]* can't be a NULL pointer, even if you're not passing any argument strings.

envp NULL, or a pointer to an array of character pointers, each pointing to a string that defines an environment variable.

The array is terminated with a NULL pointer. Each pointer points to a character string of the form:

variable=*value*

that's used to define an environment variable.

Library:

libc

Description:

The *spawnve()* function creates and executes a new child process, named in *path* with the NULL-terminated list of arguments in the *argv* vector.

If the new child process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawnve()* function *isn't* a POSIX 1003.1 function, and isn't guaranteed to behave the same on all operating systems. It calls *spawn()*.

For a diagram of how the *spawn** functions are related, see the description of *spawn()*.

If the value of *envp* is NULL, then the child process inherits the environment of the parent process. The new process can access the calling process environment by using the *environ* global variable (found in **<unistd.h>**).

A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The *spawnve()* function's return value depends on the *mode* argument:

mode	Return value
P_WAIT	The exit status of the child process.
P_NOWAIT	The process ID of the child process. To get the exit status for a P_NOWAIT process, you must use the *waitpid()* function, giving it this process ID.
P_NOWAITO	The process ID of the child process, or 0 if the process is being started on a remote node. You can't get the exit status of a P_NOWAITO process.

If an error occurs, -1 is returned (*errno* is set).

Errors:

E2BIG
: The number of bytes used by the argument list or environment list of the new child process is greater than ARG_MAX bytes.

EACCESS
: Search permission is denied for a directory listed in the path prefix of the new child process or the new child process's file doesn't have the execute bit set.

EAGAIN
: Insufficient resources available to create the child process.

EFAULT
: One of the buffers specified in the function call is invalid.

ELOOP
: Too many levels of symbolic links or prefixes.

ENAMETOOLONG
: The length of *path* exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT	The file identified by the *path* argument is empty, or one or more components of the pathname of the child process don't exist.
ENOEXEC	The child process's file has the correct permissions, but isn't in the correct format for an executable.
ENOMEM	Insufficient memory available to create the child process.
ENOSYS	The *spawnve()* function isn't implemented for the filesystem specified in *path*.
ENOTDIR	A component of the path prefix of the child process isn't a directory.

Classification:

QNX 4

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *mode* is P_WAIT, this function is a cancellation point.

See also:

execl(), execle(), execlp(), execlpe(), execv(), execve(), execvp(), execvpe(), getenv(), putenv(), setenv(), spawn(), spawnl(), spawnle(), spawnlp(), spawnlpe(), spawnp(), spawnv(), spawnvp(), spawnvpe(), wait(), waitpid()

Spawn a child process, given a vector of arguments and a relative path

Synopsis:

```
#include <process.h>

int spawnvp( int mode,
             const char * file,
             char * const argv[] );
```

Arguments:

mode How you want to load the child process, and how you want the parent program to behave after the child program is initiated:

- P_WAIT — load the child program into available memory, execute it, and make the parent program resume execution after the child process ends.
- P_NOWAIT — execute the parent program concurrently with the new child process.
- P_NOWAITO — execute the parent program concurrently with the new child process. You can't use *wait()* to obtain the exit code.
- P_OVERLAY — replace the parent program with the child program in memory and execute the child. No return is made to the parent program. This is equivalent to calling the appropriate *exec*()* function.

file The name of the executable file. If this argument contains a slash, it's used as the pathname of the executable; otherwise, the function searches for *file* in the directories listed in the **PATH** environment variable.

argv A pointer to an argument vector. The value in *argv[0]* should point to a filename that's associated with the program that you're loading. The last member of *argv must* be a NULL pointer. The value of *argv* can't be NULL, and *argv[0]* can't be a NULL pointer, even if you're not passing any argument strings.

Library:

libc

Description:

The *spawnvp()* function creates and executes a new child process, named in *file* with the NULL-terminated list of arguments in the *argv* vector.

☞ If the new process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawnvp()* function *isn't* a POSIX 1003.1 function, and isn't guaranteed to behave the same on all operating systems. It calls *spawnvpe()* before calling *spawnp()*.

For a diagram of how the *spawn** functions are related, see the description of *spawn()*.

The child process inherits the parent's environment. The environment is the collection of environment variables whose values that have been defined with the **export** shell command, the **env** utility, or by the successful execution of the *putenv()* or *setenv()* function. A program may read these values with the *getenv()* function.

☞ A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The *spawnvp()* function's return value depends on the *mode* argument:

mode	Return value
P_WAIT	The exit status of the child process.
P_NOWAIT	The process ID of the child process. To get the exit status for a P_NOWAIT process, you must use the *waitpid()* function, giving it this process ID.
P_NOWAITO	The process ID of the child process, or 0 if the process is being started on a remote node. You cannot get the exit status of a P_NOWAITO process.

If an error occurs, -1 is returned (*errno* is set).

Errors:

E2BIG — The number of bytes used by the argument list of the new child process is greater than ARG_MAX bytes.

EACCESS — Search permission is denied for a directory listed in the path prefix of the new child process or the new child process's file doesn't have the execute bit set.

EAGAIN — Insufficient resources available to create the child process.

EFAULT — One of the buffers specified in the function call is invalid.

ELOOP — Too many levels of symbolic links or prefixes.

ENAMETOOLONG — The length of *file* and its path exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT — The file identified by the *file* argument is empty, or one or more components of the pathname of the new process don't exist.

ENOEXEC — The child process file has the correct permissions, but isn't in the correct format for an executable.

ENOMEM	Insufficient memory available to create the child process.
ENOSYS	The *spawnvp()* function isn't implemented for the filesystem specified in *file*.
ENOTDIR	A component of the path prefix of the child process isn't a directory.

Classification:

QNX 4

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *mode* is P_WAIT, this function is a cancellation point.

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *setenv()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvpe()*, *wait()*, *waitpid()*

Spawn a child process, given a vector of arguments, an environment, and a relative path

Synopsis:

```
#include <spawn.h>

int spawnvpe( int mode,
              const char * file,
              char * const argv[],
              char * const envp[] );
```

Arguments:

mode How you want to load the child process, and how you want the parent program to behave after the child program is initiated:

- P_WAIT — load the child program into available memory, execute it, and make the parent program resume execution after the child process ends.
- P_NOWAIT — execute the parent program concurrently with the new child process.
- P_NOWAITO — execute the parent program concurrently with the new child process. You can't use *wait()* to obtain the exit code.
- P_OVERLAY — replace the parent program with the child program in memory and execute the child. No return is made to the parent program. This is equivalent to calling the appropriate *exec*()* function.

file The name of the executable file. If this argument contains a slash, it's used as the pathname of the executable; otherwise, the function searches for *file* in the directories listed in the **PATH** environment variable.

argv A pointer to an argument vector. The value in *argv[0]* should point to a filename that's associated with the program that you're loading. The last member of *argv must* be a NULL pointer. The value of *argv* can't be NULL, and *argv[0]* can't be a NULL pointer, even if you're not passing any argument strings.

envp NULL, or a pointer to an array of character pointers, each pointing to a string that defines an environment variable. The array is terminated with a NULL pointer. Each pointer points to a character string of the form:

variable=*value*

that's used to define an environment variable.

Library:

libc

Description:

The *spawnvpe()* function creates and executes a new child process, named in *file* with the NULL-terminated list of arguments in the *argv* vector.

☞ If the new child process is a shell script, the first line must start with **#!**, followed by the path and arguments of the shell to be run to interpret the script. The script must also be marked as executable.

The *spawnvpe()* function *isn't* a POSIX 1003.1 function, and isn't guaranteed to behave the same on all operating systems. It calls *spawnp()*.

For a diagram of how the *spawn** functions are related, see the description of *spawn()*.

If the value of *envp* is NULL, then the child process inherits the environment of the parent process. The new process can access the calling process environment by using the *environ* global variable (found in **<unistd.h>**).

☞ A parent/child relationship doesn't imply that the child process dies when the parent process dies.

Returns:

The *spawnvpe()* function's return value depends on the *mode* argument:

mode	Return value
P_WAIT	The exit status of the child process.
P_NOWAIT	The process ID of the child process. To get the exit status for a P_NOWAIT process, you must use the *waitpid()* function, giving it this process ID.
P_NOWAITO	The process ID of the child process, or 0 if the process is being started on a remote node. You cannot get the exit status of a P_NOWAITO process.

If an error occurs, -1 is returned (*errno* is set).

Errors:

E2BIG	The number of bytes used by the argument list or environment list of the new child process is greater than ARG_MAX bytes.
EACCESS	Search permission is denied for a directory listed in the path prefix of the new child process or the new child process file doesn't have the execute bit set.
EAGAIN	Insufficient resources available to create the child process.
EFAULT	One of the buffers specified in the function call is invalid.
ELOOP	Too many levels of symbolic links or prefixes.

ENAMETOOLONG
: The length of *file* plus its path exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOENT
: The file identified by the *file* argument is empty, or one or more components of the pathname of the child process don't exist.

ENOEXEC
: The child process file has the correct permissions, but isn't in the correct format for an executable.

ENOMEM
: Insufficient memory available to create the child process.

ENOSYS
: The *spawnvpe()* function isn't implemented for the filesystem specified in *file*.

ENOTDIR
: A component of the path prefix of the child process isn't a directory.

Classification:

QNX 4

Safety	
Cancellation point	Read the *Caveats*
Interrupt handler	No
Signal handler	No
Thread	Yes

Caveats:

If *mode* is P_WAIT, this function is a cancellation point.

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *getenv()*, *putenv()*, *setenv()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *wait()*, *waitpid()*

sprintf()

Print formatted output into a string

Synopsis:

```
#include <stdio.h>

int sprintf( char* buf,
             const char* format,
             ... );
```

Arguments:

buf A pointer to the buffer where you want to function to store the formatted string.

format A string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.

Library:

libc

Description:

The *sprintf()* function is similar to *fprintf()*, except that *sprintf()* places the generated output into the character array pointed to by *buf*, instead of writing it to a file. A null character is placed at the end of the generated character string.

Returns:

The number of characters written into the array, not counting the terminating null character. An error can occur while converting a value for output. When an error occurs, *errno* indicates the type of error detected.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

/* Create temporary file names using a counter */
```

```
char namebuf[13];
int  TempCount = 0;

char* make_temp_name()
  {
    sprintf( namebuf, "ZZ%.6o.TMP", TempCount++ );
    return( namebuf );
  }

int main( void )
  {
    FILE* tf1,* tf2;

    tf1 = fopen( make_temp_name(), "w" );
    tf2 = fopen( make_temp_name(), "w" );
    fputs( "temp file 1", tf1 );
    fputs( "temp file 2", tf2 );
    fclose( tf1 );
    fclose( tf2 );
    return EXIT_SUCCESS;
  }
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *fprintf()*, *fwprintf()*, *printf()*, *snprintf()*, *swprintf()*, *vfprintf()*, *vfwprintf()*, *vprintf()*, *vsnprintf()*, *vsprintf()*, *vswprintf()*, *vwprintf()*, *wprintf()*

sqrt(), sqrtf()

Calculate the nonnegative square root of a number

Synopsis:

```
#include <math.h>

double sqrt( double x );

float sqrtf( float x );
```

Arguments:

x The number that you want to calculate the square root of.

Library:

libm

Description:

These functions compute the nonnegative square root of *x*. A domain error occurs if the argument is negative.

Returns:

The nonnegative square root of the given number.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>

int main( void )
  {
    printf( "%f\n", sqrt(.5) );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
0.707107
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, exp(), log(), pow()

srand()

Start a new sequence of pseudo-random integers

Synopsis:

```
#include <stdlib.h>

void srand( unsigned int seed );
```

Arguments:

seed The seed of the sequence of pseudo-random integers.

Library:

libc

Description:

The *srand()* function uses the argument *seed* to start a new sequence of pseudo-random integers to be returned by subsequent calls to *rand()*. A particular sequence of pseudo-random integers can be repeated by calling *srand()* with the same *seed* value. The default sequence of pseudo-random integers is selected with a *seed* value of 1.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

int main( void )
  {
    int i;

    srand( 982 );
    for( i = 1; i < 10; ++i ) {
      printf( "%d\n", rand() );
    }

    /* Start the same sequence over again. */

    srand( 982 );
    for( i = 1; i < 10; ++i ) {
      printf( "%d\n", rand() );
    }
```

```
    /*
     Use the current time as a seed to
     get a different sequence.
    */

    srand( (int) time( NULL ) );
    for( i = 1; i < 10; ++i ) {
      printf( "%d\n", rand() );
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

rand()

srand48()

Initialize a sequence of pseudo-random numbers

Synopsis:

```
#include <stdlib.h>

void srand48( long seed );
```

Arguments:

seed The seed of the sequence of pseudo-random integers.

Library:

libc

Description:

The *srand48()* is used to initialize the internal buffer *r*(*n*) of *drand48()*, *lrand48()*, and *mrand48()* such that the 32 bits of the seed value are copied into the upper 32 bits of *r*(*n*), with the lower 16 bits of r(n) arbitrarily being set to **0x330E**. Additionally, the constant multiplicand and addend of the algorithm are reset to the default values: the multiplicand *a* = **0xFDEECE66D** = 25214903917 and the addend *c* = **0xB** = 11.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

drand48(), erand48(), jrand48(), lcong48(), lrand48(), mrand48(), nrand48(), seed48()

srandom()

Set the seed for a pseudo-random number generator

Synopsis:

```
#include <stdlib.h>

void srandom( unsigned int seed );
```

Arguments:

seed The seed of the sequence of pseudo-random integers.

Library:

libc

Description:

The *srandom()* function initializes the current state array using the value of *seed*.

Use this function in conjunction with the following:

initstate() Initialize the state of the pseudo-random number generator.

random() Generate a pseudo-random number using a default state.

setstate() Specify the state of the pseudo-random number generator.

The *random()* and *srandom()* functions have (almost) the same calling sequence and initialization properties as *rand()* and *srand()* Unlike *srand()*, *srandom()* doesn't return the old seed because the amount of state information used is much more than a single word. The *initstate()* and *setstate()* routines are provided to deal with restarting/changing random number generators. With 256 bytes of state information, the period of the random-number generator is greater than 269.

Like *rand()*, *random()* produces by default a sequence of numbers that can be duplicated by calling *srandom()* with 1 as the seed.

After initialization, a state array can be restarted at a different point in one of two ways:

- The *initstate()* function can be used, with the desired seed, state array, and size of the array.
- The *setstate()* function, with the desired state, can be used, followed by *srandom()* with the desired seed. The advantage of using both of these functions is that the size of the state array does not have to be saved once it is initialized.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

drand48(), *initstate()*, *rand()*, *random()*, *setstate()*, *srand()*

_srealloc()

Allocate, reallocate or free a block of memory

Synopsis:

```
#include <malloc.h>

void *_srealloc( void* ptr,
                 size_t old_size,
                 size_t new_size );
```

Arguments:

ptr	NULL, or a pointer to the block of memory that you want to reallocate.
old_size	The current size of the block, in bytes.
new_size	The size of the block to allocate, in bytes.

Library:

libc

Description:

When the value of the *ptr* argument is NULL, a new block of memory of *new_size* bytes is allocated.

If the value of *new_size* is zero, the corresponding *_sfree()* function is called to release *old_size* bytes of memory memory pointed to by *ptr*.

Otherwise, the *_srealloc()* function reallocates space for an object of *new_size* bytes by doing one of the following:

- Shrinking the allocated size of the allocated memory block *ptr* when *new_size* is sufficiently smaller than *old_size*.

  Or:

- Extending the allocated size of the allocated memory block *ptr* if there is a large enough block of unallocated memory immediately following *ptr*.

  Or:

- Allocating a new block, and copying the contents of *ptr* to the new block.

Because it's possible that a new block will be allocated, don't maintain any pointers into the old memory after a successful call to this function. These pointers will point to freed memory, with possible disastrous results when a new block is allocated.

The function returns NULL when the memory pointed to by *ptr* can't be reallocated. In this case, the memory pointed to by *ptr* isn't freed, so be sure to keep a pointer to the old memory block.

```
buffer = (char *) _srealloc( buffer, 100, 200 );
```

In the above example, *buffer* is set to NULL if the function fails, and no longer points to the old memory block. If *buffer* is your only pointer to the memory block, then you've lost access to this memory.

The *_srealloc()* function reallocates memory from the heap.

You must use *_sfree()* to deallocate the memory allocated by *_srealloc()*.

Returns:

A pointer to the start of the reallocated memory, or NULL if there's insufficient memory available, or if the value of the *new_size* argument is zero.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

calloc(), free(), realloc(), _scalloc(), _sfree(), _smalloc()

sscanf()

Scan input from a character string

Synopsis:

```
#include <stdio.h>

int sscanf( const char* in_string,
            const char* format,
            ... );
```

Arguments:

in_string	The string that you want to read from.
format	A string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.

Library:

libc

Description:

The *sscanf()* function scans input from the character string *in_string*, under control of the argument *format*. Following the format string is the list of addresses of items to receive values.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF when the scanning is terminated by reaching the end of the input string.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
  {
    int day, year;
    char weekday[20], month[20];
```

```
    sscanf( "Thursday February 0025 1999",
      "%s %s %d  %d",
      weekday, month, &day, &year );
    printf( "%s %d, %d is a %s\n",
     month, day, year, weekday );
    return EXIT_SUCCESS;
  }
```

produces the following:

```
February 25, 1999 is a Thursday
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

fscanf(), *fwscanf()*, *scanf()*, *swscanf()*, *vfscanf()*, *vfwscanf()*, *vscanf()*, *vsscanf()*, *vswscanf()*, *vwscanf()*, *wscanf()*

stat(), stat64()

Get information about a file or directory, given a path

Synopsis:

```
#include <sys/stat.h>

int stat( const char * path,
          struct stat * buf );

int stat64( const char * path,
            struct stat64 * buf );
```

Arguments:

path The path of the file or directory that you want information about.

buf A pointer to a buffer where the function can store the information; see below.

Library:

libc

Description:

The *stat()* and *stat64()* functions obtain information about the file or directory referenced in *path*. This information is placed in the structure located at the address indicated by *buf*.

`stat` structure

Here's the **stat** structure that's defined in **<sys/stat.h>**:

```
struct stat {
#if _FILE_OFFSET_BITS - 0 == 64
    ino_t           st_ino;         /* File serial number. */
    off_t           st_size;        /* File size in bytes.  */
#elif !defined(_FILE_OFFSET_BITS) || _FILE_OFFSET_BITS == 32
#if defined(__LITTLEENDIAN__)
    ino_t           st_ino;         /* File serial number. */
    ino_t           st_ino_hi;
    off_t           st_size;
    off_t           st_size_hi;
#elif defined(__BIGENDIAN__)
    ino_t           st_ino_hi;
    ino_t           st_ino;         /* File serial number. */
    off_t           st_size_hi;
    off_t           st_size;
#else
 #error endian not configured for system
#endif
#else
 #error _FILE_OFFSET_BITS value is unsupported
#endif
    dev_t           st_dev;         /* ID of the device containing the file. */
    dev_t           st_rdev;        /* Device ID.                            */
    uid_t           st_uid;         /* User ID of file.                      */
    gid_t           st_gid;         /* Group ID of file.                     */
    time_t          st_mtime;       /* Time of last data modification.       */
    time_t          st_atime;       /* Time when file data was last accessed.*/
    time_t          st_ctime;       /* Time of last file status change.      */
    mode_t          st_mode;        /* File types and permissions.           */
    nlink_t         st_nlink;       /* Number of hard links to the file.     */
    blksize_t       st_blocksize;   /* Size of a block used by st_nblocks.   */
    _int32          st_nblocks;     /* Number of blocks st_blocksize blocks. */
    blksize_t       st_blksize;     /* Preferred I/O block size for object.   */
#if _FILE_OFFSET_BITS - 0 == 64
    blkcnt_t        st_blocks;      /* No. of 512-byte blocks allocated for a file. */
#elif !defined(_FILE_OFFSET_BITS) || _FILE_OFFSET_BITS == 32
#if defined(__LITTLEENDIAN__)
    blkcnt_t        st_blocks;      /* No. of 512-byte blocks allocated for a file. */
    blkcnt_t        st_blocks_hi;
#elif defined(__BIGENDIAN__)
    blkcnt_t        st_blocks_hi;
    blkcnt_t        st_blocks;
#else
 #error endian not configured for system
#endif
#else
 #error _FILE_OFFSET_BITS value is unsupported
#endif
};
```

Access permissions

The access permissions for the file or directory are specified as a combination of bits in the *st_mode* field of a **stat** structure. These bits are defined in **<sys/stat.h>**, and are described below:

Owner	Group	Others	Permission
S_IRUSR	S_IRGRP	S_IROTH	Read
S_IRWXU	S_IRWXG	S_IRWXO	Read, write, execute/search. A bitwise inclusive OR of the other three constants. (S_IRWXU is OR of IRUSR, S_IWSUR and S_IXUSR.)
S_IWUSR	S_IWGRP	S_IWOTH	Write
S_IXUSR	S_IXGRP	S_IXOTH	Execute/search

The following bits define miscellaneous permissions used by other implementations:

Bit	Equivalent
S_IEXEC	S_IXUSR
S_IREAD	S_IRUSR
S_IWRITE	S_IWUSR

st_mode bits

The following bits are also encoded in the *st_mode* field:

S_ISUID — Set user ID on execution. The process's effective user ID is set to that of the owner of the file when the file is run as a program. On a regular file, this bit should be cleared on any write.

S_ISGID Set group ID on execution. Set effective group ID on the process to the file's group when the file is run as a program. On a regular file, this bit should be cleared on any write.

Macros

The following symbolic names for the values of *st_mode* are defined for these file types:

S_IFBLK Block special.

S_IFCHR Character special.

S_IFDIR Directory.

S_IFIFO FIFO special.

S_IFLNK Symbolic link.

S_IFMT Type of file.

S_IFNAM Special named file.

S_IFREG Regular.

S_IFSOCK Socket.

The following macros test whether a file is of a specified type. The value *m* supplied to the macros is the value of the *st_mode* field of a **stat** structure. The macros evaluate to a nonzero value if the test is true, and zero if the test is false.

S_ISBLK(*m*) Test for block special file.

S_ISCHR(*m*) Test for character special file.

S_ISDIR(*m*) Test for directory file.

S_ISFIFO(*m*) Test for FIFO.

S_ISLNK(*m*) Test for symbolic link.

S_ISNAM(*m*) Test for special named file.

S_ISREG(*m*) Test for regular file.

S_ISSOCK(*m*) Test for socket.

These macros test whether a file is of the specified type. The value of the *buf* argument supplied to the macros is a pointer to a **stat** structure. The macro evaluates to a nonzero value if the specified object is implemented as a distinct file type and the specified file type is contained in the **stat** structure referenced by the pointer *buf*. Otherwise, the macro evaluates to zero.

S_TYPEISMQ(*buf*)

Test for message queue.

S_TYPEISSEM(*buf*)

Test for semaphore.

S_TYPEISSHM(*buf*)

Test for shared memory object.

These macros manipulate device IDs:

major(*device*)

Extract the major number from a device ID.

minor(*device*)

Extract the minor number from a device ID.

makedev(*node*, *major*, *minor*)

Build a device ID from the given numbers. Currently, the *node* argument isn't used and must be zero.

The *st_rdev* member of the **stat** structure is a device ID that consists of:

- a major number in the range 0 through 63
- a minor number in the range 0 through 1023.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES Search permission is denied for a component of *path*.

EIO A physical error occurred on the block device.

ELOOP Too many levels of symbolic links or prefixes.

ENAMETOOLONG
The argument *path* exceeds PATH_MAX in length, or a pathname component is longer than NAME_MAX. These manifests are defined in the **<limits.h>** header file.

ENOENT The named file doesn't exist, or *path* is an empty string.

ENOSYS The *stat()* function isn't implemented for the filesystem specified in *path*.

ENOTDIR A component of *path* isn't a directory.

EOVERFLOW The file size in bytes or the number of blocks allocated to the file or the file serial number can't be represented correctly in the structure pointed to by *buf*.

Examples:

Determine the size of a file:

```
#include <stdio.h>
#include <stdlib.h>
#include <sys/stat.h>

int main( void )
  {
    struct stat buf;

    if( stat( "file", &buf ) != -1 ) {
      printf( "File size = %d\n", buf.st_size );
    }
    return EXIT_SUCCESS;
  }
```

Determine the amount of free memory:

```
#include <stdio.h>
#include <stdlib.h>
#include <sys/stat.h>

int main () {
   struct stat buf;

   if ( stat( "/proc", &buf ) == -1) {
      perror ("stat" );
      return EXIT_FAILURE;
   } else {
      printf ("Free memory: %d bytes\n", buf.st_size);
      return EXIT_SUCCESS;
   }
}
```

Classification:

stat() is POSIX 1003.1; *stat64()* is for large-file support

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *fstat()*, *fstat64()*, *lstat()*

statvfs(), statvfs64()

Get filesystem information, given a path

Synopsis:

```
#include <sys/statvfs.h>

int statvfs( const char *path,
             struct statvfs *buf );

int statvfs64( const char *path,
               struct statvfs64 *buf );
```

Arguments:

path The name of a file that resides on the filesystem.

buf A pointer to a buffer where the function can store the information.

Library:

libc

Description:

The *statvfs()* function returns a "generic superblock" describing a filesystem; it can be used to acquire information about mounted filesystems. The *statvfs64()* function is a 64-bit version of *statvfs()*.

The filesystem type is known to the operating system. You don't need to have read, write, or execute permission for the named file, but all directories listed in the path name leading to the file must be searchable.

The *buf* argument is a pointer to a **statvfs** or **statvfs64** structure that's filled by the function. It contains at least:

unsigned long *f_bsize*

The preferred filesystem blocksize.

unsigned long *f_frsize*

The fundamental filesystem blocksize (if supported)

fsblkcnt_t *f_blocks*

The total number of blocks on the filesystem, in units of *f_frsize*.

fsblkcnt_t *f_bfree*

The total number of free blocks.

fsblkcnt_t *f_bavail*

The number of free blocks available to a nonsuperuser.

fsfilcnt_t *f_files*

The total number of file nodes (inodes).

fsfilcnt_t *f_ffree*

The total number of free file nodes.

fsfilcnt_t *f_favail*

The number of inodes available to a nonsuperuser.

unsigned long *f_fsid*

The filesystem ID (dev for now).

char *f_basetype*[16]

The type of the target filesystem, as a null-terminated string.

unsigned long *f_flag*

A bitmask of flags; the function can set these flags:

- ST_RDONLY — read-only filesystem.
- ST_NOSUID — the filesystem doesn't support **setuid**/**setgid** semantics.

unsigned long *f_namemax*

The maximum filename length.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES	Search permission is denied on a component of the path prefix.
EFAULT	The *path* or *buf* argument points to an illegal address.
EINTR	A signal was caught during execution.
EIO	An I/O error occurred while reading the filesystem.
ELOOP	Too many symbolic links were encountered in translating *path*.
EMULTIHOP	Components of path require hopping to multiple remote machines and the filesystem type doesn't allow it.
ENAMETOOLONG	The length of a path component exceeds **{NAME_MAX}** characters, or the length of *path* exceeds **{PATH_MAX}** characters.
ENOENT	Either a component of the path prefix or the file referred to by *path* doesn't exist.
ENOLINK	The *path* argument points to a remote machine and the link to that machine is no longer active.
ENOTDIR	A component of the path prefix of *path* isn't a directory.
EOVERFLOW	One of the values to be returned can't be represented correctly in the structure pointed to by *buf*.

Classification:

statvfs() is standard Unix; *statvfs64()* is for large-file support

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The values returned for *f_files*, *f_ffree*, and *f_favail* might not be valid for NFS-mounted filesystems.

See also:

chmod(), *chown()*, *creat()*, *dup()*, *fcntl()*, *fstatvfs()*, *fstatvfs64()*, *link()*, *mknod()*, *open()*, *pipe()*, *read()*, *time()*, *unlink()*, *utime()*, *write()*

Synopsis:

```
#include <stdio.h>

FILE * stderr;
```

Description:

This global variable defines the standard error stream. It's set to the console by default, but you can redirect it by calling *freopen()*.

STDERR_FILENO, which is defined in **<unistd.h>**, defines the file descriptor that corresponds to *stderr*.

Classification:

ANSI

See also:

assert(), *err()*, *errx()*, *getopt()*, *herror()*, *perror()*, *stdin*, *stdout*, *strerror()*, *verr()*, *verrx()*, *vwarn()*, *vwarnx()*, *warn()*, *warnx()*

The standard input stream

Synopsis:

```
#include <stdio.h>

FILE * stdin;
```

Description:

This global variable defines the standard input stream. It's set to the console by default, but you can redirect it by calling *freopen()*.

STDIN_FILENO, which is defined in **<unistd.h>**, defines the file descriptor that corresponds to *stdin*.

Classification:

ANSI

See also:

fgetchar(), *getchar()*, *getchar_unlocked()*, *gets()*, *getwchar()*, *scanf()*, *stderr*, *stdout*, *vscanf()*, *vwscanf()*

Synopsis:

```
#include <stdio.h>

FILE * stdout;
```

Description:

This global variable defines the standard output stream. It's set to the console by default, but you can redirect it by calling *freopen()*.

STDOUT_FILENO, which is defined in **<unistd.h>**, defines the file descriptor that corresponds to *stdout*.

Classification:

ANSI

See also:

fputchar(), *printf()*, *putchar()*, *putchar_unlocked()*, *puts()*, *putwchar()*, *stderr*, *stdin*, *vprintf()*, *vwprintf()*, *wprintf()*

straddstr()

Concatenate one string on to the end of another

Synopsis:

```
#include <string.h>

int straddstr( const char * str,
               int len,
               char ** pbuf,
               size_t * pmaxbuf );
```

Arguments:

str	The string that you want to add to the end of another.
len	The number of characters from *str* that you want to add. If zero, the function adds all of *str*.
pbuf	The address of a pointer to the destination buffer.
pmaxbuf	A pointer to the size of the destination buffer.

Library:

libc

Description:

The *straddstr()* function adds *str* to the buffer pointed to by *pbuf*, respecting the maximum length indicated by *pmaxbuf*. The values of *pbuf* and *pmaxlen* are also updated.

Returns:

The value of *len* if it's nonzero; otherwise, the length of *str* (i.e. **strlen(***str***)**).

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcat(), strcpy(), strncat(), strncpy()

strcasecmp()

Compare two strings, ignoring case

Synopsis:

```
#include <strings.h>

int strcasecmp( const char* str1,
                const char* str2 );
```

Arguments:

str1, *str2* The strings that you want to compare.

Library:

libc

Description:

The *strcasecmp()* function compares two strings, specified by *str1* and *str2*, ignoring the case of the characters.

Returns:

< 0 *s1* is less than *s2*.

0 *s1* is equal to *s2*.

> 0 *s1* is greater than *s2*.

Examples:

```
#include <stdio.h>
#include <strings.h>
#include <stdlib.h>

void compare( const char* s1, const char* s2 )
{
    int retval;

    retval = strcasecmp( s1, s2 );
    if( retval > 0 ) {
        printf( "%s > %s\n", s1, s2 );
    } else if( retval < 0 ) {
        printf( "%s < %s\n", s1, s2 );
```

```
    } else {
        printf( "%s == %s\n", s1, s2 );
    }
}

int main( void )
{
    char* str1 = "abcdefg";
    char* str2 = "HIJ";
    char* str3 = "Abc";
    char* str4 = "aBCDEfg";

    compare( str1, str2 );
    compare( str1, str3 );
    compare( str1, str4 );
    compare( str1, str1 );

    compare( str2, str2 );
    compare( str2, str3 );
    compare( str2, str4 );
    compare( str2, str1 );

    return EXIT_SUCCESS;
}
```

This code produces output that looks like:

```
abcdefg < HIJ
abcdefg > Abc
abcdefg == aBCDEfg
abcdefg == abcdefg
HIJ == HIJ
HIJ > Abc
HIJ > aBCDEfg
HIJ > abcdefg
```

Classification:

Standard Unix

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcmp(), strcmpi(), strcoll(), stricmp(), strncasecmp(), strncmp(), strnicmp(), wcscmp(), wcscoll(), wcsncmp()

Synopsis:

```
#include <string.h>

char* strcat( char* dst,
              const char* src );
```

Arguments:

dst, *src* The strings that you want to concatenate.

Library:

libc

Description:

The *strcat()* function appends a copy of the string pointed to by *src* (including the terminating NUL character) to the end of the string pointed to by *dst*. The first character of *src* overwrites the NUL character at the end of *dst*.

Returns:

The same pointer as *dst*.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    char buffer[80];

    strcpy( buffer, "Hello " );
    strcat( buffer, "world" );

    printf( "%s\n", buffer );

    return EXIT_SUCCESS;
}
```

produces the output:

```
Hello world
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strncat(), strncpy(), strcpy()

Synopsis:

```
#include <string.h>

char* strchr(char* s,
             int c );
```

Arguments:

s The string that you want to search.

c The character that you're looking for.

Library:

libc

Description:

The *strchr()* function finds the first occurrence of *c* (converted to a **char**) in the string pointed to by *s*. The terminating NUL character is considered to be part of the string.

Returns:

A pointer to the located character, or NULL if *c* doesn't occur in the string.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    char buffer[80];
    char* where;

    strcpy( buffer, "video x-rays" );

    where = strchr( buffer, 'x' );
```

```
    if( where == NULL ) {
        printf( "'x' not found\n" );
    } else {
        printf( "'x' found: %s\n", where );
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), strcspn(), strpbrk(), strrchr(), strspn(), strstr(), strtok(), strtok_r(), wcschr(), wcscspn(), wcspbrk(), wcsrchr(), wcsspn(), wcsstr(), wcstok()

strcmp()

Compare two strings

Synopsis:

```
#include <string.h>

int strcmp( const char* s1,
            const char* s2 );
```

Arguments:

s1, *s2* The strings that you want to compare.

Library:

libc

Description:

The *strcmp()* function compares the string pointed to by *s1* to the string pointed to by *s2*.

Returns:

< 0 *s1* is less than *s2*.

0 *s1* is equal to *s2*.

> 0 *s1* is greater than *s2*.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    printf( "%d\n", strcmp( "abcdef", "abcdef" ) );
    printf( "%d\n", strcmp( "abcdef", "abc" ) );
    printf( "%d\n", strcmp( "abc", "abcdef" ) );
    printf( "%d\n", strcmp( "abcdef", "mnopqr" ) );
    printf( "%d\n", strcmp( "mnopqr", "abcdef" ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
0
1
-1
-1
1
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcasecmp(), strcmpi(), strcoll(), stricmp(), strncasecmp(), strncmp(), strnicmp(), wcscmp(), wcscoll(), wcsncmp()

strcmpi()

Compare two strings, ignoring case

Synopsis:

```
#include <string.h>

int strcmpi( const char* s1,
             const char* s2 );
```

Arguments:

s1, *s2* The strings that you want to compare.

Library:

libc

Description:

The *strcmpi()* function compares the string pointed to by *s1* to the string pointed to by *s2*, ignoring case.

All uppercase characters from *s1* and *s2* are mapped to lowercase for the purposes of doing the comparison. The *strcmpi()* function is identical to the *stricmp()* function.

Returns:

< 0 *s1* is less than *s2*.

0 *s1* is equal to *s2*.

> 0 *s1* is greater than *s2*.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    printf( "%d\n", strcmpi( "AbCDEF", "abcdef" ) );
    printf( "%d\n", strcmpi( "abcdef", "ABC"    ) );
    printf( "%d\n", strcmpi( "abc",    "ABCdef" ) );
```

```
    printf( "%d\n", strcmpi( "Abcdef", "mnopqr" ) );
    printf( "%d\n", strcmpi( "Mnopqr", "abcdef" ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
0
100
-100
-12
12
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcasecmp(), *strcmp()*, *strcoll()*, *stricmp()*, *strncasecmp()*, *strncmp()*, *strnicmp()*, *wcscmp()*, *wcscoll()*, *wcsncmp()*

Synopsis:

```
#include <string.h>

int strcoll( const char* s1,
             const char* s2 );
```

Arguments:

s1, *s2* The strings that you want to compare.

Library:

libc

Description:

The *strcoll()* function compares the strings pointed to by *s1* and *s2*, using the collating sequence selected by the *setlocale()* function.

The *strcoll()* function is equivalent to *strcmp()* when the collating sequence is selected from the **"C"** locale.

Returns:

< 0 *s1* is less than *s2*.

0 *s1* is equal to *s2*.

> 0 *s1* is greater than *s2*.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

char buffer[80] = "world";

int main( void )
{
    if( strcoll( buffer, "Hello" ) < 0 ) {
        printf( "Less than\n" );
```

```
    }

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

setlocale(), *strcasecmp()*, *strcmp()*, *strcmpi()*, *stricmp()*, *strncasecmp()*, *strncmp()*, *strnicmp()*, *wcscmp()*, *wcscoll()*, *wcsncmp()*

strcpy()

Copy a string

Synopsis:

```
#include <string.h>

char* strcpy( char* dst,
              const char* src );
```

Arguments:

dst A pointer to where you want to copy the string.

src The string that you want to copy.

Library:

libc

Description:

The *strcpy()* function copies the string pointed to by *src* (including the terminating NUL character) into the array pointed to by *dst*.

☞ Copying of overlapping objects isn't guaranteed to work properly. See the *memmove()* function for information on copying objects that overlap.

Returns:

The same pointer as *dst*.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    char buffer[80];

    strcpy( buffer, "Hello " );
    strcat( buffer, "world" );
```

```
    printf( "%s\n", buffer );

    return EXIT_SUCCESS;
}
```

produces the output:

```
Hello world
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memmove(), *strdup()*, *strncpy()*, *wcscpy()*, *wcsncpy()*, *wmemmove()*

Count the characters at the beginning of a string that aren't in a given character set

Synopsis:

```
#include <string.h>

size_t strcspn( const char* str,
                const char* charset );
```

Arguments:

str	The string that you want to search.
charset	The set of characters you want to look for.

Library:

libc

Description:

The *strcspn()* function finds the length of the initial segment of the string pointed to by *str* that consists entirely of characters *not* from the string pointed to by *charset*. The terminating NUL character isn't considered part of *str*.

Returns:

The length of the initial segment.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    printf( "%d\n", strcspn( "abcbcadef", "cba" ) );
    printf( "%d\n", strcspn( "xxxbcadef", "cba" ) );
    printf( "%d\n", strcspn( "123456789", "cba" ) );

    return EXIT_SUCCESS;
}
```

produces the output:

```
0
3
9
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), *strchr()*, *strpbrk()*, *strrchr()*, *strspn()*, *strstr()*, *strtok()*, *strtok_r()*, *wcschr()*, *wcscspn()*, *wcspbrk()*, *wcsrchr()*, *wcsspn()*, *wcsstr()*, *wcstok()*

strdup()

Create a duplicate of a string

Synopsis:

```
#include <string.h>

char* strdup( const char* src );
```

Arguments:

src The string that you want to copy.

Library:

libc

Description:

The *strdup()* function creates a duplicate of the string pointed to by *src*, and returns a pointer to the new copy.

The *strdup()* function allocates the memory for the new string by calling *malloc()*; it's up to you to release the memory by calling *free()*.

Returns:

A pointer to a copy of the string, or NULL if an error occurred.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
{
    char *dup;

    dup = strdup( "Make a copy" );
    printf( "%s\n", dup );

    return EXIT_SUCCESS;
}
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

free(), malloc(), memmove(), strcpy(), strncpy(), wcscpy(), wcsncpy(), wmemmove()

strerror()

Convert an error number into an error message

Synopsis:

```
#include <string.h>

char* strerror( int errnum );
```

Arguments:

errnum	The error number that you want the message for. This function works for any valid *errno* value.

Library:

libc

Description:

The *strerror()* function maps the error number contained in *errnum* to an error message.

Returns:

A pointer to the error message.

☞ Don't modify the string that this function returns.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <errno.h>
#include <stdlib.h>

int main( void )
{
    FILE *fp;

    fp = fopen( "file.name", "r" );
    if( fp == NULL ) {
        printf( "Unable to open file: %s\n",
            strerror( errno ) );
    }
```

```
    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *perror()*, *stderr*

Synopsis:

```
#include <time.h>

size_t strftime( char * s,
                 size_t maxsize,
                 const char * format,
                 const struct tm * timeptr );
```

Arguments:

s	A pointer to a buffer where the function can store the formatted time.
maxsize	The maximum size of the buffer.
format	The format that you want to use for the time; see "Formats," below.
timeptr	A pointer to a **tm** structure that contains the time that you want to format.

Library:

libc

Description:

The *strftime()* function formats the time in the argument *timeptr* into the array pointed to by the argument *s*, according to the *format* argument.

Formats

The *format* string consists of zero or more directives and ordinary characters. A directive consists of a **%** character followed by a character that determines the substitution that's to take place. All ordinary characters are copied unchanged into the array. No more than *maxsize* characters are placed in the array.

Local timezone information is used as if from a call to *tzset()*.

%a	Locale's abbreviated weekday name.
%A	Locale's full weekday name.
%b	Locale's abbreviated month name.
%B	Locale's full month name.
%c	Locale's appropriate date and time representation.
%d	Day of the month as a decimal number (01-31).
%D	Date in the format *mm/dd/yy*.
%e	Day of the month as a decimal number (1-31); single digits are preceded by a space.
%F	The ISO standard date format; equivalent to **%Y-%m-%d**.
%g	The last two digits of the week-based year as a decimal number (00-99).
%G	The week-based year as a decimal number (e.g. 1998).
%h	Locale's abbreviated month name.
%H	Hour (24-hour clock) as a decimal number (00-23).
%I	Hour (12-hour clock) as a decimal number (01-12).
%j	Day of the year as a decimal number (001-366).
%m	Month as a decimal number (01-12).
%M	Minute as a decimal number (00-59).
%n	Newline character.
%p	Locale's equivalent of either AM or PM.
%r	12-hour clock time (01-12) using the AM/PM notation in the format *HH:MM:SS* (AM | PM).
%R	24-hour notation; **%H:%M**.

%S Second as a decimal number (00-59).

%t Tab character.

%T 24-hour clock time in the format *HH:MM:SS*.

%u Weekday as a decimal number (1-7), where Monday is 1.

%U Week number of the year as a decimal number (00-52), where Sunday is the first day of the week.

%V Week number of the year as a decimal number (01-53), where Monday is the first day of the week. The week containing January 1 is in the new year if four or more days are in the new year, otherwise it is the last week of the previous year.

%w Weekday as a decimal number (0-6), where 0 is Sunday.

%W Week number of the year as a decimal number (00-52), where Monday is the first day of the week.

%x Locale's appropriate date representation.

%X Locale's appropriate time representation.

%y Year without century, as a decimal number (00-99).

%Y Year with century, as a decimal number.

%z Offset from UTC -0430 (4 hrs, 30 minutes behind UTC, west of Greenwich), or no characters if time zone isn't specified.

%Z Time zone name, or no characters if time zone isn't specified.

%% Character **%**.

Some of the above conversion specifiers can be modified with the prefix **E** or **O**. If alternative formats don't exist for the locale, they behave as if the unmodified conversion specifiers were called:

%Ec Alternative date and time representation.

%EC	Alternative name of the the base year (period).
%Ex	Alternative date representation.
%EX	Alternative time representation.
%Ey	Offset from **%EC** of the alternative year (only) representation.
%EY	Alternative year representation.
%Od	Day of the month using alternative numeric symbols. Leading zeros are added if an alternative symbol for zero exists, otherwise leading spaces are used.
%Oe	Day of the month using alternative numeric symbols. Leading spaces are used.
%OH	24-hour clock using alternative numeric symbols.
%OI	12-hour clock using alternative numeric symbols.
%Om	Month using alternative numeric symbols.
%OM	Minutes using alternative numeric symbols.
%OS	Seconds using alternative numeric symbols.
%Ou	Alternative week day number representation (Monday=1).
%OU	Alternative week day number representation (Rules correspond with **%U**).
%OV	Alternative week number representation. (Rules correspond with **%V**).
%Ow	Weekday as a number using alternative numeric symbols (Sunday=0).
%OW	Week number of the year using alternative numeric symbols (Monday is the first day of the week).
%Oy	Year offset from **%C** using alternative numeric symbols.

Returns:

The number of characters placed into the array, not including the terminating null character, or 0 if the number of characters exceeds *maxsize*; the string contents are indeterminate.

If an error occurs, *errno* is set.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

int main( void )
  {
    time_t time_of_day;
    char buffer[ 80 ];

    time_of_day = time( NULL );
    strftime( buffer, 80, "Today is %A %B %d, %Y",
           localtime( &time_of_day ) );
    printf( "%s\n", buffer );

    return EXIT_SUCCESS;
  }
```

This produces the output:

```
Today is Thursday February 25, 1999
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

asctime(), *asctime_r()*, *ctime()*, *ctime_r()*, *sprintf()*, `tm`, *tzset()*, *wcsftime()*

stricmp()

Compare two strings, ignoring case

Synopsis:

```
#include <string.h>

int stricmp( const char* s1,
             const char* s2 );
```

Arguments:

s1, *s2* The strings that you want to compare.

Library:

libc

Description:

The *stricmp()* function compares, with case insensitivity, the string pointed to by *s1* to the string pointed to by *s2*. All uppercase characters from *s1* and *s2* are mapped to lowercase for the purposes of doing the comparison.

Returns:

< 0 *s1* is less than *s2*.

0 *s1* is equal to *s2*.

> 0 *s1* is greater than *s2*.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
  {
    printf( "%d\n", stricmp( "AbCDEF", "abcdef" ) );
    printf( "%d\n", stricmp( "abcdef", "ABC"    ) );
    printf( "%d\n", stricmp( "abc",    "ABCdef" ) );
    printf( "%d\n", stricmp( "Abcdef", "mnopqr" ) );
    printf( "%d\n", stricmp( "Mnopqr", "abcdef" ) );
```

```
    return EXIT_SUCCESS;
  }
```

produces the output:

```
0
100
-100
-12
12
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcasecmp(), *strcmp()*, *strcmpi()*, *strcoll()*, *strncasecmp()*, *strncmp()*, *strnicmp()*, *wcscmp()*, *wcscoll()*, *wcsncmp()*

strlen()

Compute the length of a string

Synopsis:

```
#include <string.h>

size_t strlen( const char * s );
```

Arguments:

s The string whose length you want to calculate.

Library:

libc

Description:

The *strlen()* function computes the length of the string pointed to by *s*.

Returns:

The number of characters that precede the terminating null character.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main( void )
  {
    printf( "%d\n", strlen( "Howdy" ) );
    printf( "%d\n", strlen( "Hello world\n" ) );
    printf( "%d\n", strlen( "" ) );

    return EXIT_SUCCESS;
  }
```

produces the output:

```
5
12
0
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

wcslen()

strlwr()

Convert a string to lowercase

Synopsis:

```
#include <string.h>

char* strlwr( char* s1 );
```

Arguments:

s1 The string that you want to convert to lowercase.

Library:

libc

Description:

The *strlwr()* function replaces the string *s1* with lowercase characters, by invoking *tolower()* for each character in the string.

Returns:

The address of the string.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

char source[] = { "A mixed-case STRING" };

int main( void )
  {
    printf( "%s\n", source );
    printf( "%s\n", strlwr( source ) );
    printf( "%s\n", source );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
A mixed-case STRING
a mixed-case string
a mixed-case string
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strupr(), *tolower()*

strncasecmp()

Compare two strings, ignoring case, up to a given length

Synopsis:

```
#include <strings.h>

int strncasecmp( const char* str1,
                 const char* str2,
                 size_t n );
```

Arguments:

str1, *str2*	The strings that you want to compare.
n	The maximum number of characters that you want to compare.

Library:

libc

Description:

The *strncasecmp()* function compares up to *n* characters in two strings, specified by *str1* and *str2*, ignoring the case of the characters.

Returns:

< 0	*s1* is less than *s2*.
0	*s1* is equal to *s2*.
> 0	*s1* is greater than *s2*.

Examples:

The following code:

```
#include <stdio.h>
#include <strings.h>
#include <stdlib.h>

void compare( const char *s1, const char *s2 )
```

```
{
    int retval;

    retval = strncasecmp( s1, s2, 3 );
    if( retval > 0 ) {
        printf( "%s > %s\n", s1, s2 );
    } else if( retval < 0 ) {
        printf( "%s < %s\n", s1, s2 );
    } else {
        printf( "%s == %s\n", s1, s2 );
    }
}

int main( void )
{
    char *str1 = "abcdefg";
    char *str2 = "HIJ";
    char *str3 = "Abc";
    char *str4 = "aBCDEfg";

    compare( str1, str2 );
    compare( str1, str3 );
    compare( str1, str4 );
    compare( str1, str1 );

    compare( str2, str2 );
    compare( str2, str3 );
    compare( str2, str4 );
    compare( str2, str1 );

    return EXIT_SUCCESS;
}
```

produces output that looks like:

```
abcdefg < HIJ
abcdefg == Abc
abcdefg == aBCDEfg
abcdefg == abcdefg
HIJ == HIJ
HIJ > Abc
HIJ > aBCDEfg
HIJ > abcdefg
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcasecmp(), strcmp(), strcmpi(), strcoll(), stricmp(), strncmp(), strnicmp(), wcscmp(), wcscoll(), wcsncmp()

strncat()

Concatenate two strings, up to a maximum length

Synopsis:

```
#include <string.h>

char* strncat( char* dst,
               const char* src,
               size_t n );
```

Arguments:

dst, *src*	The strings that you want to concatenate.
n	The maximum number of characters that you want to add from the *src* string.

Library:

libc

Description:

The *strncat()* function appends no more than *n* characters of the string pointed to by *src* to the end of the string pointed to by *dst*. The first character of *src* overwrites the null character at the end of *dst*. This function always adds a terminating null character to the result.

Returns:

The same pointer as *dst*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

char buffer[80];

int main( void )
  {
    strcpy( buffer, "Hello " );
    strncat( buffer, "world", 8 );
    printf( "%s\n", buffer );
```

```
    strncat( buffer, "**************", 4 );
    printf( "%s\n", buffer );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
Hello world
Hello world****
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcat()

strncmp()

Compare two strings, up to a given length

Synopsis:

```
#include <string.h>

int strncmp( const char* s1,
             const char* s2,
             size_t n );
```

Arguments:

s1, *s2*	The strings that you want to compare.
n	The maximum number of characters that you want to compare.

Library:

libc

Description:

The *strncmp()* function compares up to *n* characters from the strings pointed to by *s1* and *s2*.

Returns:

< 0	*s1* is less than *s2*.
0	*s1* is equal to *s2*.
> 0	*s1* is greater than *s2*.

Examples:

```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main( void )
  {
    printf( "%d\n", strncmp( "abcdef", "abcDEF", 10 ) );
    printf( "%d\n", strncmp( "abcdef", "abcDEF",  6 ) );
```

```
    printf( "%d\n", strncmp( "abcdef", "abcDEF",  3 ) );
    printf( "%d\n", strncmp( "abcdef", "abcDEF",  0 ) );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
1
1
0
0
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcasecmp(), *strcmp()*, *strcmpi()*, *strcoll()*, *stricmp()*, *strncasecmp()*, *strnicmp()*, *wcscmp()*, *wcscoll()*, *wcsncmp()*

strncpy()

Copy a string, to a maximum length

Synopsis:

```
#include <string.h>

char* strncpy( char* dst,
               const char* src,
               size_t n );
```

Arguments:

dst	A pointer to where you want to copy the string.
src	The string that you want to copy.
n	The maximum number of characters that you want to copy.

Library:

libc

Description:

The *strncpy()* function copies no more than *n* characters from the string pointed to by *src* into the array pointed to by *dst*.

Copying of overlapping objects isn't guaranteed to work properly. See the *memmove()* function if you wish to copy objects that overlap.

If the string pointed to by *src* is shorter than *n* characters, null characters are appended to the copy in the array pointed to by *dst*, until *n* characters in all have been written. If the string pointed to by *src* is longer than *n* characters, then the result isn't terminated by a null character.

Returns:

The same pointer as *dst*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main( void )
  {
    char buffer[15];

    printf( "%s\n", strncpy( buffer, "abcdefg", 10 ) );
    printf( "%s\n", strncpy( buffer, "1234567",  6 ) );
    printf( "%s\n", strncpy( buffer, "abcdefg",  3 ) );
    printf( "%s\n", strncpy( buffer, "*******",  0 ) );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
abcdefg
123456g
abc456g
abc456g
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memmove(), *strcpy()*, *strdup()*, *wcscpy()*, *wcsncpy()*, *wmemmove()*

strnicmp()

Compare two strings up to a given length, ignoring case

Synopsis:

```
#include <string.h>

int strnicmp( const char* s1,
              const char* s2,
              size_t len );
```

Arguments:

s1, *s2*	The strings that you want to compare.
len	The maximum number of characters that you want to compare.

Library:

libc

Description:

The *strnicmp()* function compares up to *len* characters from the strings pointed to by *s1* and *s2*, ignoring case.

Returns:

< 0	*s1* is less than *s2*.
0	*s1* is equal to *s2*.
> 0	*s1* is greater than *s2*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main( void )
  {
    printf( "%d\n", strnicmp( "abcdef", "ABCXXX", 10 ) );
    printf( "%d\n", strnicmp( "abcdef", "ABCXXX",  6 ) );
```

```
    printf( "%d\n", strnicmp( "abcdef", "ABCXXX",  3 ) );
    printf( "%d\n", strnicmp( "abcdef", "ABCXXX",  0 ) );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
-20
-20
0
0
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcasecmp(), strcmp(), strcmpi(), strcoll(), stricmp(), strncasecmp(), strncmp(), wcscmp(), wcscoll(), wcsncmp()

strnset()

Fill a string with a given character, to a given length

Synopsis:

```
#include <string.h>

char * strnset( char * s1,
                int fill,
                size_t len );
```

Arguments:

s1	The string that you want to fill.
fill	The value that you want to fill the string with.
len	The number of characters to fill.

Library:

libc

Description:

The *strnset()* function fills the string *s1* with the value of the argument *fill*, converted to be a character value. When the value of *len* is greater than the length of the string, the entire string is filled. Otherwise, that number of characters at the start of the string are set to the fill character.

Returns:

The address of the string, *s1*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

char source[] = { "A sample STRING" };

int main( void )
  {
    printf( "%s\n", source );
```

```
    printf( "%s\n", strnset( source, '=', 100 ) );
    printf( "%s\n", strnset( source, '*', 7 ) );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
A sample STRING
===============
*******========
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strset()

strpbrk()

Find the first character in a string that's in a given character set

Synopsis:

```
#include <string.h>

char* strpbrk(char* str,
              char* charset );
```

Arguments:

str	The string that you want to search.
charset	The set of characters you want to look for.

Library:

libc

Description:

The *strpbrk()* function locates the first occurrence in the string pointed to by *str* of any character from the string pointed to by *charset*.

Returns:

A pointer to the located character, or NULL if no character from *charset* occurs in *str*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main( void )
  {
    char* p = "Find all vowels";

    while( p != NULL ) {
      printf( "%s\n", p );
      p = strpbrk( p+1, "aeiouAEIOU" );
    }
    return EXIT_SUCCESS;
  }
```

produces the output:

```
Find all vowels
ind all vowels
all vowels
owels
els
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), strchr(), strcspn(), strrchr(), strspn(), strstr(), strtok(), strtok_r(), wcschr(), wcscspn(), wcspbrk(), wcsrchr(), wcsspn(), wcsstr(), wcstok()

strrchr()

Find the last occurrence of a character in a string

Synopsis:

```
#include <string.h>

const char* strrchr(const char* s,
                    int c );
```

Arguments:

s The string that you want to search.

c The character that you're looking for.

Library:

libc

Description:

The *strrchr()* function locates the last occurrence of *c* (converted to a **char**) in the string pointed to by *s*. The terminating null character is considered to be part of the string.

Returns:

A pointer to the located character, or a NULL pointer if the character doesn't occur in the string.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main( void )
  {
    printf( "%s\n", strrchr( "abcdeabcde", 'a' ) );
    if( strrchr( "abcdeabcde", 'x' ) == NULL )
      printf( "NULL\n" );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
abcde
NULL
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), strchr(), strcspn(), strpbrk(), strspn(), strstr(), strtok(), strtok_r(), wcschr(), wcscspn(), wcspbrk(), wcsrchr(), wcsspn(), wcsstr(), wcstok()

strrev()

Reverse a string

Synopsis:

```
#include <string.h>

char* strrev( char* s1 );
```

Arguments:

s1 The string that you want to reverse.

Library:

libc

Description:

The *strrev()* function replaces the string *s1* with a string whose characters are in the reverse order.

Returns:

The address of the string, *s1*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

char source[] = { "A sample STRING" };

int main( void )
  {
    printf( "%s\n", source );
    printf( "%s\n", strrev( source ) );
    printf( "%s\n", strrev( source ) );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
A sample STRING
GNIRTS elpmas A
A sample STRING
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

strsep()

Separate a string into pieces marked by given delimiters

Synopsis:

```
#include <string.h>

char *strsep( char **stringp,
              char *delim );
```

Arguments:

stringp	The address of a pointer to the string that you want to break into pieces; see below.
delim	A set of characters that delimit the pieces in the string.

Library:

libc

Description:

The *strsep()* function looks in the null-terminated string pointed to by *stringp* for the first occurrence of any character in *delim* and replaces this with a `\0`, records the location of the next character in **stringp*, then returns the original value of **stringp*. If no delimiter characters are found, *strsep()* sets **stringp* to NULL; if **stringp* is initially NULL, *strsep()* returns NULL.

Returns:

A pointer to the original value of **stringp*.

Examples:

Parse strings containing runs of whitespace, making up an argument vector:

```
char inputstring[100];
char **argv[51], **ap = argv, *p, *val;

/* set up inputstring */
for (p = inputstring; p != NULL; ) {
```

```
    while ((val = strsep(&p, " \t")) != NULL && *val == '\0');
    *ap++ = val;
}
*ap = 0;
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strtok(), strtok_r(), wcstok()

strset()

Fill a string with a given character

Synopsis:

```
#include <string.h>

char* strset( char* s1,
              int fill );
```

Arguments:

s1 The string that you want to fill.

fill The value that you want to fill the string with.

Library:

libc

Description:

The *strset()* function fills the string pointed to by *s1* with the character *fill*. The terminating null character in the original string remains unchanged.

Returns:

The address of the string, *s1*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

char source[] = { "A sample STRING" };

int main( void )
  {
    printf( "%s\n", source );
    printf( "%s\n", strset( source, '=' ) );
    printf( "%s\n", strset( source, '*' ) );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
A sample STRING
===============
***************
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strnset()

strsignal()

Return the description of a signal

Synopsis:

```
#include <string.h>

char *strsignal( int signo );
```

Arguments:

signo The signal number that you want the description of.

Library:

libc

Description:

The *strsignal()* function returns a pointer to the language-dependent string describing a signal.

Returns:

A pointer to the description of the signal, or NULL if *signo* isn't a valid signal number. This array will be overwritten by subsequent calls to *strsignal()*.

☞ Don't modify the array returned by this function.

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

setlocale()

strspn()

Count the characters at the beginning of a string that are in a given character set

Synopsis:

```
#include <string.h>

size_t strspn( const char* str,
               const char* charset );
```

Arguments:

str	The string that you want to search.
charset	The set of characters you want to look for.

Library:

libc

Description:

The *strspn()* function computes the length of the initial segment of the string pointed to by *str* that consists of characters from the string pointed to by *charset*. The terminating null character isn't considered to be part of *charset*.

Returns:

The length of the segment.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main( void )
  {
    printf( "%d\n", strspn( "out to lunch", "aeiou" ) );
    printf( "%d\n", strspn( "out to lunch", "xyz" ) );
    return EXIT_SUCCESS;
  }
```

produces the output:

2
0

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), strchr(), strcspn(), strpbrk(), strrchr(), strstr(), strtok(), strtok_r(), wcschr(), wcscspn(), wcspbrk(), wcsrchr(), wcsspn(), wcsstr(), wcstok()

strstr()

Find one string inside another

Synopsis:

```
#include <string.h>

char* strstr(char* str,
             char* substr );
```

Arguments:

str	The string that you want to search.
substr	The string that you're looking for.

Library:

libc

Description:

The *strstr()* function locates the first occurrence in the string pointed to by *str* of the sequence of characters (excluding the terminating null character) in the string pointed to by *substr*.

Returns:

A pointer to the located string, or NULL if the string isn't found.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main( void )
  {
    printf( "%s\n", strstr("This is an example", "is") );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
is is an example
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), strchr(), strcspn(), strpbrk(), strrchr(), strspn(), strtok(), strtok_r(), wcschr(), wcscspn(), wcspbrk(), wcsrchr(), wcsspn(), wcsstr(), wcstok()

strtod()

Convert a string into a **double**

Synopsis:

```
#include <stdlib.h>

double strtod( const char *ptr,
               char **endptr );
```

Arguments:

ptr	A pointer to the string to parse.
endptr	If this argument isn't NULL, the function stores in it a pointer to the first unrecognized character found in the string.

Library:

libc

Description:

The *strtod()* function converts the string pointed to by *ptr* to *double* representation. The function recognizes a string containing the following:

- optional white space
- an optional plus or minus sign
- a sequence of digits containing an optional decimal point
- an optional **e** or **E**, followed by an optionally signed sequence of digits.

The conversion ends at the first unrecognized character. If *endptr* isn't NULL, a pointer to the unrecognized character is stored in the object *endptr* points to.

Returns:

The converted value. If the correct value would cause overflow, plus or minus HUGE_VAL is returned according to the sign, and *errno* is set to ERANGE. If the correct value would cause underflow, then zero is returned, and *errno* is set to ERANGE.

This function returns zero when the input string can't be converted. If an error occurs, *errno* indicates the error detected.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
  {
    double pi;

    pi = strtod( "3.141592653589793", NULL );
    printf( "pi=%17.15f\n",pi );
    return EXIT_SUCCESS;
  }
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

atof(), errno

strtoimax(), strtoumax()

Convert a string into an integer

Synopsis:

```
#include <inttypes.h>

intmax_t strtoimax ( const char * nptr,
                     char ** endptr,
                     int base );

uintmax_t strtoumax ( const char * nptr,
                      char ** endptr,
                      int base );
```

Arguments:

nptr A pointer to the string to parse.

endptr If this argument isn't NULL, the function stores in it a pointer to the first unrecognized character found in the string.

base The base of the number being parsed:

- If *base* is zero, the first characters after the optional sign determine the base used for the conversion. If the first characters are `0x` or `0X` the digits are treated as hexadecimal. If the first character is `0`, the digits are treated as octal. Otherwise, the digits are treated as decimal.
- If *base* isn't zero, it must have a value between 2 and 36. The letters a-z and A-Z represent the values 10 through 35. Only those letters whose designated values are less than *base* are permitted. If the value of *base* is 16, the characters `0x` or `0X` may optionally precede the sequence of letters and digits.

Library:

libc

Description:

The *strtoimax()* and *strtoumax()* functions are the same as the *strtol(), strtoll(), strtoul(),* and *strtoull()* functions except that they return objects of type **intmax_t** and **uintmax_t**.

Returns:

The converted value.

If the correct value causes an overflow, INTMAX_MAX | UINTMAX_MAX or INTMAX_MIN is returned according to the sign and *errno* is set to ERANGE. If *base* is out of range, zero is returned and *errno* is set to EINVAL.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strtol(), strtoul()

strtok()

Break a string into tokens

Synopsis:

```
#include <string.h>

char* strtok( char* s1,
              const char* s2 );
```

Arguments:

s1 NULL, or the string that you want to break into tokens; see below.

s2 A set of the characters that separate the tokens.

Library:

libc

Description:

The *strtok()* function breaks the string pointed to by *s1* into a sequence of tokens, each of which is delimited by a character from the string pointed to by *s2*.

The first call to *strtok()* returns a pointer to the first token in the string pointed to by *s1*. Subsequent calls to *strtok()* must pass a NULL pointer as the first argument, in order to get the next token in the string. The set of delimiters used in each of these calls to *strtok()* can be different from one call to the next.

The first call in the sequence searches *s1* for the first character that isn't contained in the current delimiter string *s2*. If no such character is found, then there are no tokens in *s1*, and *strtok()* returns a NULL pointer. If such a character is found, it's the start of the first token.

The *strtok()* function then searches from there for a character that's contained in the current delimiter string. If no such character is found, the current token extends to the end of the string pointed to by *s1*. If such a character is found, it's overwritten by a null character, which terminates the current token. The *strtok()* function saves a pointer to

the following character, from which the next search for a token will start when the first argument is a NULL pointer.

You might want to keep a copy of the original string because *strtok()* is likely to modify it.

Returns:

A pointer to the token found, or NULL if no token was found.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int main( void )
  {
    char* p;
    char* buffer;
    char* delims = { " .," };

    buffer = strdup( "Find words, all of them." );
    printf( "%s\n", buffer );
    p = strtok( buffer, delims );
    while( p != NULL ) {
      printf( "word: %s\n", p );
      p = strtok( NULL, delims );
    }
    printf( "%s\n", buffer );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
Find words, all of them.
word: Find
word: words
word: all
word: of
word: them
Find
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

memchr(), strchr(), strcspn(), strpbrk(), strrchr(), strset(), strspn(), strstr(), strtok_r(), wcschr(), wcscspn(), wcspbrk(), wcsrchr(), wcsspn(), wcsstr(), wcstok()

strtok_r()

Break a string into tokens (reentrant)

Synopsis:

```
#include <string.h>

char* strtok_r( char* s,
                const char* sep,
                char** lasts );
```

Arguments:

s1 NULL, or the string that you want to break into tokens; see below.

s2 A set of the characters that separate the tokens.

lasts The address of a pointer to a character, which the function can use to store information necessary for it to continue scanning the same string.

Library:

libc

Description:

The function *strtok_r()* breaks the string *s* into a sequence of tokens, each of which is delimited by a character from the string pointed to by *sep*.

In the first call to *strtok_r()*, *s* must point to a null-terminated string, *sep* points to a null-terminated string of separator characters, and *lasts* is ignored. The *strtok_r()* function returns a pointer to the first character of the first token, writes a NULL character into *s* immediately following the returned token, and updates *lasts*.

In subsequent calls, *s* must be a NULL pointer and *lasts* must be unchanged from the previous call so that subsequent calls will move through the string *s*, returning successive tokens until no tokens remain. The separator string *sep* may be different from call to call. When no tokens remain in *s*, a NULL pointer is returned.

Returns:

A pointer to the token found, or NULL if no token was found.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), *strchr()*, *strcspn()*, *strpbrk()*, *strrchr()*, *strset()*, *strspn()*, *strstr()*, *strtok()*, *wcschr()*, *wcscspn()*, *wcspbrk()*, *wcsrchr()*, *wcsspn()*, *wcsstr()*, *wcstok()*

strtol(), strtoll()

Convert a string into a long integer

Synopsis:

```
#include <stdlib.h>

long int strtol( const char * ptr,
                 char ** endptr,
                 int base );

int64_t strtoll( const char * ptr,
                 char ** endptr,
                 int base );
```

Arguments:

ptr A pointer to the string to parse.

endptr If this argument isn't NULL, the function stores in it a pointer to the first unrecognized character found in the string.

base The base of the number being parsed:

- If *base* is zero, the first characters after the optional sign determine the base used for the conversion. If the first characters are **0x** or **0X** the digits are treated as hexadecimal. If the first character is **0**, the digits are treated as octal. Otherwise, the digits are treated as decimal.
- If *base* isn't zero, it must have a value between 2 and 36. The letters a-z and A-Z represent the values 10 through 35. Only those letters whose designated values are less than *base* are permitted. If the value of *base* is 16, the characters **0x** or **0X** may optionally precede the sequence of letters and digits.

Library:

libc

Description:

The *strtol()* function converts the string pointed to by *ptr* to an object of type **long int**; *strtoll()* converts the string pointed to by *ptr* to an object of type **int64_t** (**long long**).

These functions recognize strings that contain the following:

- optional white space
- an optional plus or minus sign
- a sequence of digits and letters.

The conversion ends at the first unrecognized character. If *endptr* isn't NULL, a pointer to the unrecognized character is stored in the object *endptr* points to.

Returns:

The converted value.

If the correct value causes an overflow, LONG_MAX | LONGLONG_MAX or LONG_MIN | LONGLONG_MIN is returned according to the sign, and *errno* is set to ERANGE. If *base* is out of range, zero is returned and *errno* is set to EDOM.

Examples:

```
#include <stdlib.h>

int main( void )
  {
    long int v;

    v = strtol( "12345678", NULL, 10 );
    return EXIT_SUCCESS;
  }
```

Classification:

strtol() is ANSI; *strtoll()* is Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atoi(), atol(), errno, itoa(), ltoa(), sscanf(), strtoul(), ultoa(), utoa()

strtoul(), strtoull()

Convert a string into an unsigned long integer

Synopsis:

```
#include <stdlib.h>

unsigned long int strtoul( const char * ptr,
                           char ** endptr,
                           int base );

uint64_t strtoull( const char * ptr,
                   char ** endptr,
                   int base );
```

Arguments:

ptr A pointer to the string to parse.

endptr If this argument isn't NULL, the function stores in it a pointer to the first unrecognized character found in the string.

base The base of the number being parsed:

- If *base* is zero, the first characters after the optional sign determine the base used for the conversion. If the first characters are **0x** or **0X** the digits are treated as hexadecimal. If the first character is **0**, the digits are treated as octal. Otherwise, the digits are treated as decimal.
- If *base* isn't zero, it must have a value between 2 and 36. The letters a-z and A-Z represent the values 10 through 35. Only those letters whose designated values are less than *base* are permitted. If the value of *base* is 16, the characters **0x** or **0X** may optionally precede the sequence of letters and digits.

Library:

libc

Description:

The *strtoul()* function converts the string pointed to by *ptr* to an **unsigned long**; *strtoull()* converts the string pointed to by *ptr* to a **uint64_t** (**unsigned long long**).

These functions recognize strings that contain the following:

- optional white space
- a sequence of digits and letters.

The conversion ends at the first unrecognized character. A pointer to that character is stored in the object *endptr* points to, if *endptr* isn't NULL.

Returns:

The converted value.

If the correct value causes an overflow, ULONG_MAX | ULONGLONG_MAX is returned and *errno* is set to ERANGE. If *base* is out of range, zero is returned and *errno* is set to **EDOM**.

Examples:

```
#include <stdlib.h>

int main( void )
  {
    unsigned long int v;

    v = strtoul( "12345678", NULL, 10 );
    return EXIT_SUCCESS;
  }
```

Classification:

strtoul() is ANSI; *strtoull()* is Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atoi(), atol(), errno, itoa(), ltoa(), sscanf(), strtol(), ultoa(), utoa()

strupr()

Convert a string to uppercase

Synopsis:

```
#include <string.h>

char* strupr( char* s1 );
```

Arguments:

s1 The string that you want to convert to uppercase.

Library:

libc

Description:

The *strupr()* function replaces the string *s1* with uppercase characters, by invoking *toupper()* for each character in the string.

Returns:

The address of the string.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

char source[] = { "A mixed-case STRING" };

int main( void )
  {
    printf( "%s\n", source );
    printf( "%s\n", strupr( source ) );
    printf( "%s\n", source );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
A mixed-case STRING
A MIXED-CASE STRING
A MIXED-CASE STRING
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strlwr(), toupper()

strxfrm()

Transform one string into another, to a given length

Synopsis:

```
#include <string.h>

size_t strxfrm( char* dst,
                const char* src,
                size_t n );
```

Arguments:

dst	The string that you want to transform.
src	The string that you want to place in *dst*.
n	The maximum number of characters to transform.

Library:

libc

Description:

The *strxfrm()* function transforms, for no more than *n* characters, the string pointed to by *src* to the buffer pointed to by *dst*. The transformation uses the collating sequence selected by *setlocale()* so that two transformed strings compare identically (using the *strncmp()* function) to a comparison of the original two strings using *strcoll()*.

If the collating sequence is selected from the **"C"** locale, *strxfrm()* is equivalent to *strncpy()*, except that *strxfrm()* doesn't pad the *dst* argument with null characters when the argument *src* is shorter than *n* characters.

Returns:

The length of the transformed string. If this length is more than *n*, the contents of the array pointed to by *dst* are indeterminate.

If an error occurs, *strxfrm()* sets *errno* and returns 0. Since the function could also return zero on success, the only way to tell that an error has occurred is to set *errno* to 0 before calling *strxfrm()* and check *errno* afterward.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <locale.h>

char src[] = { "A sample STRING" };
char dst[20];

int main( void )
  {
    size_t len;

    setlocale( LC_ALL, "C" );
    printf( "%s\n", src );
    len = strxfrm( dst, src, 20 );
    printf( "%s (%u)\n", dst, len );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
A sample STRING
A sample STRING (15)
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

setlocale(), *strcoll()*, *wcsxfrm()*

Synopsis:

```
#include <unistd.h>

void swab( const void * src,
           void * dest,
           ssize_t nbytes );
```

Arguments:

src	A pointer to the buffer that you want to copy the bytes from.
dest	A pointer to the buffer where you want the function to copy the bytes.
nbytes	The number of bytes that you want to copy and swap.

Library:

libc

Description:

The *swab()* function copies *nbytes* bytes, pointed to by *src*, to the object pointed to by *dest*, exchanging adjacent bytes. The *nbytes* argument should be even.

If *nbytes* is:	Then:
Odd	*nbytes*-1 bytes are copied and exchanged. The disposition of the last byte is unspecified.
Negative	*swab()* does nothing.

If copying takes place between objects that overlap, the behavior is undefined.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

ENDIAN_SWAP32(), ENDIAN_SWAP64()

Synopsis:

```
#include <wchar.h>

int swprintf( wchar_t * ws,
              size_t n,
              const wchar_t * format,
              ... );
```

Arguments:

ws	A pointer to the buffer where you want to function to store the formatted string.
n	The maximum number of wide characters to store in the buffer, including a terminating null character.
format	A wide-character string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.

Library:

libc

Description:

The *swprintf()* function is similar to *fwprintf()* except that *swprintf()* places the generated output into the wide-character array pointed to by *buf*, instead of writing it to a file. A null character is placed at the end of the generated character string.

The *swprintf()* function is the wide-character version of *sprintf()*.

Returns:

The number of wide characters written, excluding the terminating **NUL**, or a negative number if an error occurred (*errno* is set).

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, fprintf(), fwprintf(), printf(), snprintf(), sprintf(), vfprintf(), vfwprintf(), vprintf(), vsnprintf(), vsprintf(), vswprintf(), vwprintf(), wprintf()

swscanf()

Scan input from a wide-character string

Synopsis:

```
#include <wchar.h>

int swscanf( const wchar_t * ws,
             const wchar_t * format,
             ... );
```

Arguments:

ws The wide-character string that you want to read from.

format A wide-character string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.

Library:

libc

Description:

The *swscanf()* function scans input from the wide-character string *ws*, under control of the argument *format*. Following the format string is the list of addresses of items to receive values.

The *swscanf()* function is the wide-character version of *sscanf()*.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF when the scanning is terminated by reaching the end of the input string.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, fscanf(), fwscanf(), scanf(), sscanf(), vfscanf(), vfwscanf(), vscanf(), vsscanf(), vswscanf(), vwscanf(), wscanf()

symlink()

Create a symbolic link to a path

Synopsis:

```
#include <unistd.h>

int symlink( const char* pname,
             const char* slink );
```

Arguments:

pname The path that you want to link to.

slink The symbolic link that you want to create.

Library:

libc

Description:

The *symlink()* function creates a symbolic link named *slink* that contains the pathname specified by *pname* (*slink* is the name of the symbolic link created, *pname* is the pathname contained in the symbolic link).

File access checking isn't performed on the file named by *pname*, and the file need not exist.

If the *symlink()* function is unsuccessful, any file named by *slink* is unaffected.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES A component of the *slink* path prefix denies search permission, or write permission is denied in the parent directory of the symbolic link to be created.

EEXIST	A file named by *slink* already exists.
ELOOP	A loop exists in symbolic links encountered during resolution of the *slink* argument, and it resolves to more then SYMLOOP_MAX levels.
ENAMETOOLONG	A component of the path specified by *slink* exceeds NAME_MAX bytes, or the length of the entire pathname exceeded PATH_MAX characters.
ENOSPC	The new symbolic link can't be created because there's no space left on the filesystem that will contain the symbolic link.
ENOSYS	The *symlink()* function isn't implemented for the filesystem specified in *slink*.
ENOTDIR	A component of the path prefix of *slink* isn't a directory.
EROFS	The file *slink* would reside on a read-only filesystem.

Examples:

```
/*
 * create a symbolic link to "/usr/nto/include"
 */
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main( void )
  {
    if( symlink( "/usr/nto/include", "slink" ) == -1) {
      perror( "slink -> /usr/nto/include" );
      exit( EXIT_FAILURE );
    }
    exit( EXIT_SUCCESS );
  }
```

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, link(), lstat(), pathmgr_symlink(), pathmgr_unlink(), readlink(), unlink()

sync()

Synchronize filesystem updates

Synopsis:

```
#include <unistd.h>

void sync( void );
```

Library:

libc

Description:

The *sync()* function queues all the modified block buffers for writing, and returns; it doesn't wait for the actual I/O to take place. Use this function — or *fsync()* for a single file — to ensure consistency of the entire on-disk filesystem with the contents of the in-memory buffer cache.

Returns:

-1 on error; any other value on success.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

fdatasync(), *fsync()*

SyncCondvarSignal(), *SyncCondvarSignal_r()* © 2004, QNX Software Systems Ltd.

Wake up any threads that are blocked on a synchronization object

Synopsis:

```
#include <sys/neutrino.h>

int SyncCondvarSignal( sync_t* sync,
                       int broadcast );

int SyncCondvarSignal_r( sync_t* sync,
                         int broadcast );
```

Arguments:

sync — A pointer to a **sync_t** for the synchronization object. You must have initialized this argument by calling *SyncTypeCreate()* or statically initialized it with the manifest PTHREAD_COND_INITIALIZER.

broadcast — Zero if you want to make ready to run the thread with the highest priority that's been waiting the longest, or nonzero if you want to make all waiting threads ready.

Library:

libc

Description:

The *SyncCondvarSignal()* and *SyncCondvarSignal_r()* kernel calls wake up one or all threads that are blocked on the synchronization object *sync*.

These functions are similar, except in the way they indicate errors. See the Returns section for details.

In all cases, each awakened thread attempts to reacquire the controlling mutex passed in *SyncCondvarWait()* before control is returned to the thread. If the mutex is already locked when the kernel attempts to lock it, the thread becomes blocked on the mutex until it's unlocked.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

SyncCondvarSignal()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

SyncCondvarSignal_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EFAULT	A fault occurred when the kernel tried to access *sync*.
EINVAL	The synchronization ID specified in *sync* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_broadcast(), *pthread_cond_signal()*,
pthread_cond_wait(), *SyncCondvarWait()*

SyncCondvarWait(), SyncCondvarWait_r()

Block a thread on a synchronization object

Synopsis:

```
#include <sys/neutrino.h>

int SyncCondvarWait( sync_t * sync,
                     sync_t * mutex );

int SyncCondvarWait_r( sync_t * sync,
                       sync_t * mutex );
```

Arguments:

sync A pointer to a **sync_t** for the synchronization object. You must have initialized this argument by calling *SyncTypeCreate()* or statically initialized it with the manifest PTHREAD_COND_INITIALIZER.

mutex The mutex that's associated with the condition variable. You must lock this mutex by calling *SyncMutexLock()* (or the POSIX *pthread_mutex_lock()* cover routine). The kernel releases the mutex lock in the kernel when it blocks the thread on *sync*.

Library:

libc

Description:

The *SyncCondvarWait()* and *SyncCondvarWait_r()* kernel calls block the calling thread on the synchronization object, *sync*. If more than one thread is blocked on the object, they're queued in priority order.

These functions are similar, except in the way they indicate errors. See the Returns section for details.

The blocked thread can be unblocked by any one of the following conditions:

Condition variable signalled

The condition variable was signaled by a call to *SyncCondvarSignal()*, that determined that this thread should be awakened.

Before returning from *SyncCondvarWait()*, *mutex* is reacquired. If *mutex* is locked, the thread enters into the STATE_MUTEX state waiting for *mutex* to be unlocked. At this point it's as though you had called *SyncMutexLock*(*mutex*).

Timeout

The wait was terminated by a timeout initiated by a previous call to *TimerTimeout()*.

Before returning from *SyncCondvarWait()*, *mutex* is reacquired. If *mutex* is locked, the thread enters into the STATE_MUTEX state waiting for *mutex* to be unlocked. At this point it's as though you had called *SyncMutexLock*(*mutex*).

POSIX signal

The wait was terminated by an unmasked signal initiated by a call to *SignalKill()*. If a signal handler has been set up, the signal handler runs with *mutex* unlocked. On return from the signal handler, *mutex* is reacquired. If *mutex* is locked, the thread enters into the STATE_MUTEX state waiting for *mutex* to be unlocked. At this point, it's as though you had called *SyncMutexLock*(*mutex*).

Thread cancellation

The wait was terminated by a thread cancellation initiated by a call to *ThreadCancel()*. Before calling the cancellation handler, *mutex* is reacquired. If *mutex* is locked, the thread enters into the STATE_MUTEX state waiting for *mutex* to be unlocked. At this point, it's as though you had called *SyncMutexLock*(*mutex*).

In all cases, *mutex* is reacquired before the call returns. If the thread enters the STATE_MUTEX state, the rules governing *SyncMutexLock()* are in effect.

Condition variables are used to block a thread until a certain condition is satisfied. Spurious wakeups may occur due to timeouts, signals, and broadcast condition variable signals. Therefore, you should always reevaluate the condition, even on a successful return. The easiest way to do this is with a while loop. For example:

```
SyncMutexLock(&mutex);

while(some_condition) {
    SyncCondvarWait(&condvar, &mutex);
}

SyncMutexUnlock(&mutex);
```

Blocking states

STATE_CONDVAR

The calling thread blocks waiting for the condition variable to be signaled.

STATE_MUTEX

The thread was unblocked from the STATE_CONDVAR state and while trying to reacquire the controlling mutex, found the mutex was locked by another thread.

Returns:

The only difference between these functions is the way they indicate errors:

SyncCondvarWait()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

SyncCondvarWait_r()

Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function returns any value in the Errors section.

Errors:

EAGAIN	On the first use of a statically initialized *sync*, all kernel synchronization objects were in use.
EFAULT	A fault occurred when the kernel tried to access *sync* or *mutex*.
EINVAL	The synchronization ID specified in *sync* doesn't exist.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_broadcast(), *pthread_cond_signal()*, *pthread_cond_wait()*, *pthread_mutex_lock()*, *SignalKill()*, *SyncCondvarSignal()*, *SyncMutexLock()*, *SyncTypeCreate()*, *ThreadCancel()*, *TimerTimeout()*

SyncCtl(), SyncCtl_r()

Perform an operation on a synchronization object

Synopsis:

```
#include <sys/neutrino.h>

int SyncCtl( int cmd,
             sync_t * sync,
             void * data );

int SyncCtl_r( int cmd,
               sync_t * sync,
               void * data );
```

Arguments:

cmd The operation type; one of:

- _NTO_SCTL_GETPRIOCEILING — get the ceiling priority of the mutex pointed to by *sync* and put it in the variable pointed to by *data*.
- _NTO_SCTL_SETPRIOCEILING — return the original ceiling priority. Set the ceiling priority of the mutex pointed to by *sync* to the value pointed to by *data*.
- _NTO_SCTL_SETEVENT — attach an event, pointed to by *data*, to the mutex pointed to by *sync*.

☞ You should use *SyncMutexEvent()* to do this.

sync A pointer to the synchronization object that you want to manipulate.

data A pointer to data associated with the command, or a place where the function can store the requested information, depending on the operation.

Library:

libc

Description:

The *SyncCtl()* and *SyncCtl_r()* kernel calls let you:

- set or get a ceiling priority for a mutex

  or

- attach an event to a mutex so you'll be notified when the mutex changes to the DEAD state.

These functions are similar, except for the way they indicate errors. See the Returns section for details.

Returns:

The only difference between these functions is the way they indicate errors:

SyncCtl()	If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.
SyncCtl_r()	Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function returns any value listed in the Errors section.

Errors:

EAGAIN	All kernel synchronization event objects are in use.
EFAULT	A fault occurred when the kernel tried to access *sync* or *data*.
EINVAL	The synchronization object pointed to by *sync* doesn't exist, or the ceiling priority value pointed to by *data* is out of range.
ENOSYS	The *SyncCtl()* and *SyncCtl_r()* functions aren't currently supported.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

SyncCondvarSignal(), SyncCondvarWait(), SyncDestroy(), SyncMutexLock(), SyncMutexRevive(), SyncMutexUnlock(), SyncTypeCreate()

SyncDestroy(), *SyncDestroy_r()*

Destroy a synchronization object

Synopsis:

```
#include <sys/neutrino.h>

int SyncDestroy( sync_t* sync );

int SyncDestroy_r ( sync_t* sync );
```

Arguments:

sync The synchronization object that you want to destroy.

Library:

libc

Description:

The *SyncDestroy()* and *SyncDestroy_r()* kernel calls destroy a synchronization object previously allocated by a call to *SyncTypeCreate()*. If the object is a locked mutex, or a condition variable with waiting threads, the call fails. Any attempt to use *sync* after it is destroyed fails.

These functions are identical except in the way they indicate errors. See the Returns section for details.

Don't call *SyncDestroy()* directly; instead, use the POSIX synchronization objects (see *pthread_cond_destroy()*, *pthread_mutex_destroy()*, *pthread_rwlock_destroy()*, and *sem_destroy()*).

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

SyncDestroy()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

SyncDestroy_r()

Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function can return any value listed in the Errors section.

Errors:

EBUSY	The synchronization object is locked by a thread.
EFAULT	A fault occurred when the kernel tried to access *sync*.
EINVAL	The synchronization ID specified in *sync* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

SyncTypeCreate()

SyncMutexEvent(), SyncMutexEvent_r()

Attach an event to a mutex

Synopsis:

```
#include <sys/neutrino.h>

int SyncMutexEvent( sync_t * sync,
                    struct sigevent * event );

int SyncMutexEvent_r( sync_t * sync,
                      struct sigevent * event );
```

Arguments:

sync A pointer to the synchronization object for the mutex that you want to attach an event to.

event A pointer to the **sigevent** structure that describes the event that you want to attach.

Library:

libc

Description:

The *SyncMutexEvent()* is a kernel call that attaches a specified *event* to a mutex pointed to by *sync*. You use *SyncMutexRevive()* to revive a DEAD mutex. Normally, a mutex will be placed in the DEAD state when the memory that was used to lock the mutex gets unmapped. One of the ways this may happen is when a process dies while holding the mutex in a shared memory.

SyncMutexEvent() and *SyncMutexEvent_r()* are similar, except for the way they indicate errors. See the Returns section for details.

Returns:

The only difference between these functions is the way they indicate errors:

SyncMutexEvent()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

SyncMutexEvent_r()

Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function returns any value listed in the Errors section.

Errors:

EAGAIN	All kernel synchronization event objects are in use.
EFAULT	A fault occurred when the kernel tried to access *sync*.
EINVAL	The synchronization object pointed to by *sync* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

`sigevent`, *SyncCondvarSignal()*, *SyncCondvarWait()*, *SyncDestroy()*, *SyncMutexLock()*, *SyncMutexRevive()*, *SyncMutexUnlock()*

SyncMutexLock(), SyncMutexLock_r()

Lock a mutex synchronization object

Synopsis:

```
#include <sys/neutrino.h>

int SyncMutexLock( sync_t * sync );

int SyncMutexLock_r( sync_t * sync );
```

Arguments:

sync A pointer to the synchronization object for the mutex that you want to lock.

Library:

libc

Description:

The *SyncMutexLock()* and *SyncMutexLock_r()* kernel calls try to lock the mutex synchronization object *sync*. If the mutex isn't currently locked, the call returns immediately with the object locked. The mutex is considered unlocked if the owner field of *sync* is zero. Otherwise, the owner field of *sync* is treated as the thread ID of the current owner of the mutex.

These functions are similar, except for the way they indicate errors. See the Returns section for details.

If the mutex is already locked, the calling thread blocks on *sync* until it's unlocked by the owner. If more than one thread is blocked on *sync* they're queued in priority order.

If the priority of the blocking thread is higher than the thread that owns the mutex, the owner's priority is boosted to match that of the caller. In other words, the owner inherits the caller's priority if it's higher. If the owner's priority is boosted, it returns to its previous value before any boosts when the mutex is unlocked. Note that the owner may be boosted more than once as higher priority threads block on *sync*.

If a thread is boosted via this mechanism and subsequently changes its own priority, that priority takes immediate effect and also becomes the value it's returned to after it releases the mutex.

Waiting for a mutex isn't a cancellation point. If a signal is delivered to the thread while waiting for the mutex, the signal handler runs and, upon return from the handler, the thread resumes waiting for the mutex as if it wasn't interrupted.

Avoid timeouts on mutexes. Mutexes should be locked for brief periods of time, eliminating the need for a timeout.

The *sync* argument must have been initialized by a call to *SyncTypeCreate()* or have been statically initialized by the manifest PTHREAD_MUTEX_INITIALIZER.

The POSIX functions *pthread_mutex_lock()*, and *pthread_mutex_unlock()*, are faster, since they can potentially avoid a kernel call.

Blocking states

STATE_MUTEX

The calling thread blocks waiting for the synchronization object to be unlocked.

Returns:

The only difference between these functions is the way they indicate errors:

SyncMutexLock()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

SyncMutexLock_r()

Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, this function returns any value listed in the Errors section.

Errors:

EAGAIN	On the first use of a statically initialized *sync*, all kernel synchronization objects were in use.
EFAULT	A fault occurred when the kernel tried to access the buffers you provided.
EINVAL	The synchronization ID specified in *sync* doesn't exist.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_lock(), *pthread_mutex_unlock()*, *SyncTypeCreate()*, *SyncDestroy()*, *SyncMutexUnlock()*

SyncMutexRevive(), *SyncMutexRevive_r()*

Revive a mutex that's in the DEAD state

Synopsis:

```
#include <sys/neutrino.h>

int SyncMutexRevive( sync_t * sync );

int SyncMutexRevive_r( sync_t * sync );
```

Arguments:

sync A pointer to the synchronization object for the mutex that you want to revive.

Library:

libc

Description:

The *SyncMutexRevive()* and *SyncMutexRevive_r()* kernel calls revive a mutex, pointed to by *sync*, that's in the DEAD state. The mutex will be put into the LOCK state and will be owned by the calling thread. The mutex counter is set to one (for recursive mutexes).

These functions are similar, except for the way they indicate errors. See the Returns section for details.

See *SyncMutexEvent()* for information on how to get notified when a mutex enters the DEAD state.

Returns:

The only difference between these functions is the way they indicate errors:

SyncMutexRevive()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

SyncMutexRevive_r()

Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function returns any value listed in the Errors section.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers you provided.
EINVAL	The synchronization object pointed to by *sync* doesn't exist or wasn't in the DEAD state.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_lock(), *pthread_mutex_unlock()*, *SyncTypeCreate()*, *SyncDestroy()*, *SyncMutexEvent()*, *SyncMutexLock()*, *SyncMutexUnlock()*

SyncMutexUnlock(), *SyncMutexUnlock_r()*

Unlock a mutex synchronization object

Synopsis:

```
#include <sys/neutrino.h>

int SyncMutexUnlock( sync_t * sync );

int SyncMutexUnlock_r( sync_t * sync );
```

Arguments:

sync A pointer to the synchronization object for the mutex that you want to unlock.

Library:

libc

Description:

The *SyncMutexUnlock()* and *SyncMutexUnlock_r()* kernel calls unlock the mutex passed as *sync*. If there are threads blocked on the mutex, the *owner* member of *sync* is set to the thread ID of the thread with the highest priority that has been waiting the longest and it's made ready to run. If no threads are waiting, it's set to zero.

These functions are similar, except for the way they indicate errors. See the Returns section for details.

If the calling thread had its priority boosted while it owned the mutex, it returns to its normal priority.

The POSIX functions *pthread_mutex_lock()*, and *pthread_mutex_unlock()*, are faster, since they can potentially avoid a kernel call.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

SyncMutexUnlock()

If an error occurs, The function returns -1 and sets *errno*. Any other value returned indicates success.

SyncMutexUnlock_r()

Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function returns any value listed in the Errors section.

Errors:

EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EINVAL	The synchronization ID specified in *sync* doesn't exist. The calling thread doesn't own the mutex.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_mutex_lock(), pthread_mutex_unlock(), SyncTypeCreate(), SyncMutexLock()

Synopsis:

```
#include <sys/neutrino.h>

int SyncSemPost( sync_t* sync );

int SyncSemPost_r( sync_t* sync );
```

Arguments:

sync A pointer to the synchronization object for the semaphore that you want to increment.

Library:

libc

Description:

The *SyncSemPost()* and *SyncSemPost_r()* kernel calls increment the semaphore referenced by the *sync* argument. If any threads are blocked on the semaphore, the one waiting the longest is unblocked and allowed to run.

These functions are identical, except for the way they indicate errors. See the Returns section for details.

☞ You should use the POSIX *sem_post()* function instead of calling *SyncSemPost()* directly.

Returns:

The only difference between these functions is the way they indicate errors:

SyncSemPost()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

SyncSemPost_r()

Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function returns one of the values listed in the Errors section.

Errors:

EAGAIN	Not enough memory for the kernel to create the internal *sync* object.
EFAULT	Invalid pointer.
EINTR	A signal interrupted this function.
EINVAL	The *sync* argument doesn't refer to a valid semaphore.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sem_destroy(), *sem_init()*, *sem_post()*, *sem_trywait()*, *sem_wait()*, *SyncDestroy()*, *SyncSemWait()*, *SyncTypeCreate()*

Synopsis:

```
#include <sys/neutrino.h>

int SyncSemWait( sync_t* sync,
                 int try );

int SyncSemWait_r( sync_t* sync,
                   int try );
```

Arguments:

sync A pointer to the synchronization object for the semaphore that you want to wait on.

try Nonzero if you want a conditional wait.

Library:

libc

Description:

The *SyncSemWait()* and *SyncSemWait_r()* kernel calls decrement the semaphore referred to by the *sync* argument. If the semaphore value isn't greater than zero and *try* is zero, then the calling process blocks until it can decrement the counter or the call is interrupted by signal.

These functions are identical, except in the way they indicate errors. See the Returns section for details.

If *try* is nonzero, the function acts as a conditional wait. If the call would block, the semaphore is unmodified, and the call returns with an error.

Returns:

The only difference between these functions is the way they indicate errors:

SyncSemWait()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success (the semaphore was successfully decremented).

SyncSemWait_r()

Returns EOK on success (the semaphore was successfully decremented). This function does **NOT** set *errno*. If an error occurs, the function returns one of the values listed in the Errors section.

Errors:

EAGAIN	Call would have blocked and *try* was nonzero.
EDEADLK	A deadlock condition was detected.
EINTR	A signal interrupted this function.
EINVAL	The *sync* argument doesn't refer to a valid semaphore.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sem_destroy(), *sem_init()*, *sem_post()*, *sem_trywait()*, *sem_wait()*, *SyncDestroy()*, *SyncSemPost()*, *SyncTypeCreate()*

SyncTypeCreate(), SyncTypeCreate_r()

Create a synchronization object

Synopsis:

```
#include <sys/neutrino.h>

int SyncTypeCreate(
        unsigned type,
        sync_t * sync,
        const struct _sync_attr_t * attr );

int SyncTypeCreate_r(
        unsigned type,
        sync_t * sync,
        const struct _sync_attr_t * attr );
```

Arguments:

type One of the following:

- _NTO_SYNC_MUTEX_FREE — create a mutex.
- _NTO_SYNC_SEM — create a semaphore.
- _NTO_SYNC_COND — create a condition variable.

sync A pointer to a **sync_t** that the kernel sets up for the synchronization object; see below.

attr A pointer to a **_sync_attr_t** structure that specifies attributes for the object. This structure contains at least the following members:

- **int** *protocol* — PTHREAD_PRIO_INHERIT or PTHREAD_PRIO_PROTECT.

If attr is NULL, the default attributes (PTHREAD_PRIO_INHERIT) are assumed.

Library:

libc

Description:

The *SyncTypeCreate()* and *SyncTypeCreate_r()* kernel calls create a synchronization object in the kernel and initializes *sync* for use in other synchronization kernel calls. The synchronization object is local to the process.

These functions are similar, except for the way they indicate errors. See the Returns section for details.

Synchronization objects can be used for mutexes, semaphores, or condition variables.

☞ Don't call *SyncTypeCreate()* directly; instead, use the POSIX synchronization objects (see *pthread_cond_init()*, *pthread_mutex_init()*, *pthread_rwlock_init()*, and *sem_init()*).

The *sync* argument contains at least the following members:

`int` *count* — The count for recursive mutexes and semaphores. The kernel sets this member when it creates the synchronization object.

`int` *owner* — When a mutex is created, this member holds the thread ID of the thread that acquired the mutex. When unowned, the value is 0. It's set to zero when the synchronization object is created.

The current state of *sync* is summarized below:

Counter	Owner	Description
–	-2	Destroyed mutex
0	-1	Statically initialized; auto-created when used

continued...

Counter	Owner	Description
0	0	Unlocked mutex
count	>0	Recursive counter number of the mutex
count	<-1	If the high bit of *count* is set, it's a flag meaning "others waiting"
–	-256	Mutex is dead, waits for revival

The synchronization object is destroyed by a call to *SyncDestroy()*.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

SyncTypeCreate()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

SyncTypeCreate_r()

Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function can return any value in the Errors section.

Errors:

EAGAIN All kernel synchronization objects are in use.

EFAULT A fault occurred when the kernel tried to access *sync* or *attr*.

EINVAL Either

- the *type* isn't one of _NTO_SYNC_COND, _NTO_SYNC_MUTEX_FREE or _NTO_SYNC_SEM

  Or:

- if the type is correct, and the synchronization object is:
  - a mutex — the protocol isn't one of PTHREAD_PRIO_INHERIT or PTHREAD_PRIO_PROTECT.
  - a mutex and PTHREAD_PRIO_PROTECT is specified — the ceiling priority isn't within the kernel priority range.
  - a condvar — the clock type is invalid.
  - a semaphore — the semaphore value exceeds SEM_VALUE_MAX.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_cond_init(), *pthread_mutex_init()*, *pthread_rwlock_init()*, *sem_init()*, *SyncCondvarSignal()*, *SyncCondvarWait()*, *SyncDestroy()*, *SyncMutexLock()*, *SyncMutexUnlock()*

sysconf()

Return the value of a configurable system limit

Synopsis:

```
#include <unistd.h>
#include <limits.h>

long sysconf( int name );
```

Arguments:

name The name of the limit that you want to get; see below.

Library:

libc

Description:

The *sysconf()* function returns the value of a configurable system limit indicated by *name*.

Configurable limits are defined in **<confname.h>**, and contain at least the following values:

_SC_ARG_MAX

Maximum length of arguments for the *exec*()* functions, in bytes, including environment data.

_SC_CHILD_MAX

Maximum number of simultaneous processes per real user ID.

_SC_CLK_TCK

The number of intervals per second used to express the value in type **clock_t**.

_SC_NGROUPS_MAX

The maximum number of simultaneous supplementary group IDs per process.

_SC_OPEN_MAX

Maximum number of files that one process can have open at any given time.

_SC_JOB_CONTROL

If this variable is defined, then job control is supported.

_SC_SAVED_IDS

If this variable is defined, then each process has a saved set-user ID and a saved set-group ID.

_SC_VERSION

The current POSIX version that is currently supported. A value of 198808L indicates the August (08) 1988 standard, as approved by the IEEE Standards Board.

Returns:

The requested configurable system limit. If *name* isn't defined for the system, -1 is returned.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <limits.h>
#include <unistd.h>

int main( void )
   {
    printf( "_SC_ARG_MAX = %ld\n",
         sysconf( _SC_ARG_MAX ) );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

confstr(), errno, pathconf()

getconf in the *Utilities Reference*

Understanding System Limits chapter of the Neutrino *User's Guide*

sysctl()

Get or set the system information

Synopsis:

```
#include <sys/param.h>
#include <sys/sysctl.h>

int sysctl( int * name,
            u_int namelen,
            void * oldp,
            size_t * oldlenp,
            void * newp,
            size_t newlen );
```

Arguments:

name	An array of integers that specifies the *Management Information Base* (MIB) stylename of the item that you want to set or get; see below.
namelen	The length of the name.
oldp	NULL, or a pointer to a buffer where the function can store the old value.
oldlenp	NULL, or a pointer to a location that initially specifies the size of the *oldp* buffer. The function changes the value in this location to be the size of the old information stored in the *oldp* buffer
newp	NULL, or a pointer to a buffer that holds the new value.
newlen	The size of the new value.

Library:

libsocket

Description:

The *sysctl()* function retrieves system information and allows processes with appropriate privileges to set system information. The data available from *sysctl()* consists of integers and tables. You can also get or set data using the **sysctl** utility at the command line.

The state is described using a *Management Information Base* (MIB) stylename, specified in *name*, which is a *namelen* length array of integers.

The information is copied into the buffer specified by *oldp*. The size of the buffer is given by the location specified by *oldlenp* before the call, and that location gives the amount of data copied after a successful call. If the amount of data available is greater than the size of the buffer supplied, the call delivers as much data as fits in the buffer provided and returns with the error code ENOMEM. If you don't need the old value, you can set *oldp* and *oldlenp* to NULL.

You can determine the size of the available data by calling *sysctl()* with a NULL parameter for *oldp*. The function stores the size of the available data in the location pointed to by *oldlenp*. For some operations, the amount of space may change often. For these operations, the system attempts to round up, so that the returned size is large enough for a call to return the data shortly thereafter.

To specify a new value, set *newp* to point to a buffer of length *newlen* from which the requested value is to be taken. If you're not setting a new value, set *newp* to NULL and *newlen* to 0.

The top-level names are defined with a CTL_ prefix in **<sys/sysctl.h>**. QNX 4 supports CTL_NET only. The next and subsequent levels down are found in the following header files:

This header file	Contains definitions for
<sys/sysctl.h>	Top-level identifiers
<sys/socket.h>	Second-level network identifiers

continued...

This header file	Contains definitions for
<netinet/in.h>	Third-level Internet identifiers and fourth-level IP identifiers
<netinet/icmp_var.h>	Fourth-level ICMP identifiers
<netinet/tcp_var.h>	Fourth-level TCP identifiers
<netinet/udp_var.h>	Fourth-level UDP identifiers

The following code fragment checks whether the UDP packets checksum is enabled:

```
int mib[5], val;
size_t len;

mib[0] = CTL_NET;
mib[1] = AF_INET;
mib[2] = IPPROTO_UDP;
mib[3] = UDPCTL_CHECKSUM;
len = sizeof(val);
sysctl(mib, 4, &val, &len, NULL, 0);
```

CTL_NET

The table and integer information available for the CTL_NET level is detailed below. The changeable column shows whether a process with appropriate privilege may change the value.

Second-level name	Type	Changeable
PF_INET	internet values	yes

PF_INET

PF_INET gets or sets global information about internet protocols.

The third-level name is the protocol. The fourth-level name is the variable name. Here are the currently defined protocols and names:

Protocol name	Variable name	Type	Changeable
ip	*forwarding*	integer	yes
	redirect	integer	yes
	ttl	integer	yes
	forwsrcrt	integer	yes
	directed-broadcast	integer	yes
	allowsrcrt	integer	yes
	subnetsarelocal	integer	yes
	mtudisc	integer	yes
	maxfragpackets	integer	yes
	sourcecheck	integer	yes
	sourcecheck_logint	integer	yes
icmp	*maskrepl*	integer	yes
tcp	*rfc1323*	integer	yes
	sendspace	integer	yes
	recvspace	integer	yes
	mssdflt	integer	yes
	syn_cache_limit	integer	yes
	syn_bucket_limit	integer	yes
	syn_cache_interval	integer	yes
udp	*checksum*	integer	yes
	sendspace	integer	yes
	recvspace	integer	yes

The variables are as follows:

ip.forwarding Returns 1 when IP forwarding is enabled for the host, meaning that the host is acting as a router.

ip.redirect Returns 1 when ICMP redirects may be sent by the host. This option is ignored unless the host is routing IP packets. Normally, this option should be enabled on all systems.

ip.ttl The maximum time-to-live (hop count) value for an IP packet sourced by the system. This value applies to normal transport protocols, not to ICMP.

ip.forwsrcrt Returns 1 when forwarding of source-routed packets is enabled for the host. This value may be changed only if the kernel security level is less than 1.

ip.directed-broadcast

Returns 1 if directed-broadcast behavior is enabled for the host.

ip.allowsrcrt Returns 1 if the host accepts source-routed packets.

ip.subnetsarelocal

Returns 1 if subnets are to be considered local addresses.

ip.mtudisc Returns 1 if path MTU discovery is enabled.

ip.maxfragpackets

Returns the maximum number of fragmented IP packets in the IP reassembly queue.

ip.sourcecheck Returns 1 if source check for received packets is enabled.

ip.sourcecheck_logint

Returns the time interval when IP source address verification messages are logged. A value of zero disables the logging.

icmp.maskrepl	Returns 1 if ICMP network mask requests are to be answered.
tcp.rfc1323	Returns 1 if RFC1323 extensions to TCP are enabled.
tcp.sendspace	Returns the default TCP send buffer size.
tcp.recvspace	Returns the default TCP receive buffer size.
tcp.mssdflt	Returns the default TCP maximum segment size.
tcp.syn_cache_limit	Returns the maximum number of entries allowed in the TCP compressed state engine.
tcp.syn_bucket_limit	Returns the maximum number of entries allowed per hash bucket in the TCP compressed state engine.
tcp.syn_cache_interval	Returns the TCP compressed state engine's timer interval.
udp.checksum	Returns 1 when UDP checksums are being computed and checked.

Disabling UDP checksums is strongly discouraged.

udp.sendspace	Returns the default UDP send buffer size.
udp.recvspace	Returns the default UDP receive buffer size.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EFAULT	The buffers: *name*, *oldp*, *newp*, or the length pointer *oldlenp* contains an invalid address.
EINVAL	The name array is less than two or greater than CTL_MAXNAME; or a non-NULL *newp* is given and its specified length in *newlen* is too large or too small.
ENOMEM	The length pointed to by *oldlenp* is too short to hold the requested value.
ENOTDIR	The name array specifies an intermediate rather than terminal name.
EOPNOTSUPP	The name array specifies an unknown value.
EPERM	An attempt was made to set a read-only value; a process, without appropriate privilege, attempts to set or change a value protected by the current system security level.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ROUTE protocol

sysctl in the *Utilities Reference*

syslog()

Write a message to the system log

Synopsis:

```
#include <syslog.h>

void syslog( int priority,
             const char * message,
             ...)
```

Arguments:

priority The priority of the message; see "Message levels," below.

message The message that you want to write. This message is identical to a *printf()*-format string, except that **%m** is replaced by the current error message (as denoted by the global variable *errno*). A trailing newline is added if none is present.

The formatting characters that you use in the message determine any additional arguments.

Library:

libc

Description:

The *syslog()* function writes *message* to the system message logger. The message is then written to the system console, log files, and logged-in users, or forwarded to other machines as appropriate. (See the **syslogd** command.)

The *vsyslog()* function is an alternate form in which the arguments have already been captured using the variable-length argument facilities of **<stdarg.h>**.

Message levels

The message is tagged with *priority*. Priorities are encoded as a *facility* and a *level*. The facility describes the part of the system generating the message. The level is selected from the following list (ordered from high to low):

LOG_EMERG	A panic condition. This is normally broadcast to all users.
LOG_ALERT	A condition that should be corrected immediately, such as a corrupted system database.
LOG_CRIT	Critical conditions (for example, hard device errors).
LOG_ERR	General errors.
LOG_WARNING	Warning messages.
LOG_NOTICE	Conditions that aren't error conditions, but should possibly be specially handled.
LOG_INFO	Informational messages.
LOG_DEBUG	Messages that contain information normally of use only when debugging a program.

Examples:

```
syslog(LOG_ALERT, "who: internal error 23");

openlog("ftpd", LOG_PID, LOG_DAEMON);
setlogmask(LOG_UPTO(LOG_ERR));
syslog(LOG_INFO, "Connection from host %d", CallingHost);

syslog(LOG_INFO|LOG_LOCAL2, "foobar error: %m");
```

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

closelog(), *openlog()*, *setlogmask()*, *vsyslog()*

`logger`, **`syslogd`** in the *Utilities Reference*

sysmgr_reboot()

Reboot the system

Synopsis:

```
#include <sys/sysmgr.h>

int sysmgr_reboot( void );
```

Library:

libc

Description:

The *sysmgr_reboot()* function reboots the calling computer. You need to be **root** for this function to succeed.

Returns:

The *sysmgr_reboot()* function doesn't return if successful. If an error occurs, it returns:

EPERM You need to be **root** to call this function.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

procnto in the *Utilities Reference*

SYSPAGE_CPU_ENTRY()

Return a CPU-specific entry from the system page

Synopsis:

```
#include <sys/syspage.h>

#define SYSPAGE_CPU_ENTRY( cpu, entry )...
```

Arguments:

cpu The CPU to get the entry for.

entry The entry to get; see below.

Library:

libc

Description:

The *SYSPAGE_CPU_ENTRY()* macro returns a pointer to the specified *entry* from the part of the system page that's specific to the given *cpu*.

The best way to reference the system page is via the kernel calls and POSIX cover functions. If there isn't a function to access the information you need, use *SYSPAGE_CPU_ENTRY()* instead of referencing the *_syspage_ptr* variable directly. For information in the rest of the **syspage_entry** structure, use *SYSPAGE_ENTRY()*.

The only entry you might currently need to use is:

ppc, **kerinfo**

This structure, defined in **<ppc/syspage.h>**, contains at least the following members:

- **unsigned long** *pretend_cpu* — we can pretend the chip is this Processor Version Register.
- **unsigned long** *init_msr* — the initial Machine Status Register for thread creation.

Returns:

A pointer to the structure for the given *entry*.

Examples:

```
#include <inttypes.h>
#include <stdio.h>
#include <stdlib.h>
#include <sys/syspage.h>

int main( void )
{
  printf ("We're pretending to be a type %ld PPC\n",
     SYSPAGE_CPU_ENTRY(ppc,kerinfo)->pretend_cpu);

  return EXIT_SUCCESS;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

SYSPAGE_CPU_ENTRY() is a macro.

See also:

ClockCycles(), *SYSPAGE_ENTRY()*, *_syspage_ptr*

Customizing Image Startup Programs chapter of the *Building Embedded Systems* guide

SYSPAGE_ENTRY()

Return an entry from the system page

Synopsis:

```
#include <sys/syspage.h>

#define SYSPAGE_ENTRY( entry )...
```

Arguments:

entry The entry to get; see below.

Library:

libc

Description:

The *SYSPAGE_ENTRY()* macro returns a pointer to the specified *entry* in the system page.

The best way to reference the system page is via the kernel calls and POSIX cover functions. If there isn't a function to access the information you need, use *SYSPAGE_ENTRY()* instead of referencing the *_syspage_ptr* variable directly. For information in the CPU-specific part of the **syspage_entry** structure, use *SYSPAGE_CPU_ENTRY()*.

Currently, the only *entry* you're likely to access with *SYSPAGE_ENTRY()* is:

qtime QNX-specific time information. The **qtime_entry** structure contains at least the following members:

- **unsigned long** *boot_time* — the time, in seconds, since the Unix Epoch (00:00:00 January 1, 1970 Coordinated Universal Time (UTC)) when this system was booted.
- **uint64_t** *cycles_per_sec* — the number of CPU clock cycles per second for this system. For more information, see *ClockCycles()*.

Returns:

A pointer to the structure for the given *entry*.

Examples:

```
#include <sys/neutrino.h>
#include <inttypes.h>
#include <stdio.h>
#include <stdlib.h>
#include <sys/syspage.h>

int main( void )
{
    uint64_t cps, cycle1, cycle2, ncycles;
    float sec;

    /* snap the time */
    cycle1=ClockCycles( );

    /* do something */
    printf("poo\n");

    /* snap the time again */
    cycle2=ClockCycles( );
    ncycles=cycle2-cycle1;
    printf("%lld cycles elapsed \n", ncycles);

    /* find out how many cycles per second */
    cps = SYSPAGE_ENTRY(qtime)->cycles_per_sec;
    printf( "This system has %lld cycles/sec.\n",cps );
    sec=(float)ncycles/cps;
    printf("The cycles in seconds is %f \n",sec);

    return EXIT_SUCCESS;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

SYSPAGE_ENTRY() is a macro.

See also:

ClockCycles(), *SYSPAGE_CPU_ENTRY()*, *_syspage_ptr*

Customizing Image Startup Programs chapter of the *Building Embedded Systems* guide

Synopsis:

```
#include <sys/syspage.h>

struct syspage_entry *_syspage_ptr
```

Description:

This global variable holds a pointer to the *system page*, which contains information about the system, including the processor type, bus type, and the location and size of available system RAM. For information about this structure, see the Customizing Image Startup Programs chapter of *Building Embedded Systems*.

The best way to reference the system information page is via the kernel calls and POSIX cover functions. If there isn't a function to access the information you need, you should use the *SYSPAGE_ENTRY()* and *SYSPAGE_CPU_ENTRY()* macros instead of referencing the *_syspage_ptr* variable directly.

Classification:

QNX Neutrino

See also:

SYSPAGE_CPU_ENTRY(), *SYSPAGE_ENTRY()*

system()

Execute a system command

Synopsis:

```
#include <stdlib.h>

int system( const char *command );
```

Arguments:

command	NULL, or the system command that you want to execute; see below.

Library:

libc

Description:

The behavior of the *system()* function depends on the value of its *command* argument:

- If *command* is NULL, *system()* determines whether or not a shell is present.
- If *command* isn't NULL, *system()* invokes a copy of the shell, and passes the string *command* to it for processing. This function uses *spawnlp()* to load a copy of the shell.

The shell used is always **/bin/sh**, regardless of the setting of the **SHELL** environment variable, because applications may rely on features of the standard shell, and may fail as a result of running a different shell.

This means that any command that can be entered to the OS can be executed, including programs, QNX Neutrino commands, and shell scripts. The *exec*()* and *spawn*()* functions can only cause programs to be executed.

Returns:

- If *command* is NULL, *system()* returns zero if the shell isn't present, or a nonzero value if the shell is present.
- If *command* isn't NULL, *system()* returns the result of invoking a copy of the shell. If the shell couldn't be loaded, *system()* returns -1; otherwise, it returns the status of the specified command. Use the *WEXITSTATUS()* macro to determine the low-order 8 bits of the termination status of the process.

  For example, assume that *status* is the value returned by *system()*. If *WEXITSTATUS(status)* returns 255, either the specified command returned a termination status of 255, or the shell didn't exit (i.e. it died from a signal or couldn't be started at all) and the return value was 255 due to implementation details. For example, under QNX Neutrino and most Unix systems, the value is 255 if *status* is `-1`, which indicates that the shell couldn't be executed. *WEXITSTATUS()* is defined in **`<sys/wait.h>`**.

For information about macros that extract information from the value returned by *system()*, see "Status macros" in the description of *wait()*.

When an error has occurred, *errno* contains a value that indicates the type of error that has been detected.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <sys/wait.h>

int main( void )
  {
    int rc;

    rc = system( "ls" );
    if( rc == -1 ) {
      printf( "shell could not be run\n" );
    } else {
      printf( "result of running command is %d\n",
          WEXITSTATUS( rc ) );
    }
    return EXIT_SUCCESS;
  }
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

abort(), *atexit()*, *close()*, *errno*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *exit()*, *_exit()*, *getenv()*, *main()*, *putenv()*, *sigaction()*, *signal()*, *spawn()*, *spawnl()*, *spawnle()*, *spawnlp()*, *spawnlpe()*, *spawnp()*, *spawnv()*, *spawnve()*, *spawnvp()*, *spawnvpe()*, *wait()*, *waitpid()*

tan(), tanf()

Calculate the tangent of an angle

Synopsis:

```
#include <math.h>

double tan( double x );

float tanf( float x );
```

Arguments:

x The angle, in radians, for which you want to compute the tangent.

Library:

libm

Description:

These functions compute the tangent (specified in radians) of *x*. A large magnitude argument may yield a result with little or no significance.

Returns:

The tangent value. If *x* is NAN or infinity, NAN is returned.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

int main( void )
  {
    printf( "%f\n", tan(.5) );
```

```
    return EXIT_SUCCESS;
}
```

produces the output:

```
0.546302
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

atan(), atan2(), cos(), sin()

tanh(), tanhf()

Calculate the hyperbolic tangent

Synopsis:

```
#include <math.h>

double tanh( double x );

float tanhf( float x );
```

Arguments:

x The angle, in radians, for which you want to compute the hyperbolic tangent.

Library:

libm

Description:

These functions compute the hyperbolic tangent (specified in radians) of *x*.

When the *x* argument is large, partial or total loss of significance may occur.

Returns:

The hyperbolic tangent value.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

int main( void )
```

```
{
  printf( "%f\n", tanh(.5) );
  return EXIT_SUCCESS;
}
```

produces the output:

```
0.462117
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

cosh(), errno, sinh()

Wait until all output has been transmitted to a device

Synopsis:

```
#include <termios.h>

int tcdrain( int fildes );
```

Arguments:

fildes A file descriptor that's associated with the device that you want to wait for.

Library:

libc

Description:

The *tcdrain()* function waits until all output has been physically transmitted to the device associated with *fildes*, or until a signal is received.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF The argument *fildes* is invalid.

EINTR A signal interrupted the operation.

ENOSYS The resource manager associated with *fildes* doesn't support this call.

ENOTTY The argument *fildes* doesn't refer to a terminal device.

Examples:

```
#include <termios.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {
    int fildes;

    fildes = open( "/dev/ser1", O_RDWR );
    write( fildes, "ATH", 3 );

    /* Wait for data to transmit before returning */
    tcdrain( fildes );
    close( fildes );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

write()

tcdropline()

Disconnect a communications line

Synopsis:

```
#include <termios.h>

int tcdropline( int fd,
                int duration );
```

Arguments:

fd	A file descriptor that's associated with the line that you want to disconnect.
duration	The number of milliseconds that you want to drop the line for.

Library:

libc

Description:

The *tcdropline()* function initiates a disconnect condition on the communication line associated with the opened file descriptor indicated by *fd*.

The disconnect condition lasts at least *duration* milliseconds, or approximately 300 milliseconds if *duration* is zero. The system rounds the effective value of *duration* up to the next highest supported interval, which is typically a multiple of 100 milliseconds.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EBADF	Invalid *fd* argument.
ENOSYS	The resource manager associated with *fd* doesn't support this call.
ENOTTY	The argument *fd* doesn't refer to a terminal device.

Examples:

```
#include <termios.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {
    int fd;

    fd = open( "/dev/ser1", O_RDWR );

    /* Disconnect for 500 milliseconds */
    tcdropline( fd, 500 );

    close( fd );
    return EXIT_SUCCESS;
  }
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

tcdrain(), tcflow(), tcflush()

tcflow()

Perform a flow-control operation on a data stream

Synopsis:

```
#include <termios.h>

int tcflow( int fildes,
            int action );
```

Arguments:

fildes	A file descriptor that's associated with the data stream that you want to perform the operation on.
action	The action you want to perform; see below.

Library:

libc

Description:

The *tcflow()* function performs a flow-control operation on the data stream associated with *fildes*, depending on the values in *action*.

At least the following actions are defined in **<termios.h>**:

TCOOFF	Use software flow control to suspend output on the device associated with *fildes*.
TCOOFFHW	Use hardware flow control to suspend output on the device associated with *fildes*.
TCOON	Use software flow control to resume output on the device associated with *fildes*.
TCOONHW	Use hardware flow control to resume output on the device associated with *fildes*.
TCIOFF	Cause input to be flow-controlled by sending a STOP character immediately across the communication line associated with *fildes*, (that is, software flow control).

TCIOFFHW	Cause input to be flow-controlled by using hardware control.
TCION	Resume input by sending a START character immediately across the communication line associated with *fildes* (that is, software flow control).
TCIONHW	Cause input to be resumed by using hardware flow control.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EBADF	Invalid *fildes* argument.
EINVAL	Invalid *action* argument.
ENOSYS	The resource manager associated with *fildes* doesn't support this call.
ENOTTY	The argument *fildes* doesn't refer to a terminal device.

Examples:

```
#include <termios.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {
    int fd;

    fd = open( "/dev/ser1", O_RDWR );

    /* Resume output on flow-controlled device */
    tcflow( fd, TCOON );
```

```
  close( fd );
  return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

tcdrain(), tcflush(), tcsendbreak()

tcflush()

Flush the input and/or output stream

Synopsis:

```
#include <termios.h>

int tcflush( int fildes,
             int queue_selector );
```

Arguments:

fildes A file descriptor that's associated with the data stream that you want to perform the operation on.

queue_selector

The stream or streams that you want to flush. At least the following values for *queue_selector* are defined in **<termios.h>**:

- TCIFLUSH — discard all data that's received, but not yet read, on the device associated with *fildes*.
- TCOFLUSH — discard all data that's written, but not yet transmitted, on the device associated with *fildes*.
- TCIOFLUSH — discard all data that's written, but not yet transmitted, as well as all data that's received, but not yet read, on the device associated with *fildes*.

Library:

libc

Description:

The *tcflush()* function flushes the input stream, the output stream, or both, depending on the value of the argument *queue_selector*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF	Invalid *fildes* argument.
EINVAL	Invalid *queue_selector* argument.
ENOSYS	The resource manager associated with *fildes* doesn't support this call.
ENOTTY	The argument *fildes* doesn't refer to a terminal device.

Examples:

```
#include <termios.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {
    int fildes;

    fildes = open( "/dev/ser1", O_RDWR );

    /* Throw away all input data */
    tcflush( fildes, TCIFLUSH );

    close( fildes );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

tcdrain(), *tcflow()*, *tcsendbreak()*

tcgetattr()

Get the current terminal control settings

Synopsis:

```
#include <termios.h>

int tcgetattr( int fildes,
               struct termios *termios_p );
```

Arguments:

fildes	The file descriptor associated with the terminal device.
termios_p	A pointer to a **termios** structure in which *tcgetattr()* can store the terminal's control attributes.

Library:

libc

Description:

The *tcgetattr()* function gets the current terminal control settings for the opened device indicated by *fildes*, and stores the results in the structure pointed to by *termios_p*.

Returns:

0	Success.
-1	An error occurred; *errno* is set.

Errors:

EBADF	The *fildes* argument is invalid.
ENOSYS	The resource manager associated with *fildes* doesn't support this call.
ENOTTY	The *fildes* argument doesn't refer to a terminal device.

Examples:

See *tcsetattr()*.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *fpathconf()*, *tcsetattr()*, **`termios`**

Chapter 7 of POSIX 1003.1

tcgetpgrp()

Get the process group ID associated with a device

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

pid_t tcgetpgrp( int fildes );
```

Arguments:

fildes A file descriptor that's associated with the device whose process group ID you want to get.

Library:

libc

Description:

The *tcgetpgrp()* function returns the process group ID of the foreground process that's associated with the device indicated by *fildes*.

Returns:

The ID of foreground process group. If an error occurs, -1 is returned, and *errno* is set.

Errors:

EBADF The argument *fildes* is invalid.

ENOSYS The resource manager associated with *fildes* doesn't support this call.

ENOTTY The argument *fildes* isn't associated with a terminal device.

Examples:

```
#include <sys/types.h>
#include <unistd.h>
#include <stdio.h>
#include <stdlib.h>

int main( void )
  {
    printf( "STDIN directs breaks to pgrp %d\n",
        tcgetpgrp( 0 ) );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

signal(), tcsetpgrp()

tcgetsid()

Get the process group ID of the session leader for a controlling terminal

Synopsis:

```
#include <unistd.h>

int tcgetsid( int filedes );
```

Arguments:

fildes A file descriptor that's associated with the device whose ID you want to get.

Library:

libc

Description:

The *tcgetsid()* function returns the process group ID of the session for which the terminal specified by *filedes* is the controlling terminal.

Returns:

The process group ID associated with the terminal, or -1 if an error occurs (*errno* is set).

Errors:

EACCES The *filedes* argument isn't associated with a controlling terminal.

EBADF The *filedes* argument isn't a valid file descriptor.

ENOTTY The file associated with *filedes* isn't a terminal.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

tcsetsid()

tcgetsize()

Get the size of a character device

Synopsis:

```
#include <termios.h>

int tcgetsize( int filedes,
               int* prows,
               int* pcols );
```

Arguments:

fildes	A file descriptor that's associated with the device whose size you want to get.
prows, *pcols*	NULL, or pointers to locations where the function can store the number of rows and columns.

Library:

libc

Description:

The *tcgetsize()* function gets the size of the character device associated with *filedes* and stores the number of rows and columns in *prows* and *pcols* if they're not NULL.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EACCES	The *filedes* argument isn't associated with a controlling terminal.
EBADF	The *filedes* argument isn't a valid file descriptor.
ENOTTY	The file associated with *filedes* isn't a terminal.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

tcsetsize()

tcinject()

Inject characters into a device's input buffer

Synopsis:

```
#include <termios.h>

int tcinject( int fd,
              char *buf,
              int n );
```

Arguments:

fildes	A file descriptor that's associated with the device whose input buffer you want to add characters to.
buf	A pointer to a buffer that contains the characters that you want to insert.
n	The number of characters to insert. If *n* is positive, the characters are written to the canonical (edited) queue. If *n* is negative, the characters are written to the raw queue.

Library:

libc

Description:

The *tcinject()* function injects *n* characters pointed to by *buf* into the input buffer of the device given in *fd*.

Note that while injecting into the canonical queue, editing characters in *buf* are acted upon as though the user entered them directly from the device. If *buf* doesn't contain a newline ('**\n**'), carriage return ('**\r**') or a data-forwarding character such as an EOF, data doesn't become available for reading. If *buf* does contain a data-forwarding character, it should contain only one as the last character in *buf*.

This function is useful for implementing command-line recall algorithms by injecting recalled lines into the canonical queue.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EBADF The *fd* argument is invalid or the file isn't opened for read.

ENOSYS This function isn't supported for the device opened.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <termios.h>

int main( void )
{
  char *p = "echo Hello world!\n";

  /* Inject the line all at once */
  tcinject(0, p, strlen(p));

  /* Inject the line one character at a time */
  while(*p)
    tcinject(0, p++, 1);
  return EXIT_SUCCESS;
}
```

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes

continued...

Safety	
Thread	Yes

tcischars()

Determine the number of characters waiting to be read

Synopsis:

```
#include <termios.h>

int tcischars( int filedes );
```

Arguments:

fildes A file descriptor that's associated with the device that you want to check.

Library:

libc

Description:

The *tcischars()* function checks to see how many characters are waiting to be read from the given file descriptor, *filedes*.

Returns:

The number of characters waiting to be read, or -1 if an error occurred.

Errors:

ENOTTY The *fd* argument isn't the file descriptor for a character device.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>

int socket( AF_INET,
            SOCK_STREAM,
            0 );
```

Description:

The TCP protocol provides reliable, flow-controlled, two-way transmission of data. It's a byte-stream protocol used to support the SOCK_STREAM abstraction.

TCP uses the standard Internet address format and also provides a per-host collection of "port addresses." Thus, each address is composed of an Internet address specifying the host and network, with a specific TCP port on the host identifying the peer entity.

Sockets using the TCP protocol are either *active* or *passive*. Active sockets initiate connections to passive sockets. By default, TCP sockets are created active.

To create a passive socket, you must bind the socket with the *bind()* system call, and then use the *listen()* system call. Only passive sockets may use the *accept()* call to accept incoming connections; only active sockets may use the *connect()* call to initiate connections.

Passive sockets may "underspecify" their location to match incoming connection requests from multiple networks. With this technique, termed *wildcard addressing*, a single server can provide service to clients on multiple networks. If you wish to create a socket that listens on all networks, the Internet address INADDR_ANY must be bound. You can still specify the TCP port at this time. If the port isn't specified, the system assigns one.

Once a connection has been established, the socket's address is fixed by the peer entity's location. The address assigned to the socket is the address associated with the network interface through which packets

are being transmitted and received. Normally this address corresponds to the peer entity's network.

TCP supports several socket options (defined in **<netinet/tcp.h>**) that you can set with *setsockopt()* and retrieve with *getsockopt()*. The option level for these calls is the protocol number for TCP, available from *getprotobyname()*.

TCP_NODELAY

Under most circumstances, TCP sends data when it's presented. When outstanding data hasn't yet been acknowledged, TCP gathers small amounts of output to be sent in a single packet once an acknowledgment is received.

For a few clients (such as windowing systems that send a stream of mouse events that receive no replies), this packetization may cause significant delays. Therefore, TCP provides a boolean option, TCP_NODELAY, to defeat this algorithm.

TCP_MAXSEG

The Maximum Segment Size (MSS) for a TCP connection. The value returned is the maximum amount of data that TCP sends to the other end. If this value is fetched before the socket is connected, the value returned is the default value that's used if an MSS option isn't received from the other end.

TCP_KEEPALIVE

Specifies the idle time in seconds for the connection before TCP starts sending "keepalive" probes. The default value is 2 hours. This option is effective only when the SO_KEEPALIVE socket option is enabled.

You can use options at the IP transport level with TCP (see the IP protocol. Incoming connection requests that are source-routed are noted, and the reverse source route is used in responding.

Returns:

A descriptor referencing the socket, or -1 if an error occurs (*errno* is set).

Errors:

EADDRINUSE — You tried to create a socket with a port that's already been allocated.

EADDRNOTAVAIL — You tried to create a socket with a network address for which no network interface exists.

ECONNREFUSED — The remote peer actively refused connection establishment (usually because no process was listening to the port).

ECONNRESET — The remote peer forced the connection to be closed.

EISCONN — You tried to establish a connection on a socket that already has one.

ENOBUFS — The system ran out of memory for an internal data structure.

ETIMEDOUT — A connection was dropped due to excessive retransmissions.

See also:

IP protocol

accept(), bind(), connect(), getprotobyname(), getsockopt(), listen(), setsockopt(), socket()

RFC 793

tcsendbreak()

Assert a break condition over a communications line

Synopsis:

```
#include <termios.h>

int tcsendbreak( int fildes,
                 int duration );
```

Arguments:

fd	A file descriptor that's associated with the line that you want to assert the break on.
duration	The number of milliseconds that you want to break for.

Library:

libc

Description:

The *tcsendbreak()* function asserts a break condition over the communication line associated with the opened file descriptor indicated by *fildes*.

The break condition lasts for at least *duration* milliseconds, or approximately 300 milliseconds if *duration* is zero. The system rounds the effective value of *duration* up to the next highest supported interval, which is typically a multiple of 100 milliseconds.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EBADF	The argument *fildes* is invalid.
ENOSYS	The resource manager associated with *fildes* doesn't support this call.

ENOTTY The argument *fildes* doesn't refer to a terminal device.

Examples:

```
#include <termios.h>
#include <fcntl.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {
    int fd;

    fd = open( "/dev/ser1", O_RDWR );

    /* Send a 500 millisecond break */
    tcsendbreak( fd, 500 );

    close( fd );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

tcdrain(), tcflow(), tcflush()

tcsetattr()

Change the terminal control settings for a device

Synopsis:

```
#include <termios.h>

int tcsetattr( int fildes,
               int optional_actions,
               const struct termios *termios_p );
```

Arguments:

fildes	The file descriptor associated with the terminal device.
termios_p	A pointer to a **termios** structure that describes the attributes that you want to set for the terminal device.

Library:

libc

Description:

The *tcsetattr()* function sets the current terminal control settings for the opened device indicated by *fildes* to the values stored in the structure pointed to by *termios_p*.

The operation of *tcsetattr()* depends on the values in *optional_actions*:

TCSANOW	The change is made immediately.
TCSADRAIN	No change is made until all currently written data has been transmitted.
TCSAFLUSH	No change is made until all currently written data has been transmitted, at which point any received but unread data is also discarded.

The **termios** control structure is defined in **<termios.h>**. For more information, see *tcgetattr()*.

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Errors:

EBADF	The argument *fildes* is invalid;
EINVAL	The argument *action* is invalid, or one of the members of *termios_p* is invalid.
ENOSYS	The resource manager associated with *fildes* doesn't support this call.
ENOTTY	The argument *fildes* doesn't refer to a terminal device.

Examples:

```
#include <stdlib.h>
#include <termios.h>

int main( void )
  {
    raw( 0 );
    /*
     * Stdin is now "raw"
     */
    unraw ( 0 );
    return EXIT_SUCCESS;
  }

int raw( fd )
  int fd;
  {
    struct termios termios_p;

    if( tcgetattr( fd, &termios_p ) )
      return( -1 );

    termios_p.c_cc[VMIN]  =  1;
    termios_p.c_cc[VTIME] =  0;
    termios_p.c_lflag &= ~( ECHO|ICANON|ISIG|
              ECHOE|ECHOK|ECHONL );
    termios_p.c_oflag &= ~( OPOST );
    return( tcsetattr( fd, TCSADRAIN, &termios_p ) );
```

```
  }

int unraw( fd )
  int fd;
  {
    struct termios termios_p;

    if( tcgetattr( fd, &termios_p ) )
      return( -1 );

    termios_p.c_lflag |= ( ECHO|ICANON|ISIG|
             ECHOE|ECHOK|ECHONL );
    termios_p.c_oflag |= ( OPOST );
    return( tcsetattr( fd, TCSADRAIN, &termios_p ) );
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *select()*, *tcgetattr()*, **termios**

tcsetpgrp()

Set the process group ID for a device

Synopsis:

```
#include <sys/types.h>
#include <unistd.h>

int tcsetpgrp( int fildes,
               pid_t pgrp_id );
```

Arguments:

fildes	A file descriptor that's associated with the device whose process group ID you want to set.
pgrp_id	The process group ID that you want to assign to the device.

Library:

libc

Description:

The *tcsetpgrp()* function sets the process group ID associated with the device indicated by *fildes* to be *pgrp_id*.

If successful, the *tcsetpgrp()* function causes subsequent breaks on the indicated terminal device to generate a SIGINT on all process in the given process group.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EBADF	The argument *fildes* is invalid.
EINVAL	The argument *pgrp_id* is invalid.

ENOSYS	The resource manager associated with *fildes* doesn't support this call.
ENOTTY	The argument *fildes* isn't associated with a terminal device.
EPERM	The argument *pgrp_id* isn't part of the same session as the calling process.

Examples:

```
#include <sys/types.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
  {
    /*
     * Direct breaks on stdin to me
     */
    tcsetpgrp( 0, getpid() );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

signal(), tcgetpgrp()

tcsetsid()

Make a terminal device a controlling device

Synopsis:

```
#include <termios.h>

int tcsetsid( int fd,
              pid_t pid );
```

Arguments:

fd A file descriptor that's associated with the device that you want to make a controlling device.

pid The ID of the process that you want to associate with the controlling device.

Library:

libc

Description:

The *tcsetsid()* function makes the terminal device associated with the file descriptor argument *fd* into a controlling terminal that's associated with the process *pid*. If successful, this call causes subsequent hangup conditions on the terminal device *fd* to generate a SIGHUP signal on the given process.

This call is equivalent to calling **ioctl(fd, TIOCSCTTY)** to set the controlling terminal to the current process. You can clear the controlling terminal by passing -1 as *fd*.

Returns:

0 Success.

-1 Failure; *errno* is set.

Errors:

EBADF Invalid file descriptor.

EINVAL The argument *pid* is invalid.

ENOSYS, ENOTTY
The argument *fd* isn't associated with a terminal device.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ioctl(), *tcgetsid()*

tcsetsize()

Set the size of a character device

Synopsis:

```
#include <termios.h>

int tcsetsize( int filedes,
               int rows,
               int cols );
```

Arguments:

fildes	A file descriptor that's associated with the device whose size you want to set.
rows, *cols*	The number of rows and columns that you want to use.

Library:

libc

Description:

The *tcsetsize()* function sets the size of the character device associated with *filedes* to the given number of rows and columns.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Errors:

EACCES	The *filedes* argument isn't associated with a controlling terminal.
EBADF	The *filedes* argument isn't a valid file descriptor.
EINVAL	The *rows* or *cols* argument is invalid.
ENOTTY	The file associated with *filedes* isn't a terminal.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

tcgetsize()

tell(), *tell64()*

Determine the current file position

Synopsis:

```
#include <unistd.h>

off_t tell( int filedes );

off64_t tell( int filedes );
```

Arguments:

filedes The file descriptor of the file whose position you want to get.

Library:

libc

Description:

The *tell()* function determines the current file position for any subsequent *read()* or *write()* operation (that is, any subsequent unbuffered file operation). The *filedes* value is the file descriptor returned by a successful call to *open()*.

You can use the returned value in conjunction with *lseek()* to reset the current file position.

Returns:

The current file position, expressed as the number of bytes from the start of the file, or -1 if an error occurs (*errno* is set). A value of 0 indicates the start of the file.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <sys/stat.h>
#include <unistd.h>
#include <fcntl.h>

char buffer[]
```

```
    = { "A text record to be written" };

int main( void )
  {
    int filedes ;
    int size_written;

    /* open a file for output          */
    /* replace existing file if it exists */
    filedes = open( "file",
        O_WRONLY | O_CREAT | O_TRUNC,
        S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP );

    if( filedes != -1 ) {

      /* print file position */
      printf( "%ld\n", tell( filedes ) );

      /* write the text */
      size_written = write( filedes , buffer,
                sizeof( buffer ) );

      /* print file position */
      printf( "%ld\n", tell( filedes ) );

      /* close the file */
      close( filedes );
    }
    return EXIT_SUCCESS;
  }
```

produces the output:

```
0
28
```

Classification:

tell() is QNX 4; *tell64()* is for large-file support

Safety	
Cancellation point	Yes

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chsize(), *close()*, *creat()*, *dup()*, *dup2()*, *eof()*, *errno*, *execl()*, *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *fcntl()*, *fileno()*, *fstat()*, *isatty()*, *lseek()*, *open()*, *read()*, *sopen()*, *stat()*, *umask()*, *write()*

telldir()

Get the location associated with the directory stream

Synopsis:

```
#include <dirent.h>

long int telldir( DIR * dirp );
```

Arguments:

dirp The directory stream for which you want to get the current location.

Library:

libc

Description:

The *telldir()* function obtains the current location associated with the directory stream specified by *dirp*.

Returns:

The current position of the specified directory stream, or -1 if an error occurs (*errno* is set).

Errors:

EBADF The *dirp* argument doesn't refer to an open directory stream.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	No

See also:

closedir(), *errno*, *lstat()*, *opendir()*, *readdir()*, *readdir_r()*, *rewinddir()*, *seekdir()*, *stat()*

tempnam()

Create a name for a temporary file

Synopsis:

```
#include <stdio.h>

char* tempnam( const char* dir,
               const char* pfx );
```

Arguments:

dir NULL, or the directory to use in the pathname.

pfx NULL, or a prefix to use in the pathname.

☞ If *pfx* isn't NULL, the string it points to must be no more than 5 bytes long.

Library:

libc

Description:

The *tempnam()* function generates a pathname for use as a temporary file. The pathname is in the directory specified by *dir* and has the prefix specified in *pfx*.

If *dir* is NULL, the pathname is prefixed with the first accessible directory contained in:

- the temporary file directory *P_tmpdir* (defined in **<stdio.h>**)
- the **TMPDIR** environment variable
- the _PATH_TMP constant (defined in **<paths.h>**).

If all of these paths are inaccessible, *tempnam()* attempts to use **/tmp** and then the current working directory.

The *tempnam()* function generates up to TMP_MAX unique file names before it starts to recycle them.

Returns:

A pointer to the generated file name, which you should deallocate with the *free()* function when the application no longer needs it, or NULL if an error occurs.

Errors:

ENOMEM	There's insufficient memory available to create the pathname.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

Caveats:

The *tempnam()* functions creates only pathnames; the application must create and remove the files.

It's possible for another thread or process to create a file with the same name between the time the pathname is created and the file is opened.

See also:

free(), tmpfile(), tmpnam(), unlink()

Synopsis:

```
struct termios {
    tcflag_t        c_iflag;
    tcflag_t        c_oflag;
    tcflag_t        c_cflag;
    tcflag_t        c_lflag;
    cc_t            c_cc[NCCS];
    uint32_t        reserved[3];
    speed_t         c_ispeed;
    speed_t         c_ospeed;
};
```

Description:

The **termios** control structure is defined in **<termios.h>**, and contains at least the members described below.

tcflag_t *c_iflag*

Input modes. This member contains at least the following bits:

BRKINT	Signal interrupt on break.
ICRNL	Map CR to NL on input.
IGNBRK	Ignore break conditions.
IGNCR	Ignore CR.
IGNPAR	Ignore characters with parity errors.
INLCR	Map NL to CR on input.
INPCK	Enable input parity check.
ISTRIP	Strip top bit from character.
IXOFF	Enable software input flow control (via START/STOP chars).
IXON	Enable software output flow control (via START/STOP chars).
PARMRK	Mark parity errors in the input data stream.

tcflag_t *c_oflag*

Output modes. This member contains at least the following bits:

OPOST	Perform output processing.

tcflag_t *c_cflag*

Control modes. This member contains at least the following bits:

CLOCAL	Ignore modem status lines.
CREAD	Enable receiver.
CSIZE	Number of data bits per character.
CS5	5 data bits.
CS6	6 data bits.
CS7	7 data bits.
CS8	8 data bits.
CSTOPB	Two stop bits, else one.
HUPCL	Hang up on last close.
IHFLOW	Support input flow control using the hardware handshaking lines.
OHFLOW	Support output flow control using the hardware handshaking lines.
PARENB	Parity enable.
PARODD	Odd parity, else even.
PARSTK	Stick parity (mark parity if PARODD is set, else space parity).

tcflag_t *c_lflag*

Local modes. This member contains at least the following bits:

ECHO	Enable echo.
ECHOE	Echo ERASE as destructive backspace.
ECHOK	Echo KILL as a line erase.

ECHONL	Echo '\n', even if ECHO is off.
ICANON	Canonical input mode (line editing enabled).
IEXTEN	QNX extensions to POSIX are enabled.
ISIG	Enable signals.
NOFLSH	Disable flush after interrupt, quit, or suspend.
TOSTOP	Send SIGTTOU for background output.

cc_t *c_cc*[NCCS]

Control characters. The array *c_cc* includes at least the following control characters:

c_cc[VEOF]	EOF character.
c_cc[VEOL]	EOL character.
c_cc[VERASE]	ERASE character.
c_cc[VINTR]	INTR character.
c_cc[VKILL]	KILL character.
c_cc[VMIN]	MIN value.
c_cc[VQUIT]	QUIT character.
c_cc[VSUSP]	SUSP character.
c_cc[VTIME]	TIME value.
c_cc[VSTART]	START character.
c_cc[VSTOP]	STOP character.

The following control characters are also defined, but are only acted on if they're immediately preceded by the nonzero characters in *c_cc*[VPREFIX][4], and are immediately followed by the nonzero characters in *c_cc*[VSUFFIX][4] and the IEXTEN bit of *c_lflag* is set:

c_cc[VLEFT]	Left cursor motion.
c_cc[VRIGHT]	Right cursor motion.
c_cc[VUP]	Up cursor motion.

c_cc[VDOWN]	Down cursor motion.
c_cc[VINS]	Insert character.
c_cc[VDEL]	Delete character.
c_cc[VRUB]	Rubout character.
c_cc[VCAN]	Cancel character.
c_cc[VHOME]	Home character.
c_cc[VEND]	End character.

Any of the control characters in the *c_cc* array can be disabled by setting that character to the _PC_VDISABLE parameter which is returned by *fpathconf()* (typically a zero).

speed_t *c_ispeed*

Input baud rate. This member should be queried and set with the *cfgetispeed()* and *cfsetispeed()* functions.

speed_t *c_ospeed*

Output baud rate. This member should be queried and set with the *cfgetospeed()* and *cfsetospeed()* functions.

Classification:

POSIX 1003.1

See also:

cfgetispeed(), cfgetospeed(), cfsetispeed(), cfsetospeed(), cfmakeraw(), fpathconf(), forkpty(), openpty(), pathconf(), readcond(), tcgetattr(), tcsetattr()

thread_pool_control()

Control the thread pool behavior

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

thread_pool_control( thread_pool_t * pool,
                     thread_pool_attr_t * attr,
                     uint16_t lower,
                     uint16_t upper,
                     unsigned flags )
```

Arguments:

pool
A thread pool handle that was returned by *thread_pool_create()*.

attr
A pointer to a **thread_pool_attr_t** structure that specifies the attributes that you want to use for the thread pool. For more information, see "Thread-pool attributes," in the documentation for *thread_pool_create()*.

lower, upper
This function blocks until the number of threads created is between the range of *upper* and *lower*, unless you set THREAD_POOL_CONTROL_NONBLOCK in *flags*.

flags
Which attributes you want to change for the thread pool; any combination of the following bits:

- THREAD_POOL_CONTROL_HIWATER — adjust the high-water value of the number of threads allowed in the thread pool.
- THREAD_POOL_CONTROL_INCREMENT — adjust the increment value of the number of threads.
- THREAD_POOL_CONTROL_LOWATER — adjust the low-water value of the number of threads allowed in the thread pool.

- THREAD_POOL_CONTROL_MAXIMUM — adjust the maximum value of the number of threads allowed in the thread pool.
- THREAD_POOL_CONTROL_NONBLOCK — don't block while creating threads.

Library:

libc

Description:

Use *thread_pool_control()* to specify a thread pool's behavior and adjust its attributes.

Having several threads call this function with the same thread pool handle isn't recommended.

Returns:

-1 if an error occurs (*errno* is set).

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

thread_pool_destroy(), thread_pool_create(), thread_pool_limits(), thread_pool_start()

thread_pool_create()

Create a thread pool handle

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

thread_pool_t * thread_pool_create (
                    thread_pool_attr_t * pool_attr,
                    unsigned flags );
```

Arguments:

pool_attr — A pointer to a **thread_pool_attr_t** structure that specifies the attributes that you want to use for the thread pool. For more information, see "Thread-pool attributes," below.

flags — Flags (defined in **<sys/dispatch.h>**) that affect what happens to the thread that's creating the pool:

- POOL_FLAG_EXIT_SELF — when the pool is started using *thread_pool_start()*, exit the thread that called this function.
- POOL_FLAG_USE_SELF — when the pool is started, use the calling thread as part of the pool.

Library:

libc

Description:

The *thread_pool_create()* function creates a thread pool handle. This handle is then used to start a thread pool with *thread_pool_start()*. With the thread pool functions, you can create and manage a pool of worker threads.

How it works

The worker threads work in the following way:

- When a new worker thread is created, a context is allocated, which the thread uses to do its work.
- The thread then calls the blocking function. This function blocks until the thread has work to do. For example, the blocking function could call *MsgReceive()* to wait for a message.
- After the blocking function returns, the worker thread calls the handler function, which performs the actual work.
- When the handler function returns, the thread calls the blocking function again.

The thread continues to block and handle events until the thread pool decides this worker thread is no longer needed. Finally, when the worker thread exits, it releases the allocated context.

The thread pool manages these worker threads so that there's a certain number of them in the blocked state. Thus, as threads become busy in the handler function, the thread pool creates new threads to keep a minimum number of threads in a state where they can accept requests from clients. By the same token, if the demand on the thread pool goes down, the thread pool lets some of these blocked threads exit.

Thread-pool attributes

The *pool_attr* argument sets the:

- functions that get called, when a new thread is started or one dies, to allocate and free contexts used by threads
- blocking and handler functions
- parameters of the thread pool such as the number of worker threads, etc.

The *thread_pool_attr_t* structure that the *pool_attr* argument points to is defined as:

```
typedef struct _thread_pool_attr {
   THREAD_POOL_HANDLE_T   *handle;
   THREAD_POOL_PARAM_T    *(*block_func)
                             (THREAD_POOL_PARAM_T *ctp);
   THREAD_POOL_PARAM_T    *(*context_alloc)
                             (THREAD_POOL_HANDLE_T *handle);
   void                   (*unblock_func)
                             (THREAD_POOL_PARAM_T *ctp);
   int                    (*handler_func)
                             (THREAD_POOL_PARAM_T *ctp);
   void                   (*context_free)
                             (THREAD_POOL_PARAM_T *ctp);
   pthread_attr_t         *attr;
   unsigned short         lo_water;
   unsigned short         increment;
   unsigned short         hi_water;
   unsigned short         maximum;
   unsigned               reserved[8];
} thread_pool_attr_t;
```

The members include:

handle — A handle that gets passed to the *context_alloc* function.

block_func — The function that's called when the worker thread is ready to block, waiting for work. It returns a pointer that's passed to *handler_func*. If the function returns NULL, it indicates to the thread pool that this thread should exist.

context_alloc — The function that's called when a new thread is created by the thread pool. It is passed *handle*. The function returns a pointer, which is then passed to the blocking function *block_func*.

unblock_func — The function that's called to unblock threads. If you use *dispatch_block()* as the *block_func*, use *dispatch_unblock()* as the *unblock_func*.

handler_func — The function that's called after *block_func* returns to do some work. The function is passed in the pointer returned by *block_func*.

context_free	The function that's called when the worker thread exits, to free the context allocated with *context_alloc*.
attr	A pointer to a *pthread_attr_*()* function that's passed to *pthread_create()*. The *pthread_attr_*()* functions set the stack size, priority, etc. of the worker threads. If NULL, default values are used.
lo_water	The minimum number of threads that the pool should keep in the blocked state (i.e. threads that are ready to do work).
increment	The number of new threads created at one time.
hi_water	The maximum number of threads to keep in a blocked state.
maximum	The maximum number of threads that the pool can create.

Returns:

A thread pool handle, or NULL if an error occurs (*errno* is set).

Errors:

ENOMEM	Insufficient memory to allocate internal data structures.

Examples:

Here's a simple multithreaded resource manager:

```
/* Define an appropriate interrupt number: */
#define INTNUM 0

#include <stdio.h>
#include <stddef.h>
#include <stdlib.h>
#include <sys/iofunc.h>
#include <sys/dispatch.h>
#include <sys/neutrino.h>
```

```
static resmgr_connect_funcs_t   connect_funcs;
static resmgr_io_funcs_t        io_funcs;
static iofunc_attr_t            attr;

void *interrupt_thread( void *data)
/* *data isn't used */
{
    struct sigevent event;
    int             id;

    /* fill in "event" structure */
    memset( &event, 0, sizeof(event) );
    event.sigev_notify = SIGEV_INTR;

    /* INTNUM is the desired interrupt level */
    id = InterruptAttachEvent( INTNUM, &event, 0 );

    .
    .
    .

    while (1) {
        InterruptWait( 0, NULL );
        /*
         do something about the interrupt,
         perhaps updating some shared
         structures in the resource manager

         unmask the interrupt when done
        */
        InterruptUnmask( INTNUM, id );
    }
}

int
main(int argc, char **argv) {
    thread_pool_attr_t    pool_attr;
    thread_pool_t         *tpp;
    dispatch_t            *dpp;
    resmgr_attr_t         resmgr_attr;
    int                   id;


    if((dpp = dispatch_create()) == NULL) {
        fprintf( stderr,
           "%s: Unable to allocate dispatch handle.\n",
           argv[0] );
        return EXIT_FAILURE;
    }
```

```
    memset( &pool_attr, 0, sizeof pool_attr );
    pool_attr.handle = dpp;
    /* We are only doing resmgr-type attach */
    pool_attr.context_alloc = resmgr_context_alloc;
    pool_attr.block_func = resmgr_block;
    pool_attr.handler_func = resmgr_handler;
    pool_attr.context_free = resmgr_context_free;
    pool_attr.lo_water = 2;
    pool_attr.hi_water = 4;
    pool_attr.increment = 1;
    pool_attr.maximum = 50;

    if((tpp = thread_pool_create( &pool_attr,
                POOL_FLAG_EXIT_SELF)) == NULL ) {
        fprintf(stderr,
                "%s: Unable to initialize thread pool.\n",
                argv[0]);
        return EXIT_FAILURE;
    }

    iofunc_func_init( _RESMGR_CONNECT_NFUNCS,
                      &connect_funcs,
                      _RESMGR_IO_NFUNCS, &io_funcs );
    iofunc_attr_init( &attr, S_IFNAM | 0666, 0, 0 );

    memset( &resmgr_attr, 0, sizeof resmgr_attr );
    resmgr_attr.nparts_max = 1;
    resmgr_attr.msg_max_size = 2048;

    if((id = resmgr_attach( dpp, &resmgr_attr,
                            "/dev/mynull",
                           _FTYPE_ANY, 0, &connect_funcs,
                            &io_funcs,
                            &attr )) == -1) {
        fprintf( stderr,
                 "%s: Unable to attach name.\n", argv[0] );
        return EXIT_FAILURE;
    }

    /* Start the thread which will handle interrupt events. */
    pthread_create ( NULL, NULL, interrupt_thread, NULL );

    /* Never returns */
    thread_pool_start( tpp );
}
```

For more examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, and *resmgr_attach()*. For information on advanced topics in designing and implementing a resource manager, see

"Combine messages" section of the Writing a Resource Manager chapter in the *Programmer's Guide*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

dispatch_block(), *dispatch_create()*, *dispatch_unblock()*, *pthread_create()*, *resmgr_attach()*, *select_attach()*, *thread_pool_destroy()*, *thread_pool_start()*

thread_pool_destroy()

Free the memory allocated to a thread pool

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int thread_pool_destroy( thread_pool_t * pool );
```

Arguments:

pool A thread pool handle that was returned by *thread_pool_create()*.

Library:

libc

Description:

The *thread_pool_destroy()* function frees the memory allocated to a thread pool that's identified by the handle *pool*. This is done only after all the threads of the thread pool have exited.

☞ Prior to QNX Neutrino 6.1.0, this function simply deallocated the thread pool handle and returned. Although this was acceptable for servers that never exited (and consequently never shut down their thread pools), it's unsuitable for closing down a thread pool.

The *thread_pool_destroy()* function calls the unblock handler provided in the pool attribute structure. The unblock handler is called at least once for every thread in the thread pool. Once the unblock handler is called, the thread calling *thread_pool_destroy()* blocks until the number of threads in the thread pool drops to zero. When there are no more threads in the thread pool, the handle pool is freed and *thread_pool_destroy()* returns.

A side effect of this behavior is that a thread that's created by the thread pool can't call *thread_pool_destroy()* because the thread pool count will never drop to zero, and subsequently the function will never return.

Returns:

0 Success.

-1 An error occurred.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>

int main( int argc, char **argv ) {
   thread_pool_t        *tpp;

   .
   .
   .

   thread_pool_destroy ( tpp );
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

thread_pool_control(), *thread_pool_create()*, *thread_pool_limits()*, *thread_pool_start()*

thread_pool_limits()

Convenience wrapper function for thread_pool_control()

Synopsis:

```
#include <sys/iofunc.h>
#include <sys/dispatch.h>

int thread_pool_limits( thread_pool_t * pool,
                        int lowater,
                        int hiwater,
                        int maximum,
                        int increment,
                        unsigned flags );
```

Arguments:

pool	A thread pool handle that was returned by *thread_pool_create()*.
lowater	The minimum number of threads that the pool should keep in the blocked state (i.e. threads that are ready to do work), or a negative number if you don't want to change the current value.
hiwater	The maximum number of threads that the pool should keep in the blocked state, or a negative number if you don't want to change the current value.
maximum	The maximum number of threads that the pool can create, or a negative number if you don't want to change the current value.
increment	The number of new threads created at one time, or a negative number if you don't want to change the current value.
flags	The only flag that's accepted is THREAD_POOL_CONTROL_NONBLOCK. For more information, see the documentation for *thread_pool_control()*.

Library:

libc

Description:

The *thread_pool_limits()* function is a wrapper function for *thread_pool_control()*. If the value of *lowater*, *hiwater*, *maximum* or *increment* is ≥0 then that value is adjusted in the thread pool according to the handle *pool*.

If you don't set THREAD_POOL_CONTROL_NONBLOCK, the upper and lower bounds for waiting are:

- **lower = (lowater != -1) : lowater ? 0;**
- **upper = (maximum != -1) : maximum ? USHRT_MAX;**

Having several threads call this function with the same thread pool handle isn't recommended.

Returns:

-1 if an error occurs (*errno* is set).

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

thread_pool_control(), *thread_pool_create()*, *thread_pool_destroy()*, *thread_pool_start()*

thread_pool_start()

Start a thread pool

Synopsis:

```
#include <sys/dispatch.h>

int thread_pool_start( void *pool );
```

Arguments:

pool A thread pool handle that was returned by *thread_pool_create()*.

Library:

libc

Description:

The *thread_pool_start()* function starts the thread pool *pool*. The function may or may not return, depending on the flags that you passed to *thread_pool_create()*.

Returns:

EOK Success.

-1 An error occurred.

Examples:

```
#include <sys/dispatch.h>
#include <stdio.h>
#include <stdlib.h>

int main( int argc, char **argv ) {
   thread_pool_attr_t   pool_attr;
   thread_pool_t        *tpp;
   dispatch_t           *dpp;
   resmgr_attr_t        attr;
   resmgr_context_t     *ctp;

   if( (dpp = dispatch_create()) == NULL ) {
     fprintf( stderr, "%s: Unable to allocate \
              dispatch context.\n", argv[0] );
```

```
    return EXIT_FAILURE;
  }

  memset( &pool_attr, 0, sizeof (pool_attr) );
  pool_attr.handle = dpp;
  /* We are only doing resmgr-type attach */
  pool_attr.context_alloc = resmgr_context_alloc;
  pool_attr.block_func = resmgr_block;
  pool_attr.handler_func = resmgr_handler;
  pool_attr.context_free = resmgr_context_free;
  pool_attr.lo_water = 2;
  pool_attr.hi_water = 4;
  pool_attr.increment = 1;
  pool_attr.maximum = 50;

  if( (tpp = thread_pool_create( &pool_attr,
             POOL_FLAG_EXIT_SELF )) == NULL ) {
    fprintf( stderr, "%s: Unable to initialize \
             thread pool.\n", argv[0] );
    return EXIT_FAILURE;
  }

  .
  .
  .

  /* Never returns */
  thread_pool_start( tpp );
}
```

For examples using the dispatch interface, see *dispatch_create()*, *message_attach()*, *resmgr_attach()*, and *thread_pool_create()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

thread_pool_create(), *thread_pool_destroy()*

ThreadCancel(), *ThreadCancel_r()*

Cancel a thread

Synopsis:

```
#include <sys/neutrino.h>

int ThreadCancel( int tid,
                  void (*canstub)(void) );

int ThreadCancel_r( int tid,
                    void (*canstub)(void) );
```

Arguments:

tid	The ID of the thread that you want to destroy, as returned by *ThreadCreate()*.
canstub	A pointer to the location that you want the thread to jump to when the cancellation occurs; see below.

☞ You must provide a *canstub* function.

Library:

libc

Description:

These kernel calls request that the thread specified by *tid* be canceled. The target thread's cancelability state and type determine when the cancellation takes effect.

The *ThreadCancel()* and *ThreadCancel_r()* functions are identical, except in the way they indicate errors. See the Returns section for details.

When the cancellation is acted upon, the thread jumps to the location specified by *canstub*. This stub should call cancellation cleanup handlers for the thread. When the last cancellation cleanup handler returns, the stub must terminate the thread using:

```
ThreadDestroy( 0, -1, PTHREAD_CANCEL);
```

Unlike *ThreadDestroy()*, which destroys a thread immediately, *ThreadCancel()* requests that the target thread execute any cleanup code and then terminate at its earliest convenience.

The cancellation processing in the target thread runs asynchronously with respect to the calling thread, which doesn't block.

The combinations of cancelability state and type are as follows:

State	Type	Description
Disabled	Deferred	Cancel requests are made pending
Disabled	Async	Cancel requests are made pending
Enabled	Deferred	Cancellation happens at the next cancellation point. These are at explicitly coded calls to *pthread_testcancel()* or an attempt to enter a blocking state in any of the calls defined in the table below. All kernel calls that block are cancellation points, with the exception of *MsgSendvnc()* and *SyncMutexLock()*.
Enabled	Async	Cancellation happens immediately.

Use *pthread_setcancelstate()*, and *pthread_setcanceltype()* to set the state and type.

POSIX defines a list of functions that are cancellation points; some functions that aren't listed there may also be cancellation points. For a full list, see "Cancellation points" in the appendix, Summary of Safety Information. Any function that calls a blocking kernel call that's a cancellation point will itself become a cancellation point when the kernel call is made. The most common blocking kernel call in library code is *MsgSendv()*.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ThreadCancel()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

ThreadCancel_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

ESRCH The thread indicated by *tid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_setcancelstate(), pthread_setcanceltype(), pthread_testcancel(), ThreadCreate(), ThreadDestroy()

ThreadCreate(), ThreadCreate_r()

Create a thread

Synopsis:

```
#include <sys/neutrino.h>

int ThreadCreate(
          pid_t pid,
          void* (func)( void* ),
          void* arg,
          const struct _thread_attr* attr );

int ThreadCreate_r(
          pid_t pid,
          void* (func)( void* ),
          void* arg,
          const struct _thread_attr* attr );
```

Arguments:

pid The ID of the process that you want to create the thread in, or 0 to create the thread in the current process.

func A pointer to the function that you want the thread to execute. The *arg* argument that you pass to *ThreadCreate()* is passed to *func()* as its sole argument. If *func()* returns, it returns to the address defined in the *exitfunc* member of *attr*.

arg A pointer to any data that you want to pass to *func*.

attr A pointer to a **_thread_attr** structure that specifies the attributes for the new thread, or NULL if you want to use the default attributes.

☞ If you modify the attributes after creating the thread, the thread isn't affected.

For more information, see "Thread attributes," below.

Library:

libc

Description:

These kernel calls create a new thread of execution, with attributes specified by *attr*, within the process specified by *pid*. If *pid* is zero, the current process is used.

☞ Only the Process Manager can create threads in another process.

The *ThreadCreate()* and *ThreadCreate_r()* functions are identical, except in the way they indicate errors. See the Returns section for details.

The new thread shares all resources of the process in which it's created. This includes memory, timers, channels and connections. The standard C library contains mutexes to make it thread-safe.

Thread attributes

The **_thread_attr** structure pointed to by *attr* contains at least the following members:

int *flags* See below for a list of *flags*. The default flag is always zero.

size_t *stacksize*

The stack size of the thread stack defined in the *stackaddr* member. If *stackaddr* is NULL, then *stacksize* specifies the size of stack to dynamically allocate. If *stacksize* is zero, then 4096 bytes are assumed. The minimum allowed *stacksize* is defined by PTHREAD_STACK_MIN.

void* *stackaddr*

NULL, or the address of a stack that you want the thread to use. Set the *stacksize* member to the size of the stack.

If you provide a non-NULL *stackaddr*, it's your responsibility to release the stack when the thread dies. If *stackaddr* is NULL, then the kernel dynamically allocates a stack on thread creation and automatically releases it on the thread's death.

void* (*exitfunc*)(**void*** *status*)

The address to return to if the thread function returns.

The thread *returns* to *exitfunc*. This means that the *status* variable isn't passed as a normal parameter. Instead, it appears in the return-value position dictated by the CPU's calling convention (e.g. **EAX** on an x86, **R3** on PPC, **V0** on MIPS, and so on).

The *exitfunc* function normally has to have compiler- and CPU-specific manipulation to access the *status* data (pulling it from the return register location to a proper local variable). Alternatively, you can write the *exitfunc* function in assembly language for each CPU.

---

int *policy*

The scheduling policy, as defined by the *SchedSet()* kernel call. This member is used only if you set the PTHREAD_EXPLICIT_SCHED flag. If you want the thread to inherit the policy, but you want to specify the scheduling parameters in the *param* member, set the PTHREAD_EXPLICIT_SCHED flag and set the *policy* member to SCHED_NOCHANGE.

struct sched_param *param*

A **sched_param** structure that specifies the scheduling parameters, as defined by the *SchedSet()* kernel call. This member is used only if you set the PTHREAD_EXPLICIT_SCHED flag.

You can set the *attr* argument's *flags* member to a combination of the following:

PTHREAD_CREATE_JOINABLE (default)

Put the thread into a zombie state when it terminates. It stays in this state until you retrieve its exit status or detach the thread.

PTHREAD_CREATE_DETACHED

Create the thread in the detached state; it doesn't become a zombie. You can't call *ThreadJoin()* for a detached thread.

PTHREAD_INHERIT_SCHED (default)

Use the scheduling attributes of the creating thread for the new thread.

PTHREAD_EXPLICIT_SCHED

Take the scheduling policy and parameters for the new thread from the *policy* and *param* members of *attr*.

PTHREAD_SCOPE_SYSTEM (default)

Schedule the thread is against all threads in the system.

PTHREAD_SCOPE_PROCESS

Don't set this flag; the QNX Neutrino OS implements true microkernel threads that have only a system scope.

PTHREAD_MULTISIG_ALLOW (default)

If the thread dies because of an unblocked, uncaught signal, terminate all threads, and hence, the process.

PTHREAD_MULTISIG_DISALLOW

Terminate only this thread; all other threads in the process are unaffected.

PTHREAD_CANCEL_DEFERRED (default)

Cancellation occurs only at cancellation points as defined by *ThreadCancel()*.

PTHREAD_CANCEL_ASYNCHRONOUS

Every opcode executed by the thread is considered a cancellation point. The POSIX and C library aren't asynchronous-cancel safe.

Signal state

The signal state of the new thread is initialized as follows:

- The signal mask is inherited from the creating thread.
- The set of pending signals is empty.
- The cancel state and type are PTHREAD_CANCEL_ENABLE and PTHREAD_CANCEL_DEFERRED.

Local storage for private data

Each thread contains a thread local storage area for its private data. This area can be accessed using the global variable *_TLS* defined in **<sys/neutrino.h>** as a pointer. The kernel ensures that *_TLS* always points to the thread local storage for the thread that's running.

The thread local storage is defined by the structure **_thread_local_storage**, which contains at least the following members:

void* (*exitfunc*)(void *)
: The exit function to call if the thread returns.

void* *arg*
: The sole argument that was passed to the thread.

int* *errptr*
: A pointer to a thread unique *errno* value. For the main thread, this points to the global variable *errno*. For all other threads, this points to the member *errval* in this structure.

int *errval*
: A thread-unique *errno* that the thread uses if it isn't the main thread.

int *flags*
: The thread flags used on thread creation in addition to runtime flags used for implementing thread cancellation.

pid_t *pid*
: The ID of the process that contains the thread.

int *tid*
: The thread's ID.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ThreadCreate()

The thread ID of the newly created thread. If an error occurs, the function returns -1 and sets *errno*.

ThreadCreate_r()

The thread ID of the newly created thread. This function does **NOT** set *errno*. If an error occurs, the function returns the negative of a value from the Errors section.

Errors:

EAGAIN	All kernel thread objects are in use.
EFAULT	A fault occurred when the kernel tried to access the buffers provided.
EINVAL	Invalid scheduling policy or priority specified.
ENOTSUP	PTHREAD_SCOPE_PROCESS was requested. All kernel threads are PTHREAD_SCOPE_SYSTEM.
EPERM	The calling thread doesn't have sufficient permission to create a thread in another process. Only a thread with a process ID of 1 can create threads in other processes.
ESRCH	The process indicated by *pid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The QNX interpretation of PTHREAD_STACK_MIN is enough memory to run a thread that does nothing:

```
void nothingthread( void )
{
    return;
}
```

See also:

sched_param, *SchedSet()*, *ThreadCancel()*, *ThreadDestroy()*

Synopsis:

```
#include <sys/neutrino.h>

int ThreadCtl( int cmd,
               void * data );

int ThreadCtl_r( int cmd,
                 void * data );
```

Arguments:

cmd The command you want to execute; see below.

data A pointer to data associated with the specific command; see below.

Library:

libc

Description:

These kernel calls allow you to make QNX-specific changes to a thread.

The *ThreadCtl()* and *ThreadCtl_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

The following calls are defined:

ThreadCtl(_NTO_TCTL_ALIGN_FAULT, *data*)

Control the misaligned access response. The *data* argument is a pointer to an **int** whose value indicates how you want to respond:

- Greater than 0 — make a misaligned access fault with a SIGBUS, if the architecture permits it.
- Less than 0 — make the kernel attempt to emulate an instruction with a misaligned access. If the attempt fails, it also faults with a SIGBUS.

- 0 — don't change the alignment-fault handling for the thread.

The function sets *data* to a positive or negative number, indicating the previous state of the the alignment-fault handling.

ThreadCtl(_NTO_TCTL_IO, 0)

Request I/O privity; let the thread execute the I/O opcodes **`in, ins, out, outs, cli, sti`** on architectures where it has the appropriate privilege, and let it attach IRQ handlers. You need **`root`** permissions to use this command. If a thread attempts to use these opcodes without successfully executing this call, the thread faults with a SIGSEGV when the opcode is attempted.

☞ Threads created by the calling thread inherit the _NTO_TCTL_IO status.

ThreadCtl(_NTO_TCTL_RUNMASK, (**`int`**)*runmask*)

Set processor affinity for the calling thread in a multiprocessor system. Each set bit in *runmask* represents a processor that the thread can run on.

By default, a thread's *runmask* is set to all ones, which allows it to run on any available processor. A value of **`0x01`** would, for example, force the thread to only run on the first processor.

You can use _NTO_TCTL_RUNMASK to optimize the runtime performance of your system by, for example, relegating nonrealtime threads to a specific processor. In general, this shouldn't be necessary, since the QNX realtime scheduler always preempts a lower-priority thread immediately when a higher priority thread becomes ready.

The main effect of processor locking is the effectiveness of the CPU cache, since threads can be prevented from migrating.

☞ Threads created by the calling thread don't inherit the _NTO_TCTL_RUNMASK status.

ThreadCtl(_NTO_TCTL_THREADS_CONT, 0)

Unfreeze all threads in the current process that were frozen using the _NTO_TCTL_THREADS_HOLD command.

ThreadCtl(_NTO_TCTL_THREADS_HOLD, 0)

Freeze all threads in the current process except the calling thread.

☞ Threads created by the calling thread aren't frozen.

The *data* pointer is reserved for passing extra data for new commands that may be introduced in the future.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ThreadCtl()	If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.
ThreadCtl_r()	EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EPERM	The process doesn't have superuser capabilities.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

InterruptDisable(), *InterruptEnable()*, *InterruptMask()*, *InterruptUnmask()*

ThreadDestroy(), ThreadDestroy_r()

Destroy a thread immediately

Synopsis:

```
#include <sys/neutrino.h>

int ThreadDestroy( int tid,
                   int priority,
                   void* status );

int ThreadDestroy_r( int tid,
                     int priority,
                     void* status );
```

Arguments:

tid	The ID of the thread that you want to destroy, as returned by *ThreadCreate()*, or 0 to destroy the current thread, or -1 to destroy all the threads in the current process.
priority	The priority at which you want to destroy multiple threads, or -1 to use the priority of the current thread.
status	The value to make available to a to a thread that joins a nondetached thread that's destroyed.

Library:

libc

Description:

These kernel calls terminate the thread specified by *tid*. If *tid* is 0, the calling thread is assumed. If *tid* is -1, all of the threads in the process are destroyed. When multiple threads are destroyed, the destruction is scheduled one thread at a time at the priority specified by the *priority* argument. If *priority* is -1, then the priority of the calling thread is used.

The *ThreadDestroy()* and *ThreadDestroy_r()* functions are identical, except in the way they indicate errors. See the Returns section for details.

If a terminated thread isn't detached, it makes the value specified by the *status* argument available to any successful join on it. Until another thread retrieves this value, the thread ID *tid* isn't reused, and a small kernel resource (a thread object) is held in the system. If the thread is detached, then *status* is ignored, and all thread resources are immediately released.

When the last thread in a process is destroyed, the process terminates, and all thread resources are released, even if they're not detached and unjoined.

On return from *ThreadDestroy()* or *ThreadDestroy_r()*, the target thread is marked for death, but if it isn't possible to kill it immediately, it may not be terminated until it attempts to run.

Blocking states

If these calls return, they don't block.

Returns:

If the calling thread is destroyed, *ThreadDestroy()* and *ThreadDestroy_r()* don't return.

The only difference between these functions is the way they indicate errors:

ThreadDestroy()

If this function returns and an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

ThreadDestroy_r()

EOK is returned on success. This function does **NOT** set *errno*. If this function returns and an error occurs, any value in the Errors section may be returned.

Errors:

ESRCH The thread indicated by *tid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ThreadCancel(), ThreadCreate()

ThreadDetach(), *ThreadDetach_r()*

Detach a thread from a process

Synopsis:

```
#include <sys/neutrino.h>

int ThreadDetach( int tid );

int ThreadDetach_r( int tid );
```

Arguments:

tid The ID of the thread that you want to detach, as returned by *ThreadCreate()*, or 0 to detach the current thread.

Library:

libc

Description:

These kernel calls detach the thread specified by *tid*. If *tid* is zero, the calling thread is used. Once detached, attempts to call *ThreadJoin()* on *tid* fail. When a detached thread terminates, its termination status is discarded and all its resources are released.

The *ThreadDetach()* and *ThreadDetach_r()* functions are identical, except in the way they indicate errors. See the Returns section for details.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

ThreadDetach()

If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.

ThreadDetach_r()

Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function can return any value listed in the Errors section.

Errors:

EINVAL	The thread is already detached.
ESRCH	The thread indicated by *tid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ThreadCreate(), ThreadJoin()

ThreadJoin(), *ThreadJoin_r()*

Block until a thread terminates

Synopsis:

```
#include <sys/neutrino.h>

int ThreadJoin( int tid,
                void** status );


int ThreadJoin_r( int tid,
                  void** status );
```

Arguments:

tid The ID of the thread that you want to detach, as returned by *ThreadCreate()*.

status The address of a pointer to a location where the function can store the thread's exit status.

Library:

libc

Description:

The *ThreadJoin()* and *ThreadJoin_r()* kernel calls block until the thread specified by *tid* terminates. If *status* isn't NULL, the functions save the thread's exit status in the area pointed to by *status*. If the thread *tid* has already terminated, the functions immediately return with success and the status, if requested.

These functions are identical except in the way they indicate errors. See the Returns section for details.

When *ThreadJoin()* returns successfully, the target thread has been successfully terminated. Until this occurs, the thread ID *tid* isn't reused and a small kernel resource (a thread object) is retained.

You can't join a thread that's detached (see *ThreadCreate()* and *ThreadDetach()*).

The target thread must be joinable. Multiple *pthread_join(), pthread_timedjoin(), ThreadJoin(),* and *ThreadJoin_r()* calls on the same target thread aren't allowed.

Blocking states

STATE_JOIN	The calling thread blocks waiting for the indicated thread to exit.

Returns:

The only difference between these functions is the way they indicate errors:

ThreadJoin()	If an error occurs, the function returns -1 and sets *errno*. Any other value returned indicates success.
ThreadJoin_r()	Returns EOK on success. This function does **NOT** set *errno*. If an error occurs, the function may return any value listed in the Errors section.

Errors:

EBUSY	Attempt to join a thread which has been joined by another thread.
EDEADLK	Attempt to join to yourself.
EFAULT	A fault occurred when the kernel tried to access *status*.
EINTR	The call was interrupted by a signal.
EINVAL	Attempt to join a thread which is detached (see *ThreadDetach()*).
ESRCH	The thread indicated by *tid* doesn't exist.
ETIMEDOUT	A kernel timeout unblocked the call. See *TimerTimeout()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

pthread_join(), pthread_timedjoin(), ThreadCreate(), ThreadDetach()

Synopsis:

```
#include <time.h>

time_t time( time_t * tloc );
```

Arguments:

tloc NULL, or a pointer to a **time_t** object where the function can store the current calendar time.

Library:

libc

Description:

The *time()* function takes a pointer to **time_t** as an argument and returns a value of **time_t** on exit. The returned value is the current calendar time, in seconds, since the Unix Epoch, 00:00:00 January 1, 1970 Coordinated Universal Time (UTC) (formerly known as Greenwich Mean Time (GMT)).

You typically use the **date** command to set the computer's internal clock using Coordinated Universal Time (UTC). Use the **TZ** environment variable or **_CS_TIMEZONE** configuration string to establish the local time zone. For more information, see "Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*.

Returns:

The current calendar time, in seconds, since 00:00:00 January 1, 1970 Coordinated Universal Time (UTC). If *tloc* isn't NULL, the current calendar time is also stored in the object pointed to by *tloc*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

int main( void )
  {
    time_t time_of_day;

    time_of_day = time( NULL );
    printf( "It is now: %s", ctime( &time_of_day ) );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
It is now: Wed Jun 30 09:09:33 1999
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

asctime(), *asctime_r()*, *clock()*, *clock_gettime()*, *ctime()*, *difftime()*, *gmtime()*, *localtime()*, *localtime_r()*, *mktime()*, *strftime()*, *tzset()*

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

Synopsis:

```
#include <signal.h>
#include <time.h>

int timer_create( clockid_t clock_id,
                  struct sigevent * evp,
                  timer_t * timerid );
```

Arguments:

clock_id The clock source that you want to use; one of:

- CLOCK_REALTIME — the standard POSIX-defined timer.
- CLOCK_SOFTTIME — currently, the same as CLOCK_REALTIME.

evp NULL, or a pointer to a **sigevent** structure containing the event that you want to deliver when the timer fires.

timerid A pointer to a **timer_t** object where the function stores the ID of the new timer.

Library:

libc

Description:

The *timer_create()* function creates a per-process timer using the specified clock source, *clock_id*, as the timing base.

You can use the time ID that the function stores in *timerid* in subsequent calls to *timer_gettime()*, *timer_settime()*, and *timer_delete()*.

The timer is created in the disabled state, and isn't enabled until you call *timer_settime()*.

We recommend the following event types:

- SIGEV_SIGNAL
- SIGEV_SIGNAL_CODE
- SIGEV_SIGNAL_THREAD
- SIGEV_PULSE

If the *evp* argument is NULL, a SIGALRM signal is sent to your process when the timer expires. To specify a handler for this signal, call *sigaction()*.

Returns:

0 Success. The *timerid* argument is set to the timer's ID.

-1 An error occurred (*errno* is set).

Errors:

EAGAIN All timers are in use. You'll have to wait for a process to release one.

EINVAL The *clock_id* isn't one of the valid CLOCK_* constants.

Examples:

```
/*
 * Demonstrate how to set up a timer that, on expiry,
 * sends us a pulse.  This example sets the first
 * expiry to 1.5 seconds and the repetition interval
 * to 1.5 seconds.
 */

#include <stdio.h>
#include <time.h>
#include <sys/netmgr.h>
#include <sys/neutrino.h>

#define MY_PULSE_CODE   _PULSE_CODE_MINAVAIL

typedef union {
        struct _pulse   pulse;
        /* your other message structures would go
           here too */
```

```
} my_message_t;

main()
{
   struct sigevent         event;
   struct itimerspec       itime;
   timer_t                 timer_id;
   int                     chid;
   int                     rcvid;
   my_message_t            msg;

   chid = ChannelCreate(0);

   event.sigev_notify = SIGEV_PULSE;
   event.sigev_coid = ConnectAttach(ND_LOCAL_NODE, 0,
                                    chid,
                                    _NTO_SIDE_CHANNEL, 0);
   event.sigev_priority = getprio(0);
   event.sigev_code = MY_PULSE_CODE;
   timer_create(CLOCK_REALTIME, &event, &timer_id);

   itime.it_value.tv_sec = 1;
   /* 500 million nsecs = .5 secs */
   itime.it_value.tv_nsec = 500000000;
   itime.it_interval.tv_sec = 1;
   /* 500 million nsecs = .5 secs */
   itime.it_interval.tv_nsec = 500000000;
   timer_settime(timer_id, 0, &itime, NULL);

   /*
    * As of the timer_settime(), we will receive our pulse
    * in 1.5 seconds (the itime.it_value) and every 1.5
    * seconds thereafter (the itime.it_interval)
    */

   for (;;) {
       rcvid = MsgReceive(chid, &msg, sizeof(msg), NULL);
       if (rcvid == 0) { /* we got a pulse */
            if (msg.pulse.code == MY_PULSE_CODE) {
                printf("we got a pulse from our timer\n");
            } /* else other pulses ... */
       } /* else other messages ... */
   }
}
```

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The QNX Neutrino version of *timer_create()* is different from the QNX 4 version, which was based on a draft standard.

See also:

clock_getres(), *clock_gettime()*, *clock_settime()*, *nanosleep()*, **_pulse**, *sigaction()*, **sigevent**, *sleep()*, *TimerCreate()*, *timer_delete()*, *timer_getexpstatus()*, *timer_getoverrun()*, *timer_gettime()*, *timer_settime()*

timer_delete()

Delete a timer

Synopsis:

```
#include <time.h>

int timer_delete( timer_t timerid );
```

Arguments:

timerid A **timer_t** object that holds a timer ID, as set by *timer_create()*.

Library:

libc

Description:

The *timer_delete()* function removes a previously attached timer based upon the *timerid* returned from the *timer_create()* function. The timer is removed from the active system timer list, and returned to the free list of available timers.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL The timer *timerid* isn't attached to the calling process.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_getres(), *clock_gettime()*, *clock_settime()*, *nanosleep()*, *sleep()*, *timer_create()*, *timer_getexpstatus()*, *timer_getoverrun()*, *timer_gettime()*, *timer_settime()*

timer_getexpstatus()

Get the expiry status of a timer

Synopsis:

```
#include <time.h>

int timer_getexpstatus( timer_t timerid );
```

Arguments:

timerid A **timer_t** object that holds a timer ID, as set by *timer_create()*.

Library:

libc

Description:

The *timer_getexpstatus()* function gets the expiry status of the time with the ID given by *timerid*.

Returns:

0 The timer has expired.

-1 An error occurred (*errno* is set).

Errors:

EINVAL The timer specified by *timerid* doesn't exist.

Classification:

POSIX 1003.1j (draft)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

timer_create(), *timer_delete()*, *timer_getoverrun()*, *timer_gettime()*, *timer_settime()*, *TimerInfo()*

timer_getoverrun()

Return the number of timer overruns

Synopsis:

```
#include <signal.h>
#include <time.h>

int timer_getoverrun( timer_t timerid );
```

Arguments:

timerid A **timer_t** object that holds a timer ID, as set by *timer_create()*.

Library:

libc

Description:

When a timer expiration signal is received by a process, the *timer_getoverrun()* function returns the timer expiration overrun count for the timer specified by *timerid*.

Only a single signal is queued to the process for a given timer at any point in time. When a timer that has a signal pending expires, no signal is queued and a timer overrun occurs.

The overrun count returned is the number of extra timer expirations that occurred between the time the expiration signal was queued and when it was delivered or accepted, up to but not including DELAYTIMER_MAX. If the number of overruns is greater than or equal to DELAYTIMER_MAX, the overrun count is set to DELAYTIMER_MAX.

The value returned by *timer_getoverrun()* applies to the most recent expiration signal for the specified timer. If no expiration signal has been delivered, the overrun count is `0`.

Returns:

The number of overruns, or -1 if an error occurs (*errno* is set).

Errors:

EINVAL Invalid timer *timerid*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

timer_create(), *timer_delete()*, *timer_getexpstatus()*, *timer_gettime()*, *timer_settime()*, *TimerInfo()*

timer_gettime()

Get the amount of time left on a timer

Synopsis:

```
#include <time.h>

int timer_gettime( timer_t timerid,
                   struct itimerspec *value );
```

Arguments:

timerid A **timer_t** object that holds a timer ID, as set by *timer_create()*.

value A pointer to a **itimerspec** structure that the function fills in with the timer's time until expiry. The structure contains at least the following members:

struct timespec *it_value*

A **timespec** structure that contains the amount of time left before the timer expires, or zero if the timer is disarmed. This value is expressed as the relative interval until expiration, even if the timer was armed with an absolute time.

struct timespec *it_interval*

A **timespec** structure that contains the timer's reload value. If nonzero, it indicates a repetitive timer period.

Library:

libc

Description:

The *timer_gettime()* function gets the amount of time left before the specified timer is to expire, along with the timer's reload value, and stores it in the space provided by the *value* argument.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EINVAL The timer *timerid* isn't attached to the calling process.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_getres(), *clock_gettime()*, *clock_settime()*, *nanosleep()*, *sleep()*, *timer_create()*, *timer_delete()*, *timer_getexpstatus()*, *timer_getoverrun()*, *timer_settime()*, **`timespec`**

timer_settime()

Set the expiration time for a timer

Synopsis:

```
#include <time.h>

int timer_settime( timer_t timerid,
                   int flags,
                   struct itimerspec * value,
                   struct itimerspec * ovalue );
```

Arguments:

timerid A **timer_t** object that holds a timer ID, as set by *timer_create()*.

flags The type of timer to arm if you aren't disarming the timer. The valid bits include:

- TIMER_ABSTIME — the *it_value* represents an absolute expiration date in seconds and nanoseconds from 1970. If the date specified has already passed, the function succeeds and the expiration notice is made.

  If you don't set this bit, the *it_value* represents a relative expiration period that's offset from the current system time by the specified number of seconds and nanoseconds.

value A pointer to a **itimerspec** structure that specifies the value that you want to set for the timer's time until expiry. For more information, see *timer_gettime()*.

ovalue NULL, or a pointer to a **itimerspec** structure that the function fills in with the timer's former time until expiry.

Library:

libc

Description:

The *timer_settime()* function sets the expiration time of the timer specified by *timerid* from the *it_value* member of the *value* argument. If the *it_value* structure member of *value* is zero, then the timer is disarmed.

If the *it_interval* member of *value* is nonzero, then it specifies a repeat rate that is added to the timer once the *it_value* period has expired. Subsequently, the timer is automatically rearmed, causing it to become continuous with a period of *it_interval*.

If the *ovalue* parameter isn't NULL, then on return from this function it contains a value representing the previous amount of time left before the timer was to have expired, or zero if the timer was disarmed. The previous interval timer period is also stored in the *it_interval* member.

The *timerid* is local to the calling process, and must have been created using *timer_create()*.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EFAULT A fault occurred trying to access the buffers provided.

EINVAL The timer *timerid* isn't attached to the calling process or the number of nanoseconds specified by the *tv_nsec* member of one of the **`timespec`** structures in the **`itimerspec`** structure pointed to by *value* is less than zero or greater than or equal to 1000 million.

Examples:

See *timer_create()*.

Classification:

POSIX 1003.1 (Realtime Extensions)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_getres(), *clock_gettime()*, *clock_settime()*, *errno*, *nanosleep()*, *sleep()*, *timer_create()*, *timer_delete()*, *timer_getexpstatus()*, *timer_getoverrun()*, *timer_gettime()*

timer_timeout(), *timer_timeout_r()*

Set a timeout on a blocking state

Synopsis:

```
#include <time.h>

extern int timer_timeout(
              clockid_t id,
              int flags,
              const struct sigevent* notify,
              const struct timespec* ntime,
              struct timespec* otime );

extern int timer_timeout_r(
              clockid_t id,
              int flags,
              const struct sigevent* notify,
              const struct timespec* ntime,
              struct timespec* otime );
```

Arguments:

id The type of timer used to implement the timeout. The possible clock types of *id* are:

CLOCK_MONOTONIC

A clock that always increases at a constant rate and can't be adjusted.

CLOCK_SOFTTIME

Same as CLOCK_REALTIME, but if the CPU is in powerdown mode, the clock stops running.

CLOCK_REALTIME

A clock that maintains the system time.

flags A bitmask that specifies which states you want the timeout to apply to; see below.

notify A pointer to a **sigevent** structure that defines the event that the kernel acts on if the timeout expires; see below.

ntime A pointer to a **timespec** structure that specifies the timeout.

otime A pointer to a **timespec** structure where the function can store the actual timeout.

Library:

libc

Description:

The *timer_timeout()* and *timer_timeout_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

The *timer_timeout()* function sets the timeout *ntime* on any kernel blocking state. The actual timeout that occurred is returned in *otime*. The difference between the closely related *timer_timeout()* and *TimerTimeout()* functions is the unit of time. The time in *TimerTimeout()*'s *ntime* and *otime* arguments is in nanoseconds. When *ntime* is passed to *TimerTimeout()*, the time (in **timespec**) is converted from seconds and nanoseconds into nanoseconds. When *otime* is returned to *timer_timeout()*, the time is converted from nanoseconds into seconds and nanoseconds.

The kernel blocking states are entered as a result of the following kernel calls:

Kernel function call	Blocking state
InterruptWait()	STATE_INTR
MsgReceivev()	STATE_RECEIVE
MsgSendv()	STATE_SEND or STATE_REPLY
SignalSuspend()	STATE_SIGSUSPEND

continued...

Kernel function call	Blocking state
SignalWaitinfo()	STATE_SIGWAITINFO
SyncCondvarWait()	STATE_CONDVAR
SyncMutexLock()	STATE_MUTEX
SyncSemWait()	STATE_SEM
ThreadJoin()	STATE_JOIN

The user specifies which states the timeout should apply to via a bitmask passed in the *flags* argument. The bits are defined by the following constants:

Constant	Meaning
_NTO_TIMEOUT_CONDVAR	Timeout on STATE_CONDVAR.
_NTO_TIMEOUT_JOIN	Timeout on STATE_JOIN.
_NTO_TIMEOUT_INTR	Timeout on STATE_INTR.
_NTO_TIMEOUT_MUTEX	Timeout on STATE_MUTEX.
_NTO_TIMEOUT_RECEIVE	Timeout on STATE_RECEIVE.
_NTO_TIMEOUT_REPLY	Timeout on STATE_REPLY.
_NTO_TIMEOUT_SEM	Timeout on STATE_SEM.
_NTO_TIMEOUT_SEND	Timeout on STATE_SEND.
_NTO_TIMEOUT_SIGSUSPEND	Timeout on STATE_SIGSUSPEND.
_NTO_TIMEOUT_SIGWAITINFO	Timeout on STATE_SIGWAITINFO.

For example, to set a timeout on *MsgSendv()*, specify:

```
_NTO_TIMEOUT_SEND | _NTO_TIMEOUT_REPLY
```

Once a timeout is specified using *timer_timeout()*, it's armed and released under the following conditions:

Armed	The kernel attempts to enter a blocking state specified in *flags*.
Released	One of the above kernel calls completed without blocking, *or* the kernel call blocks but unblocks before the timeout expires, *or* the timeout expires.

The *timer_timeout()* function always operates on a one-shot basis. When one of the above kernel calls returns (or is interrupted by a signal), the timeout request is removed from the system. Only one timeout per thread may be in effect at a time. A second call to *timer_timeout()*, without calling one of the above kernel functions, replaces the existing timeout on that thread. A call with *flags* set to zero ensures that a timeout won't occur on any state. This is the default when a thread is created.

Always call *timer_timeout()* just before the function that you wish to timeout. For example:

```
...
event.sigev_notify = SIGEV_UNBLOCK;

timeout.tv_sec  = 10;
timeout.tv_nsec =  0;

timer_timeout( CLOCK_REALTIME,
               _NTO_TIMEOUT_SEND | _NTO_TIMEOUT_REPLY,
               &event, &timeout, NULL );
MsgSendv( coid, NULL, 0, NULL, 0 );
...
```

If the signal handler is called between the calls to *timer_timeout()* and *MsgSendv()*, the *timer_timeout()* values are saved during the signal handler and then are restored when the signal handler exits.

If the timeout expires, the kernel acts upon the event specified by the **`sigevent`** structure pointed to by the *notify* argument. We recommend the following event types in this case:

- SIGEV_SIGNAL
- SIGEV_SIGNAL_CODE
- SIGEV_SIGNAL_THREAD
- SIGEV_PULSE
- SIGEV_UNBLOCK
- SIGEV_INTR

Only SIGEV_UNBLOCK guarantees that the kernel call unblocks. A signal may be ignored, blocked, or accepted by another thread and a pulse can only unblock a *MsgReceivev()*. If a NULL is passed for *event* then SIGEV_UNBLOCK is assumed. In this case, a timed out kernel call will return failure with an error of ETIMEDOUT.

MsgSendv() won't unblock on SIGEV_UNBLOCK if the server has already received the message via *MsgReceivev() and* has specified _NTO_CHF_UNBLOCK in the *flags* argument to its *ChannelCreate()* call. In this case, it's up to the server to do a *MsgReplyv()* or *MsgError()*.

The timeout:

- Is specified by the *ntime* argument.
- Is relative to the current time (when *timer_timeout()* is called), unless *flags* includes TIMER_ABSTIME, which makes the timeout occur at the absolute time set in *ntime*.
- Occurs on a clock tick (see *ClockPeriod()*) so the actual wakeup time is a minimum of:

  (*tv_sec* × 1000000000 + *tv_nsec*) ÷ (size of timer tick) nanoseconds

  where *tv_sec* and *tv_nsec* are fields of the **timespec** structure (defined in **<time.h>**).

If you specify a resolution that amounts to 1.7 timer ticks, you may wakeup anywhere from 1 to 1.99999999... timer ticks.

If you don't wish to block for any time, you can pass a NULL for *ntime* in which case no timer is used, the event is assumed to be SIGEV_UNBLOCK and an attempt to enter a blocking state as set by *flags* will immediately return with ETIMEDOUT. Although a questionable practice, this can be used to poll potential blocking kernel calls. For example, you can poll for messages using *MsgReceivev()* with an immediate timeout. A much better approach is to use multiple threads and have one block waiting for messages.

If *flags* is set to _NTO_TIMEOUT_NANOSLEEP, then these calls block in the STATE_NANOSLEEP state until the timeout (or a signal which unblocks the thread) occurs. This can be used to implement an efficient kernel sleep as follows:

```
timer_timeout( CLOCK_REALTIME, _NTO_TIMEOUT_NANOSLEEP,
               NULL, &ntime, &otime );
```

If *otime* isn't NULL and the sleep is unblocked by a signal then it contains the time remaining in the sleep.

Blocking states

The kernel calls don't block unless _NTO_TIMEOUT_NANOSLEEP is specified in *flags*. In this case, the calls block as follows:

STATE_NANOSLEEP

The calling thread blocks for the requested time period.

Returns:

timer_timeout()

The previous flags. If an error occurs, the function returns -1 and sets *errno*.

timer_timeout_r()

The previous flags. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EAGAIN	All kernel timer entries are in use.
EFAULT	A fault occurred when the kernel tried to access *ntime*, *otime*, or *notify*.
EINTR	The call was interrupted by a signal.
EINVAL	The clock type *id* isn't one of CLOCK_MONOTONIC, CLOCK_SOFTTIME, or CLOCK_REALTIME.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The timeout value *starts timing out* when *timer_timeout()* is called, *not* when the blocking state is entered. It might be possible to get preempted after calling *timer_timeout()* but before the blocking kernel call.

See also:

`sigevent`, *TimerCreate()*, *TimerInfo()*, *TimerTimeout()*

Synopsis:

```
#include <sys/neutrino.h>

int TimerAlarm( clockid_t id,
                const struct _itimer * itime,
                struct _itimer * otime );

int TimerAlarm_r( clockid_t id,
                  const struct _itimer * itime,
                  struct _itimer * otime );
```

Arguments:

id The timer type to use to implement the alarm; one of:

- CLOCK_REALTIME — This is the standard POSIX-defined clock. Timers based on this clock should will wake up the processor if it's in a power-saving mode.
- CLOCK_SOFTTIME — This clock is only active when the processor is *not* in a power-saving mode. For example, an application using a CLOCK_SOFTTIME timer to sleep wouldn't wake up the processor when the application was due to wake up. This will allow the processor to enter a power-saving mode.

  While the processor isn't in a power-saving mode, CLOCK_SOFTTIME behaves the same as CLOCK_REALTIME.
- CLOCK_MONOTONIC — This clock always increases at a constant rate and can't be adjusted.

itime NULL, or a pointer to a **_itimer** structure that specifies the length of time to wait.

otime NULL, or a pointer to a **_itimer** structure where the function can store the old timer trigger time.

Library:

libc

Description:

These kernel calls set an alarm signal (SIGALRM) to be delivered to the thread waiting on the timer at the time specified by *itime*. If *otime* isn't NULL, the old timer trigger time is returned.

The *TimerAlarm()* and *TimerAlarm_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

Alarm requests aren't stacked; only a single SIGALRM may be outstanding on a timer at one time. If you call *TimerAlarm()* while an alarm is outstanding, the alarm is reset to the new value passed in *itime*.

If *itime* is NULL, any previous alarm request is canceled, and no new alarm is set.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

TimerAlarm()	If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.
TimerAlarm_r()	EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EAGAIN	All kernel timer entries are in use.
EINVAL	Invalid timer value *id*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *alarm()*, *TimerAlarm()*, and *ualarm()* requests aren't stacked; only a single SIGALRM generator can be scheduled with these functions. If the SIGALRM signal hasn't been generated, the next call to *alarm()*, *TimerAlarm()*, or *ualarm()* reschedules it.

See also:

alarm(), *TimerCreate()*, *ualarm()*

TimerCreate(), TimerCreate_r()

Create a timer for a process

Synopsis:

```
#include <sys/neutrino.h>

int TimerCreate( clockid_t id,
                 const struct sigevent *event );

int TimerCreate_r( clockid_t id,
                   const struct sigevent *event );
```

Arguments:

id The timing base; supported types are:

- CLOCK_REALTIME — This is the standard POSIX-defined clock. Timers based on this clock should will wake up the processor if it's in a power-saving mode.
- CLOCK_SOFTTIME — This clock is only active when the processor is *not* in a power-saving mode. For example, an application using a CLOCK_SOFTTIME timer to sleep wouldn't wake up the processor when the application was due to wake up. This will allow the processor to enter a power-saving mode.

  While the processor isn't in a power-saving mode, CLOCK_SOFTTIME behaves the same as CLOCK_REALTIME.
- CLOCK_MONOTONIC — This clock always increases at a constant rate and can't be adjusted.

event NULL, or a pointer to a **sigevent** structure that contains the event to deliver when the timer fires; see below.

Library:

libc

Description:

The *TimerCreate()* and *TimerCreate_r()* kernel calls create a per-process timer using the clock specified by *id* as the timing base.

These functions are identical except in the way they indicate errors. See the Returns section for details.

Use the returned timer ID in subsequent calls to the other timer functions.

The timer is created in the disabled state, and isn't enabled until you call *TimerSettime()*.

The **`sigevent`** structure pointed to by *event* contains the event to deliver when the timer fires. We recommend the following event types in this case:

- If your process executes in a loop using *MsgReceivev()*, then SIGEV_PULSE is a convenient way of receiving timer pulses.
- If you use signals for event notification, note that signals are always delivered to the process and not directly to the thread that created or armed the timer. You can change this by using a *sigev_notify* of SIGEV_SIGNAL_THREAD.
- The notify types of SIGEV_UNBLOCK and SIGEV_INTR, while allowed, are of questionable use with timers. SIGEV_UNBLOCK is typically used by the *TimerTimeout()* kernel call, and SIGEV_INTR is typically used with the *InterruptWait()* kernel call.

If the *event* argument is NULL, a SIGALRM signal is sent to your process when the timer expires. To specify a handler for this signal, call *sigaction()*.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

TimerCreate() The timer ID of the newly created timer. If an error occurs, -1 is returned and *errno* is set.

TimerCreate_r() The timer ID of the newly created timer. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EINVAL The clock ID isn't valid.

EAGAIN All kernel timer objects are in use.

EFAULT A fault occurred when the kernel tried to access the buffers provided.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sigevent, *TimerAlarm()*, *TimerDestroy()*, *TimerInfo()*, *TimerSettime()*, *TimerTimeout()*

TimerDestroy(), TimerDestroy_r()

Destroy a process timer

Synopsis:

```
#include <sys/neutrino.h>

int TimerDestroy( timer_t id );

int TimerDestroy_r( timer_t id );
```

Arguments:

id The ID of the timer that you want to destroy, as returned by *TimerCreate()*.

Library:

libc

Description:

These kernel calls remove a previously created timer specified by *id*. The timer is removed from the active system timer list and returned to the list of available timers.

The *TimerDestroy()* and *TimerDestroy_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

If a timeout is pending when *TimerDestroy()* removes the timer, the timer is removed without being activated.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

TimerDestroy()

If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

TimerDestroy_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EINVAL The timer specified by *id* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

TimerCreate()

TimerInfo(), *TimerInfo_r()*

Get information about a timer

Synopsis:

```
#include <sys/neutrino.h>

int TimerInfo( pid_t pid,
               timer_t id,
               int flags,
               struct _timer_info* info );

int TimerInfo_r( pid_t pid,
                 timer_t id,
                 int flags,
                 struct _timer_info* info );
```

Arguments:

pid The process ID that you're requesting the timer information for.

id The ID of the timer, as returned by *TimerCreate()*.

flags Supported flags are:

- _NTO_TIMER_SEARCH — if this flag is specified and the timer ID doesn't exist, return information on the *next* timer ID. This provides a mechanism to discover all of the timers in the process.
- _NTO_RESET_OVERRUNS — reset the overrun count to zero in the **_timer_info** structure.

info A pointer to a **_timer_info** structure where the function can store the information about the specified timer. For more details, see "**struct _timer_info**," below.

Library:

libc

Description:

These kernel calls get information about a previously created timer specified by *id*, and stores the information in the buffer pointed to by *info*.

The *TimerInfo()* and *TimerInfo_r()* functions are identical except in the way they indicate errors. See the Returns section for details.

struct _timer_info

The **_timer_info** structure pointed to by *info* contains at least these members:

uint32_t *flags*

One or more of these bit flags:

_NTO_TI_ACTIVE

The timer is active.

_NTO_TI_ABSOLUTE

The timer is waiting for an absolute time to occur; otherwise, the timer is relative.

_NTO_TI_EXPIRED

The timer has expired.

int32_t *tid*

The thread to which the timer is directed (0 if it's directed to the process).

int32_t *notify*

The notify type.

clockid_t *clockid*

The type of clock used.

uint32_t *overruns*

The number of overruns.

struct sigevent *event*

The event dispatched when the timer expires.

struct itimerspec *itime*

Time when the timer was started.

struct itimerspec *otime*

Time remaining before the timer expires.

For more information, see the description of *TimerCreate()*.

Blocking states

These calls don't block.

Returns:

The only difference between these functions is the way they indicate errors:

TimerInfo() The ID of the timer that the information is for. If an error occurs, -1 is returned and *errno* is set.

TimerInfo_r() The ID of the timer that the information is for. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EINVAL The timer specified by *id* doesn't exist.

ESRCH The process specified by *pid* doesn't exist.

Classification:

QNX Neutrino

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sigevent, *TimerCreate()*

TimerSettime(), TimerSettime_r()

Set the expiration time for a timer

Synopsis:

```
#include <sys/neutrino.h>

int TimerSettime( timer_t id,
                  int flags,
                  const struct _itimer * itime,
                  struct _itimer * oitime );

int TimerSettime_r( timer_t id,
                    int flags,
                    const struct _itimer * itime,
                    struct _itimer * oitime );
```

Arguments:

id The ID of the timer whose an expiration date you want to set, as returned by *TimerCreate()*.

flags The only supported flag is TIMER_ABSTIME. If specified, then *nsec* represents an "absolute" expiration date in nanoseconds from the Unix Epoch, 00:00:00 January 1, 1970 UTC. If the date specified has already passed, then the expiration event is delivered immediately.

If the flag isn't specified, *nsec* represents a "relative" expiration period that's offset from the given clock's current system time in nanoseconds.

itime A pointer to a **_itimer** structure that specifies the expiration date. For detailed information, see "Expiration date, " below.

oitime NULL, or a pointer to a **_itimer** structure where the function can store the interval timer period (i.e. previous amount of time left before the timer was to have expired), or zero if the timer was disarmed at the time of the call. The previous interval timer period is also stored in the *interval_nsec* member.

Library:

libc

Description:

The *TimerSettime()* and *TimerSettime_r()* kernel calls set the expiration time of the timer specified by *id*.

These functions are identical except in the way they indicate errors. See the Returns section for details.

Expiration date

The expiration is specified by the *itime* argument. The **_itimer** structure contains at least the following members:

uint64_t *nsec*

The expiration time to set.

uint64_t *interval_nsec*

The interval reload time.

If the *nsec* member of *itime* is zero, then the timer is disarmed.

If the *interval_nsec* member of *itime* is nonzero, then it specifies a repeat rate which is added to the timer once the *nsec* period has expired. Subsequently, the timer is automatically rearmed, causing it to become repetitive with a period of *interval_nsec*.

If the timer is already armed when you call *TimerSettime()*, this call discards the previous setting and sets a new setting.

If the event notification specified by *TimerCreate()* has a *sigev_code* of SI_TIMER, then at most one event is queued. In this case, if an event is pending from a previous timer when the timer fires again, a timer overrun occurs. You can use the *TimerInfo()* kernel call to obtain the number of overruns that have occurred on this timer.

Blocking states

This call doesn't block.

Returns:

The only difference between these functions is the way they indicate errors:

TimerSettime()

If an error occurs, -1 is returned and *errno* is set. Any other value returned indicates success.

TimerSettime_r()

EOK is returned on success. This function does **NOT** set *errno*. If an error occurs, any value in the Errors section may be returned.

Errors:

EINVAL	The timer specified by *id* doesn't exist.
EFAULT	A fault occurred when the kernel tried to access *itime* or *oitime*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

TimerCreate(), TimerInfo()

TimerTimeout(), *TimerTimeout_r()*

Set a timeout on a blocking state

Synopsis:

```
#include <sys/neutrino.h>

int TimerTimeout( clockid_t id,
                  int flags,
                  const struct sigevent * notify,
                  const uint64_t * ntime,
                  uint64_t * otime );

int TimerTimeout_r( clockid_t id,
                    int flags,
                    const struct sigevent * notify,
                    const uint64_t * ntime,
                    uint64_t * otime );
```

Arguments:

id The type of timer to implement the timeout; one of:

- CLOCK_REALTIME — This is the standard POSIX-defined clock. Timers based on this clock should will wake up the processor if it's in a power-saving mode.
- CLOCK_SOFTTIME — This clock is only active when the processor is *not* in a power-saving mode. For example, an application using a CLOCK_SOFTTIME timer to sleep wouldn't wake up the processor when the application was due to wake up. This will allow the processor to enter a power-saving mode.

  While the processor isn't in a power-saving mode, CLOCK_SOFTTIME behaves the same as CLOCK_REALTIME.
- CLOCK_MONOTONIC — This clock always increases at a constant rate and can't be adjusted.

flags Flags that specify which states the timeout applies to. For the list and description of applicable states, see the section "Timeout states."

notify A pointer to a **sigevent** structure that contains the event to act on when the timeout expires. See "Event types" for the list of recommended event types.

ntime The timeout (in nanoseconds).

otime A pointer to a location where the function can store the time remaining in the sleep.

Library:

libc

Description:

The *TimerTimeout()* and *TimerTimeout_r()* kernel calls set a timeout on any kernel blocking state.

These functions are identical except in the way they indicate errors. See the Returns section for details.

These blocking states are entered as a result of the following kernel calls:

Call	Blocking state
InterruptWait()	STATE_INTR
MsgReceivev()	STATE_RECEIVE
MsgSendv()	STATE_SEND or STATE_REPLY
SignalSuspend()	STATE_SIGSUSPEND
SignalWaitinfo()	STATE_SIGWAITINFO
SyncCondvarWait()	STATE_CONDVAR
SyncMutexLock()	STATE_MUTEX
SyncSemWait()	STATE_SEM

continued...

Call	Blocking state
ThreadJoin()	STATE_JOIN

Timeout states

You can specify which states the timeout should apply to via a bitmask passed in the *flags* argument. The bits are defined by the following constants:

_NTO_TIMEOUT_CONDVAR

Timeout on STATE_CONDVAR.

_NTO_TIMEOUT_JOIN

Timeout on STATE_JOIN.

_NTO_TIMEOUT_INTR

Timeout on STATE_INTR.

_NTO_TIMEOUT_MUTEX

Timeout on STATE_MUTEX.

_NTO_TIMEOUT_RECEIVE

Timeout on STATE_RECEIVE.

_NTO_TIMEOUT_REPLY

Timeout on STATE_REPLY.

_NTO_TIMEOUT_SEM

Timeout on STATE_SEM.

_NTO_TIMEOUT_SEND

Timeout on STATE_SEND.

_NTO_TIMEOUT_SIGSUSPEND

Timeout on STATE_SIGSUSPEND.

_NTO_TIMEOUT_SIGWAITINFO

Timeout on STATE_SIGWAITINFO.

For example, to set a timeout on *MsgSendv()*, specify:

```
_NTO_TIMEOUT_SEND | _NTO_TIMEOUT_REPLY
```

Once a timeout is specified using *TimerTimeout()*, it's armed and released under the following conditions:

Armed	The kernel attempts to enter a blocking state specified in *flags*.
Released	One of the above kernel calls completed without blocking, *or* the kernel call blocks but unblocks before the timeout expires, *or* the timeout expires.

TimerTimeout() always operates on a one-shot basis. When one of the above kernel calls returns (or is interrupted by a signal), the timeout request is removed from the system. Only one timeout per thread may be in effect at a time. A second call to *TimerTimeout()*, without calling one of the above kernel functions, replaces the existing timeout on that thread. A call with *flags* set to zero ensures that a timeout won't occur on any state. This is the default when a thread is created.

Always call *TimerTimeout()* just before the function that you wish to timeout. For example:

```
...
event.sigev_notify = SIGEV_UNBLOCK;

timeout = 10×1000000000;

TimerTimeout( CLOCK_REALTIME,
              _NTO_TIMEOUT_SEND | _NTO_TIMEOUT_REPLY,
              &event, &timeout, NULL );
MsgSendv( coid, NULL, 0, NULL, 0 );
...
```

If the signal handler is called between the calls to *TimerTimeout()* and *MsgSendv()*, the *TimerTimeout()* values are saved during the signal handler and then are restored when the signal handler exits.

EventTypes

If the timeout expires, the kernel acts upon the event specified in the **sigevent** structure pointed to by the *notify* argument. We recommend the following event types in this case:

- SIGEV_SIGNAL
- SIGEV_SIGNAL_CODE
- SIGEV_SIGNAL_THREAD
- SIGEV_PULSE
- SIGEV_UNBLOCK
- SIGEV_INTR

Only SIGEV_UNBLOCK guarantees that the kernel call unblocks. A signal may be ignored, blocked, or accepted by another thread, and a pulse can only unblock a *MsgReceivev()*. If you pass NULL for *event*, SIGEV_UNBLOCK is assumed. In this case, a timed out kernel call returns failure with an error of ETIMEDOUT.

MsgSendv() doesn't unblock on SIGEV_UNBLOCK if the server has already received the message via *MsgReceivev() and* has specified _NTO_CHF_UNBLOCK in the *flags* argument to its *ChannelCreate()* call. In this case, it's up to the server to do a *MsgReplyv()*.

The timeout

The type of timer used to implement the timeout is specified with the *id* argument.

The timeout:

- Is specified by the *ntime* argument (the number of nanoseconds).
- Is relative to the current time (when *TimerTimeout()* is called), unless *flags* includes TIMER_ABSTIME, which makes the timeout occur at the absolute time set in *ntime*.

- Occurs on a clock tick (see *ClockPeriod()*) so the actual wakeup time is a minimum of:
  `( ntime ) ÷ ( size of timer tick ) nanoseconds`

If you specify a resolution that amounts to 1.7 timer ticks, you'll wake up in at least 1.7 timer ticks.

If you don't wish to block for any time, you can pass a NULL for *ntime*, in which case no timer is used, the event is assumed to be SIGEV_UNBLOCK, and an attempt to enter a blocking state as set by *flags* immediately returns with ETIMEDOUT. Although a questionable practice, you can use it to poll potential blocking kernel calls. For example, you can poll for messages using *MsgReceivev()* with an immediate timeout. A much better approach is to use multiple threads and have one block waiting for messages.

If you set *flags* to _NTO_TIMEOUT_NANOSLEEP, then these calls block in the STATE_NANOSLEEP state until the timeout (or a signal that unblocks the thread) occurs. You can use this to implement an efficient kernel sleep as follows:

```
TimerTimeout( CLOCK_REALTIME, _NTO_TIMEOUT_NANOSLEEP,
              NULL, ntime, otime );
```

If *otime* isn't NULL and the sleep is unblocked by a signal, it contains the time remaining in the sleep.

Blocking states

These calls don't block unless you specify _NTO_TIMEOUT_NANOSLEEP in *flags*. In this case, the calls block as follows:

STATE_NANOSLEEP

The calling thread blocks for the requested time period.

Returns:

The only difference between these functions is the way they indicate errors:

TimerTimeout()

The previous flags. If an error occurs, -1 is returned and *errno* is set.

TimerTimeout_r()

The previous flags. This function does **NOT** set *errno*. If an error occurs, the negative of a value from the Errors section is returned.

Errors:

EAGAIN	All kernel timer entries are in use.
EFAULT	A fault occurred when the kernel tried to access *ntime*, *otime*, or *notify*.
EINTR	The call was interrupted by a signal.
EINVAL	Invalid timer value *id*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

sigevent, *TimerCreate()*, *TimerInfo()*

times()

Get time-accounting information

Synopsis:

```
#include <sys/times.h>

clock_t times( struct tms* buffer );
```

Arguments:

buffer A pointer to a **tms** structure where the function can store the time-accounting information. For information about the **tms** structure, see below.

Library:

libc

Description:

The *times()* function stores time-accounting information in the structure pointed to by *buffer*. The type **clock_t** and the **tms** structure are defined in the **<sys/times.h>** header file.

The **tms** structure contains at least the following members:

clock_t *tms_utime*

The CPU time charged for the execution of user instructions of the calling process.

clock_t *tms_stime*

The CPU time charged for execution by the system on behalf of the calling process.

clock_t *tms_cutime*

The sum of the *tms_utime* and *tms_cutime* values of the child processes.

clock_t *tms_cstime*

The sum of the *tms_stime* and *tms_cstime* values of the child processes.

All times are in CLK_TCK'ths of a second. CLK_TCK is defined in the **<time.h>** header file. A CLK_TCK is the equivalent of:

```
#define sysconf( _SC_CLK_TCK )
```

The times of a terminated child process are included in the *tms_cutime* and *tms_cstime* elements of the parent when a *wait()* or *waitpid()* function returns the process ID of this terminated child. If a child process hasn't waited for its terminated children, their times aren't included in its times.

Returns:

The elapsed real time, in clock ticks, of kernel uptime.

☞ The value returned may overflow the possible range of type **clock_t**.

Examples:

```
/*
 * The following program executes the program
 * specified by argv[1].  After the child program
 * is finished, the cpu statistics of the child are
 * printed.
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <sys/times.h>

int main( int argc, char **argv )
  {
    struct tms childtim;

    system( argv[1] );
    times( &childtim );
    printf( "system time = %d\n", childtim.tms_cstime );
    printf( "user time   = %d\n", childtim.tms_cutime );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

clock_gettime()

Synopsis:

```
#include <time.h>

struct timespec {
   time_t   tv_sec;
   long     tv_nsec;
}
```

Description:

The **timespec** structure specifies a time in seconds and nanoseconds. The members include:

tv_sec The number of seconds. If specifying an absolute time, this member is the number of seconds since 1970.

tv_nsec The number of nanoseconds.

Classification:

POSIX 1003.1 (Realtime Extensions)

See also:

nsec2timespec(), *timespec2nsec()*

timespec2nsec()

Convert a **timespec** *structure to nanoseconds*

Synopsis:

```
#include <time.h>

_uint64 timespec2nsec( const struct timespec* ts );
```

Arguments:

ts A pointer to the **timespec** that you want to convert to nanoseconds.

Library:

libc

Description:

The *timespec2nsec()* function converts the number of seconds and nanoseconds in the **timespec** structure pointed to by *ts* into nanoseconds.

Returns:

The number of nanoseconds.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

nsec2timespec(), **`timespec`**

The number of seconds by which the local time zone is earlier than UTC

Synopsis:

```
#include <time.h>

long int timezone;
```

Description:

This global variable holds the number of seconds by which the local time zone is earlier than Coordinated Universal Time (UTC) (formerly known as Greenwich Mean Time). Whenever you call a time function, *tzset()* is called to set the variable, based on the current time zone.

Classification:

QNX Neutrino

See also:

daylight, *tzname*, *tzset()*

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

Synopsis:

```
#include <time.h>
struct  tm {
        int tm_sec;
        int tm_min;
        int tm_hour;
        int tm_mday;
        int tm_mon;
        int tm_year;
        int tm_wday;
        int tm_yday;
        int tm_isdst;
        long int tm_gmtoff;
        const char * tm_zone;
};
```

Description:

The **tm** structure describes the calendar time. The members of this structure include:

tm_sec	Seconds after the minute, in the range [0,61], allowing for leap seconds.
tm_min	Minutes after the hour, in the range [0,59].
tm_hour	Hours after midnight, in the range [0,23].
tm_mday	Day of the month, in the range [1,31].
tm_mon	Months since January, in the range [0,11].
tm_year	Years since 1900.
tm_wday	Days since Sunday, in the range [0,6].
tm_yday	Days since January 1, in the range [0,365], allowing for leap years.
tm_isdst	Daylight saving time flag.

tm_gmtoff Offset from UTC — see *setlocale()*.

tm_zone String for the time zone name.

Classification:

ANSI

See also:

asctime(), *gmtime()*, *gmtime_r()*, *localtime()*, *localtime_r()*, *mktime()*, *setlocale()*, *strftime()*, *wcsftime()*

tmpfile(), tmpfile64()

Create a temporary file

Synopsis:

```
#include <stdio.h>

FILE* tmpfile( void );

FILE* tmpfile64( void );
```

Library:

libc

Description:

The *tmpfile()* and *tmpfile64()* functions create a temporary file and opens a corresponding **FILE** stream. The file is automatically removed when it's closed or when the program terminates. The file is opened in update mode (as in *fopen()*'s **w+** mode).

If the process is killed between file creation and unlinking, a permanent file may be left behind.

☞ When a stream is opened in update mode, both reading and writing may be performed. However, writing may not be followed by reading without an intervening call to the *fflush()* function, or to a file-positioning function (*fseek(), fsetpos(), rewind()*). Similarly, reading may not be followed by writing without an intervening call to a file-positioning function, unless the read resulted in end-of-file.

Returns:

A pointer to the stream of the temporary file, or NULL if an error occurs (*errno* is set).

Errors:

EACCESS The calling process doesn't have permission to create the temporary file.

EMFILE	The calling process already has already used OPEN_MAX file descriptors.
ENFILE	The system already has the maximum number of files open.
EROFS	The filesystem for the temporary file is read-only.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

static FILE *TempFile;

int main( void )
{
    TempFile = tmpfile();
...
    fclose( TempFile );

    /* The temporary file will be removed when we exit. */
    return EXIT_SUCCESS;
}
```

Classification:

tmpfile() is ANSI, *tmpfile64()* is for large-file support

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fopen(), fopen64(), freopen(), freopen64(), tempnam(), tmpnam()

tmpnam()

Generate a unique string for use as a filename

Synopsis:

```
#include <stdio.h>

char* tmpnam( char* buffer );
```

Arguments:

buffer NULL, or a pointer to a buffer where the function can store the filename. If *buffer* isn't NULL, the buffer must be at least *L_tmpnam* bytes long.

Library:

libc

Description:

The *tmpnam()* function generates a unique string that's a valid filename and that's not the same as the name of an existing file.

The *tmpnam()* function generates up to TMP_MAX unique file names before it starts to recycle them.

The generated filename is prefixed with the first accessible directory contained in:

- The **TMPDIR** environment variable
- The temporary file directory *P_tmpdir* (defined in **<stdio.h>**)
- The _PATH_TMP constant (defined in **<paths.h>**)

If all of these paths are inaccessible, *tmpnam()* attempts to use **/tmp** and then the current working directory.

The generated filename is stored in an internal buffer; if *buffer* is NULL, the function returns a pointer to this buffer; otherwise, *tmpnam()* copies the filename into *buffer*.

Subsequent calls to *tmpnam()* reuse the internal buffer. If *buffer* is NULL, you might want to duplicate the resulting string. For example,

```
char *name1, *name2;

name1 = strdup( tmpnam( NULL ) );
name2 = strdup( tmpnam( NULL ) );
```

Returns:

A pointer to the generated filename for success, or NULL if an error occurs (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
{
    char filename[L_tmpnam];
    FILE *fp;

    tmpnam( filename );
    fp = fopen( filename, "w+b" );
...
    fclose( fp );
    remove( filename );

    return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Read the *Caveats*

Caveats:

The *tmpnam()* function *isn't thread-safe* if you pass it a NULL *buffer*.

This function only creates pathnames; the application must create and remove the files.

It's possible for another thread or process to create a file with the same name between when the pathname is created and the file is opened.

See also:

tempnam(), tmpfile()

tolower()

Convert a character to lowercase

Synopsis:

```
#include <ctype.h>

int tolower( int c );
```

Arguments:

c The character that you want to convert.

Library:

libc

Description:

The *tolower()* function converts *c* to a lowercase letter, if *c* represents an uppercase letter.

Returns:

The corresponding lowercase letter when the argument is an uppercase letter; otherwise, the original character is returned.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char chars[] = {
    'A',
    '5',
    '$',
    'Z'
};

#define SIZE sizeof( chars ) / sizeof( char )

int main( void )
  {
    int   i;

    for( i = 0; i < SIZE; i++ ) {
```

```
    printf( "%c ", tolower( chars[ i ] ) );
    }
    printf( "\n" );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
a 5 $ z
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), *isalpha()*, *iscntrl()*, *isdigit()*, *isgraph()*, *islower()*, *isprint()*, *ispunct()*, *isspace()*, *isupper()*, *isxdigit()*, *strlwr()*, *strupr()*, *toupper()*

toupper()

Convert a character to uppercase

Synopsis:

```
#include <ctype.h>

int toupper( int c );
```

Arguments:

c The character that you want to convert.

Library:

libc

Description:

The *toupper()* function converts *c* to a uppercase letter, if *c* represents a lowercase letter.

Returns:

The corresponding uppercase letter when the argument is a lowercase letter; otherwise, the original character is returned.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

char chars[] = {
    'a',
    '5',
    '$',
    'z'
};

#define SIZE sizeof( chars ) / sizeof( char )

int main( void )
  {
    int   i;

    for( i = 0; i < SIZE; i++ ) {
```

```
    printf( "%c ", toupper( chars[ i ] ) );
    }
    printf( "\n" );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
A 5 $ Z
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

isalnum(), *isalpha()*, *iscntrl()*, *isdigit()*, *isgraph()*, *islower()*, *isprint()*, *ispunct()*, *isspace()*, *isupper()*, *isxdigit()*, *strlwr()*, *strupr()*, *tolower()*

towctrans()

Convert a wide character in a specified manner

Synopsis:

```
#include <wctype.h>

wint_t towctrans( wint_t wc,
                  wctrans_t category );
```

Arguments:

wc	The wide character that you want to convert.
category	How you want to convert the character; get this by calling *wctrans()*.

Library:

libc

Description:

The *towctrans()* function converts *wc*, using the mapping described by *category*. The following functions are equivalent:

Function	Equivalent *wctrans()* call
`towlower( wc )`	`towctrans( wc, wctrans("tolower") )`
`towupper( wc )`	`towctrans( wc, wctrans("toupper") )`

Returns:

The corresponding converted wide character when the argument is valid; otherwise, the original wide character.

Errors:

EINVAL The conversion descriptor in *category* is invalid.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

wctrans()

"Character manipulation functions" and "Wide-character functions" in *Library Reference Summary*

towlower()

Convert a wide character to lowercase

Synopsis:

```
#include <wctype.h>

wint_t towlower( wint_t wc );
```

Arguments:

wc The wide character that you want to convert.

Library:

libc

Description:

The *towlower()* function converts *wc* to a lowercase letter, if *wc* represents an uppercase letter.

Returns:

The corresponding lowercase letter when the argument is an uppercase letter; otherwise, the original wide character is returned.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

"Character manipulation functions" and "Wide-character functions" in *Library Reference Summary*

towupper()

Convert a wide character to uppercase

Synopsis:

```
#include <wctype.h>

wint_t towupper( wint_t wc );
```

Arguments:

wc The wide character that you want to convert.

Library:

libc

Description:

The *towupper()* function converts *wc* to an uppercase letter if *wc* represents a lowercase letter.

Returns:

The corresponding uppercase letter when the argument is a lowercase letter; otherwise, the original wide character is returned.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

"Character manipulation functions" and "Wide-character functions" in *Library Reference Summary*

TraceEvent()

Trace kernel events

Synopsis:

```
#include <sys/neutrino.h>

int TraceEvent( int mode,
                ... );
```

Arguments:

mode A command that indicates what you want to trace. Certain modes require additional arguments.

Library:

libc

Description:

The *TraceEvent()* function controls all stages of the instrumentation process such as initialization, starting, execution control and stopping. These stages consist of the following activities:

- creating internal circular link list of trace buffers
- initializing filters
- turning on or off the event stream
- deallocating the internal circular link list of trace buffers

This function requires the instrumented kernel. For more information, see the documentation for the System Analysis Toolkit (SAT).

Returns:

If *mode* is set to _NTO_TRACE_QUERYEVENTS

Number of events in the buffer, or -1 if an error occurs (*errno* is set).

If *mode* isn't set to _NTO_TRACE_QUERYEVENTS

0 for success, or -1 if an error occurs (*errno* is set).

Errors:

ECANCELED	The requested action has been canceled.
EFAULT	The requested action has been specified out of order.
ENOMEM	Insufficient memory to allocate the trace buffers.
ENOSUP	The requested action isn't supported.
EPERM	The application doesn't have the appropriate permission to perform the action.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Read the *Caveats*
Signal handler	Yes
Thread	Yes

Caveats:

You can call *TraceEvent()* from an interrupt/event handler. However, not all trace modes are valid in this case. The valid trace modes are:

- _NTO_TRACE_INSERTSUSEREVENT
- _NTO_TRACE_INSERTCUSEREVENT
- _NTO_TRACE_INSERTUSRSTREVENT

- _NTO_TRACE_INSERTEVENT
- _NTO_TRACE_STOP
- _NTO_TRACE_STARTNOSTATE
- _NTO_TRACE_START

See also:

InterruptAttach(), *InterruptHookTrace()*

truncate()

Truncate a file to a specified length

Synopsis:

```
#include <unistd.h>

int truncate( const char* path,
              off_t length );
```

Arguments:

path The path name of the file that you want to truncate.

length The new size of the file.

Library:

libc

Description:

The *truncate()* function causes the regular file named by *path* to have a size of *length* bytes.

The effect of *truncate()* on other types of files is unspecified. If the file previously was larger than *length*, the extra data is lost. If it was previously shorter than *length*, bytes between the old and new lengths are read as zeroes. The process must have write permission for the file.

If the request would cause the file size to exceed the soft file size limit for the process, the request fails and the implementation generates the SIGXFSZ signal for the process.

This function doesn't modify the file offset for any open file descriptions associated with the file. On successful completion, if the file size is changed, *truncate()* marks for update the *st_ctime* and *st_mtime* fields of the file, and if the file is a regular file, the S_ISUID and S_ISGID bits of the file mode may be cleared.

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Errors:

EACCES A component of the path prefix denies search permission, or write permission is denied on the file.

EFAULT The *path* argument points outside the process's allocated address space.

EFBIG The *length* argument was greater than the maximum file size.

EINTR A signal was caught during execution.

EINVAL The *length* argument is invalid, or the *path* argument isn't an ordinary file.

EIO An I/O error occurred while reading from or writing to a filesystem.

EISDIR The named file is a directory.

ELOOP Too many symbolic links were encountered in resolving *path*.

EMFILE The maximum number of file descriptors available to the process has been reached.

EMULTIHOP Components of *path* require hopping to multiple remote machines and filesystem type doesn't allow it.

ENAMETOOLONG

The length of the specified pathname exceeds PATH_MAX bytes, or the length of a component of the pathname exceeds NAME_MAX bytes.

ENFILE	Additional space couldn't be allocated for the system file table.
ENOENT	A component of *path* doesn't name an existing file or *path* is an empty string.
ENOLINK	The *path* argument points to a remote machine and the link to that machine is no longer active.
ENOTDIR	A component of the path prefix of *path* isn't a directory.
EROFS	The named file resides on a read-only filesystem.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chmod(), fcntl(), ftruncate(), open()

ttyname()

Get a fully qualified pathname for a file

Synopsis:

```
#include <unistd.h>

char *ttyname( int fildes );
```

Arguments:

fildes A file descriptor that's associated with the file whose name you want to get.

Library:

libc

Description:

The *ttyname()* function returns a pointer to a static buffer that contains a fully qualified pathname associated with the file associated with *fildes*.

Returns:

A pointer to the pathname for *fildes*, or NULL if an error occurred (*errno* is set).

Errors:

EBADF The *fildes* argument is invalid.

ENOSYS The *ttyname()* function isn't implemented for the filesystem specified by *filedes*.

ENOTTY Not a tty.

Examples:

```
/*
 * The following program prints out the name
 * of the terminal associated with stdin.
 */
```

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main( void )
{
    if( isatty( 0 ) ) {
       printf( "%s\n", ttyname( 0 ) );
    } else {
       printf( "\n" );
    }
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	No

See also:

ctermid(), *setsid()*, *ttyname_r()*

ttyname_r()

Get a fully qualified pathname for a file

Synopsis:

```
#include <unistd.h>

int ttyname_r( int fildes,
               char* name,
               size_t namesize );
```

Arguments:

fildes	A file descriptor that's associated with the file whose name you want to get.
name	A pointer to a buffer where the function can store the path name.
namesize	The size of the buffer.

Library:

libc

Description:

The *ttyname_r()* function stores the null-terminated pathname of the terminal associated with the file descriptor *fildes* in the character array referenced by *name*. The array is *namesize* characters long and should have space for the name and the terminating NULL character.

Returns:

Zero for success, or an error number.

Errors:

EBADF	The *fildes* argument isn't a valid file descriptor.
ENOSYS	The *ttyname_r()* function isn't implemented for the filesystem specified by *filedes*.
ENOTTY	The *fildes* argument doesn't refer to a tty.

ERANGE — The value of *namesize* is smaller than the length of the string to be returned, including the terminating null character.

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

ctermid(), *errno*, *setsid()*, *ttyname()*

The abbreviations for the time zone for standard and daylight savings time

Synopsis:

```
#include <time.h>

char *tzname[];
```

Description:

This global variable holds the standard abbreviations for the time zone and the time zone when daylight saving time is in effect. Whenever you call a time function, *tzset()* is called to set the values in the array, based on the current time zone.

Classification:

QNX Neutrino

See also:

daylight, *timezone*, *tzset()*

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

tzset()

Set the time according to the current time zone

Synopsis:

```
#include <time.h>

void tzset( void );
```

Library:

libc

Description:

The *tzset()* function sets the global variables *daylight*, *timezone* and *tzname* according to the value of the **TZ** environment variable, or to the value of the **_CS_TIMEZONE** configuration string if **TZ** isn't set.

The global variables have the following values after *tzset()* is executed:

daylight — Zero indicates that daylight saving time isn't supported in the locale; a nonzero value indicates that daylight saving time is supported in the locale. This variable is cleared or set after a call to the *tzset()* function, depending on whether or not a daylight saving time abbreviation is specified in the **TZ**environment variable.

timezone — The number of seconds that the local time zone is earlier than Coordinated Universal Time (UTC) (formerly known as Greenwich Mean Time (GMT)).

tzname — A two-element array pointing to strings giving the abbreviations for the name of the time zone when standard and daylight saving time are in effect.

The time that you set on the computer with the **date** command reflects Coordinated Universal Time (UTC). The environment variable **TZ** is used to establish the local time zone. For more information, see "Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

void print_zone()
  {
    char *tz;

    printf( "TZ: %s\n", (tz = getenv( "TZ" ))
            ? tz : "default EST5EDT" );
    printf( "  daylight: %d\n", daylight );
    printf( "  timezone: %ld\n", timezone );
    printf( "  time zone names: %s %s\n",
        tzname[0], tzname[1] );
  }

int main( void )
  {
    print_zone();
    setenv( "TZ", "PST8PDT", 1 );
    tzset();
    print_zone();
    return EXIT_SUCCESS;
  }
```

produces the output:

```
TZ: default EST5EDT
  daylight: 1
  timezone: 18000
  time zone names: EST EDT
TZ: PST8PDT
  daylight: 1
  timezone: 28800
  time zone names: PST PDT
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

ctime(), daylight, localtime(), localtime_r(), mktime(), strftime()
timezone, tzname

"Setting the time zone" in the Configuring Your Environment chapter of the Neutrino *User's Guide*

ualarm()

Schedule an alarm

Synopsis:

```
#include <unistd.h>

useconds_t ualarm( useconds_t usec,
                   useconds_t interval );
```

Arguments:

usec The number of microseconds that you want to elapse before the first alarm occurs, or 0 to cancel any previous request for an alarm.

interval The number of microseconds that you want to elapse before the subsequent alarms occur.

Library:

libc

Description:

The *ualarm()* function causes the system to send the calling process a SIGALRM signal after *usec* microseconds of real-time have elapsed. The alarm is then sent every *interval* microseconds after that.

Processor scheduling delays may cause a delay between when the signal is sent and when the process actually handles it.

If *usec* is `0`, any previous *ualarm()* request is canceled.

Returns:

0 There was no previous *ualarm()* request.

`-1` An error occurred (*errno* is set).

Any other value

The number of microseconds until the next scheduled SIGALRM.

Errors:

EAGAIN	All timers are in use; wait for a process to release one and try again.

Examples:

```
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>

int main( void )
{
    useconds_t timeleft;

    printf( "Set the alarm and sleep\n" );
    ualarm( (useconds_t)( 10 * 1000 * 1000 ), 0 );
    sleep( 5 );   /* go to sleep for 5 seconds */

    /*
     To get the time left before the SIGALRM is
     to arrive, one must cancel the initial timer,
     which returns the amount of time it had
     remaining.
    */
    timeleft = ualarm( 0, 0 );
    printf( "Time left before cancel, and rearm: %ld\n",
        timeleft );

    /*
     Start a new timer that kicks us when timeleft
     seconds have passed.
    */
    ualarm( timeleft, 0 );

    /*
     Wait until we receive the SIGALRM signal; any
     signal kills us, though, since we don't have
     a signal handler.
    */
    printf( "Hanging around, waiting to exit\n" );
    pause();

    /* You'll never get here. */
    return EXIT_SUCCESS;
}
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

alarm(), TimerAlarm(), and *ualarm()* requests aren't "stacked"; only a single SIGALRM generator can be scheduled with these functions. If the SIGALRM signal hasn't been generated, the next call to *alarm(), TimerAlarm(),* or *ualarm()* reschedules it.

Don't mix calls to *ualarm()* with *nanosleep(), sleep(), timer_create(), timer_delete(), timer_getoverrun(), timer_gettime(), timer_settime(),* or *usleep()*.

See also:

alarm(), nanosleep(), sigaction(), sleep(), timer_create(), timer_delete(), timer_getoverrun(), timer_gettime(), timer_settime(), TimerAlarm(), usleep()

UDP

Internet User Datagram Protocol

Synopsis:

```
#include <sys/socket.h>
#include <netinet/in.h>

int socket( AF_INET,
            SOCK_DGRAM,
            0 );
```

Description:

UDP is a simple, unreliable datagram protocol that's used to support the SOCK_DGRAM abstraction for the Internet protocol family. UDP sockets are connectionless and are normally used with the *sendto()* and *recvfrom()* calls, although you can also use the *connect()* call to fix the destination for future packets (in which case you can use the *recv()* or *read()* and *send()* or *write()* system calls).

UDP address formats are identical to those used by TCP. In particular, UDP provides a port identifier in addition to the normal Internet address format. Note that the UDP port space is separate from the TCP port space; that is, a UDP port may *not* be "connected" to a TCP port. In addition, broadcast packets may be sent — assuming the underlying network supports this — by using a reserved broadcast address; this address is network-interface dependent.

You can use options at the IP transport level with UDP (see the IP protocol).

Returns:

A descriptor referencing the socket, or -1 if an error occurs (*errno* is set).

Errors:

EADDRINUSE — You tried to create a socket with a port that has already been allocated.

EADDRNOTAVAIL
: You tried to create a socket with a network address for which no network interface exists.

EISCONN
: You tried to establish a connection on a socket that already has one, or to send a datagram with the destination address specified and the socket is already connected.

ENOBUFS
: The system ran out of memory for an internal data structure.

ENOTCONN
: You tried to send a datagram, but no destination address was specified and the socket hasn't been connected.

See also:

IP protocol

connect(), getsockopt(), read(), recv(), recvfrom(), send(), sendto(), socket(), write()

RFC 768

ultoa(), *ulltoa()*

Convert an unsigned long integer into a string, using a given base

Synopsis:

```
#include <stdlib.h>

char* ultoa( unsigned long int value,
             char* buffer,
             int radix );

char* ulltoa( uint64_t value
              char* buffer,
              int radix );
```

Arguments:

value The value to convert into a string.

buffer A buffer in which the function stores the string. The size of the buffer must be at least 33 bytes when converting values in base 2 (binary).

radix The base to use when converting the number. This value must be in the range:

$2 \leq radix \leq 36$

Library:

libc

Description:

The *ultoa()* and *ulltoa()* functions convert the unsigned binary integer *value* into the equivalent string in base *radix* notation, storing the result in the character array pointed to by *buffer*. A NUL character is appended to the result.

Returns:

A pointer to the result.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

void print_value( unsigned long int value )
  {
    int base;
    char buffer[33];

    for( base = 2; base <= 16; base = base + 2 )
      printf( "%2d %s\n", base,
          ultoa( value, buffer, base ) );
  }

int main( void )
  {
    print_value( (unsigned) 12765L );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
 2 11000111011101
 4 3013131
 6 135033
 8 30735
10 12765
12 7479
14 491b
16 31dd
```

Classification:

ultoa() is QNX 4; *ulltoa()* is Unix

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atoi(), atol(), itoa(), ltoa(), sscanf(), strtol(), strtoul(), utoa()

Synopsis:

```
#include <sys/types.h>
#include <sys/stat.h>

mode_t umask( mode_t cmask );
```

Arguments:

cmask The new file-mode creation mask; that is, the permissions that you don't want set when the process creates a file. The mask is a combination of these bits:

Owner	Group	Others	Permission
S_IRUSR	S_IRGRP	S_IROTH	Read
S_IRWXU	S_IRWXG	S_IRWXO	Read, write, execute/search. A bitwise inclusive OR of the other three constants. (S_IRWXU is OR of IRUSR, S_IWSUR and S_IXUSR.)
S_IWUSR	S_IWGRP	S_IWOTH	Write
S_IXUSR	S_IXGRP	S_IXOTH	Execute/search

Library:

libc

Description:

The *umask()* function sets the process's file-mode creation mask to *cmask*, and returns the previous value of the mask. Only the file permission bits (as defined in **<sys/stat.h>**) are used.

The file-mode creation mask for the process is used when you call *creat()*, *mkdir()*, *mkfifo()*, and *open()*, to turn off permission bits in the *mode* argument supplied. Bit positions set in *cmask* are cleared in the mode of the created file.

Returns:

The previous value of the file-mode creation mask.

Examples:

```
/*
 * Set the umask to RW for owner,group; R for other
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <sys/stat.h>

int main( void )
  {
    mode_t omask;
    mode_t nmask;

    nmask = S_IRUSR | S_IWUSR | /* owner read write */
            S_IRGRP | S_IWGRP | /* group read write */
            S_IROTH;            /* other read */
    omask = umask( nmask );
    printf( "Mask changed from %o to %o\n",
             omask, nmask );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chmod(), creat(), mkdir(), mkfifo(), open(), stat()

umount()

Unmount a filesystem

Synopsis:

```
#include <sys/mount.h>

int umount( const char* dir,
            int flags);
```

Arguments:

dir The filesystem that you want to unmount.

flags Flags that control the operation. Currently, the only valid value for *flags* is:

- _MOUNT_FORCE — force an unmount to occur.

Library:

libc

Description:

The *umount()* function sends a request to the server to unmount the path described by *dir*.

Returns:

-1 on failure.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

mount()

Writing a Resource Manager in *Programmer's Guide*

UNALIGNED_PUT16()

Write a misaligned 16-bit value safely

Synopsis:

```
#include <gulliver.h>

void UNALIGNED_PUT16( uint16_t *loc,
                      uint16_t num );
```

Arguments:

loc The address where you want to write the value.

num The value that you want to write.

Library:

libc

Description:

The *UNALIGNED_PUT16()* macro lets you write the value *num* at the misaligned address *loc* without faulting.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

UNALIGNED_PUT16() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*

UNALIGNED_PUT32()

Write a misaligned 32-bit value safely

Synopsis:

```
#include <gulliver.h>

void UNALIGNED_PUT32( uint32_t *loc,
                      uint32_t num );
```

Arguments:

loc The address where you want to write the value.

num The value that you want to write.

Library:

libc

Description:

The *UNALIGNED_PUT32()* macro lets you write the value *num* at the misaligned address *loc* without faulting.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

UNALIGNED_PUT32() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT64()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*

UNALIGNED_PUT64()

Write a misaligned 64-bit value safely

Synopsis:

```
#include <gulliver.h>

void UNALIGNED_PUT64( uint64_t * loc,
                      uint64_t num );
```

Arguments:

loc The address where you want to write the value.

num The value that you want to write.

Library:

libc

Description:

The *UNALIGNED_PUT64()* macro lets you write the value *num* at the misaligned address *loc* without faulting.

This macro isn't currently implemented.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

UNALIGNED_PUT64() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*

UNALIGNED_RET16()

Access a misaligned 16-bit value safely

Synopsis:

```
#include <gulliver.h>

uint16_t UNALIGNED_RET16( const uint16_t *loc );
```

Arguments:

loc The address where you want to get the value from.

Library:

libc

Description:

The *UNALIGNED_RET16()* macro lets you access the misaligned 16-bit value pointed to by *loc* without faulting.

Returns:

The 16-bit value pointed to by *loc*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

UNALIGNED_RET16() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*, *UNALIGNED_RET32()*, *UNALIGNED_RET64()*

UNALIGNED_RET32()

Access a misaligned 32-bit value safely

Synopsis:

```
#include <gulliver.h>

uint32_t UNALIGNED_RET32( const uint32_t *loc );
```

Arguments:

loc The address where you want to get the value from.

Library:

libc

Description:

The *UNALIGNED_RET32()* macro lets you access the misaligned 32-bit value pointed to by *loc* without faulting.

Returns:

The 32-bit value pointed to by *loc*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

UNALIGNED_RET32() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*, *UNALIGNED_RET16()*, *UNALIGNED_RET64()*

UNALIGNED_RET64()

Access a misaligned 64-bit value safely

Synopsis:

```
#include <gulliver.h>

uint64_t UNALIGNED_RET64( const uint64_t * loc );
```

Arguments:

loc The address where you want to get the value from.

Library:

libc

Description:

The *UNALIGNED_RET64()* macro lets you access the misaligned 64-bit value pointed to by *loc* without faulting.

This macro isn't currently implemented.

Returns:

The 64-bit value pointed to by *loc*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

UNALIGNED_RET64() is implemented as a macro.

See also:

ENDIAN_BE16(), *ENDIAN_BE32()*, *ENDIAN_BE64()*, *ENDIAN_LE16()*, *ENDIAN_LE32()*, *ENDIAN_LE64()*, *ENDIAN_RET32()*, *ENDIAN_RET64()*, *ENDIAN_SWAP16()*, *ENDIAN_SWAP32()*, *ENDIAN_SWAP64()*, *htonl()*, *htons()*, *ntohl()*, *ntohs()*, *UNALIGNED_PUT16()*, *UNALIGNED_PUT32()*, *UNALIGNED_PUT64()*, *UNALIGNED_RET16()*, *UNALIGNED_RET32()*

uname()

Get information about the operating system

Synopsis:

```
#include <sys/utsname.h>

int uname( struct utsname * name );
```

Arguments:

name A pointer to a **utsname** where the function can store the information; see below.

Library:

libc

Description:

The *uname()* function stores information about the current operating system in the structure pointed to by the argument *name*.

The system name structure, **utsname**, is defined in **<sys/utsname.h>**, and contains at least the following structure members:

char* *sysname* The name of the OS.

char* *nodename*
The name of this node.

char* *release* The current release level.

char* *version* The current version level.

char* *machine* The hardware type.

Each of these items is a null-terminated character array.

Returns:

0	Success.
-1	An error occurred (*errno* is set).

Examples:

```
/*
 * The following program prints some information about the
 * system it's running on.
 */
#include <stdio.h>
#include <stdlib.h>
#include <sys/types.h>
#include <sys/utsname.h>

int main( void )
  {
    struct utsname sysinfo;

    if( uname( &sysinfo ) == -1 ) {
       perror( "uname" );
       return EXIT_FAILURE;
    }
    printf( "system name  : %s\n", sysinfo.sysname );
    printf( "node name    : %s\n", sysinfo.nodename );
    printf( "release name : %s\n", sysinfo.release );
    printf( "version name : %s\n", sysinfo.version );
    return EXIT_SUCCESS;
  }
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno

uname in the *Utilities Reference*

ungetc()

Push a character back onto an input stream

Synopsis:

```
#include <stdio.h>

int ungetc( int c,
            FILE *fp );
```

Arguments:

c The character that you want to push back.

fp The stream you want to push the character back on.

Library:

libc

Description:

The *ungetc()* function pushes the character specified by *c* back onto the input stream pointed to by *fp*. This character will be returned the next time that you read from the stream. The pushed-back character is discarded if you call *fflush()* or a file-positioning function (*fseek()*, *fsetpos()*, or *rewind()*) before performing the next read operation.

Only one character (the most recent one) of pushback is guaranteed.

The *ungetc()* function clears the end-of-file indicator, unless the value of *c* is EOF.

Returns:

The character pushed back.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>

int main( void )
  {
    FILE *fp;
```

```
  int c;
  long value;

  fp = fopen( "file", "r" );
  value = 0;
  c = fgetc( fp );
  while( isdigit(c) ) {
    value = value*10 + c - '0';
    c = fgetc( fp );
  }
  ungetc( c, fp ); /* put last character back */
  printf( "Value=%ld\n", value );
  fclose( fp );
  return EXIT_SUCCESS;
}
```

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fopen(), *getc()*, *getc_unlocked()*, *ungetwc()*

ungetwc()

Push a wide character back onto an input stream

Synopsis:

```
#include <wchar.h>

wint_t ungetwc( wint_t wc,
                FILE * fp );
```

Arguments:

c The wide character that you want to push back.

fp The stream you want to push the wide character back on.

Library:

libc

Description:

The *ungetwc()* function pushes the wide character specified by *wc* back onto the input stream pointed to by *fp*.

The pushed-back character will be returned the next time that you read from the stream but is discarded if you call *fflush()* or a file-positioning function (*fseek()*, *fsetpos()*, or *rewind()*) before the next read operation is performed.

Only one character (the most recent one) of pushback is guaranteed.

The *ungetwc()* function clears the end-of-file indicator, unless the value of *wc* is WEOF.

Returns:

The character pushed back.

Errors:

EILSEQ Invalid character sequence or wide character.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fopen(), *getwc()*, *ungetc()*

Synopsis:

```
#include <sys/socket.h>
#include <sys/un.h>

socket( AF_LOCAL,
        SOCK_STREAM,
        0 );

socket( AF_LOCAL,
        SOCK_DGRAM,
        0 );
```

Description:

The UNIX-domain protocol family provides local (on-machine or QNX-network) interprocess communication through the normal *socket()* mechanisms. The UNIX-domain family supports the SOCK_STREAM and SOCK_DGRAM socket types and uses filesystem pathnames for addressing.

Addressing

UNIX-domain addresses are variable-length filesystem pathnames of at most 104 characters. The **<sys/un.h>** include file defines this address:

```
struct sockaddr_un {
    u_char  sun_len;
    u_char  sun_family;
    char    sun_path[104];
};
```

Binding a name to a UNIX-domain socket with *bind()* causes a socket file to be created in the filesystem. This file isn't removed when the socket is closed; you must use *unlink()* to remove the file.

You can use the macro *SUN_LEN()* (defined in **<sys/un.h>**) to calculate the length of UNIX-domain address, required by *bind()* and *connect()*. The *sun_path* field must be terminated by a NUL character

to be used with *SUN_LEN()*, but the terminating NUL isn't part of the address.

The UNIX-domain protocol family doesn't support broadcast addressing or any form of "wildcard" matching on incoming messages. All addresses are absolute- or relative-pathnames of other UNIX-domain sockets. Normal filesystem access-control mechanisms are also applied when referencing pathnames (e.g. the destination of a *connect()* or *sendto()* must be writable).

Protocols

The UNIX-domain protocol family consists of simple transport protocols that support the SOCK_STREAM and SOCK_DGRAM abstractions. UNIX-domain sockets also support the communication of QNX file descriptors through the use of the *msg_control* field in the *msg* argument to *sendmsg()* and *recvmsg()*.

Any valid descriptor may be sent in a message. The file descriptor to be passed is described using a **`struct cmsghdr`** defined in the include file **`<sys/socket.h>`**. The type of the message is SCM_RIGHTS, and the data portion of the messages is an array of integers representing the file descriptors to be passed. The number of descriptors being passed is defined by the length field of the message; the length field is the sum of the size of the header plus the size of the array of file descriptors.

The received descriptor is a duplicate of the sender's descriptor, as if it were created with a call to *dup()*. Descriptors awaiting delivery or purposely not received are automatically closed by the system when the destination socket is closed.

LOCAL_CREDS

There is one socket-level option for *setsockopt()* and *getsockopt()* available in the UNIX-domain. The LOCAL_CREDS option may be enabled on a SOCK_DGRAM or a SOCK_STREAM socket. This option provides a mechanism for the receiver to receive the credentials of the process as a *recvmsg()* message. The *msg_control* field in the **`msghdr`** structure points to a buffer that contains a **`cmsghdr`** structure

followed by a variable length **sockcred** structure defined in **<sys/socket.h>** as follows:

```
struct sockcred {
    uid_t   sc_uid;         /* real user id */
    uid_t   sc_euid;        /* effective user id */
    gid_t   sc_gid;         /* real group id */
    gid_t   sc_egid;        /* effective group id */
    int     sc_ngroups;     /* number of supplemental groups */
    gid_t   sc_groups[1];   /* variable length */
};
```

The *SOCKCREDSIZE()* macro computes the size of the **sockcred** structure for a specified number of groups. The **cmsghdr** fields have the following values:

```
cmsg_len = sizeof(struct cmsghdr) + SOCKCREDSIZE(ngroups)
cmsg_level = SOL_SOCKET
cmsg_type = SCM_CREDS
```

See also:

bind(), connect(), dup(), getsockopt(), recvmsg(), sendmsg(), sendto(), setsockopt(), socket(), unlink()

unlink()

Remove a link to a file

Synopsis:

```
#include <unistd.h>

int unlink( const char * path );
```

Arguments:

path The name of the file that you want to unlink.

Library:

libc

Description:

The *unlink()* function removes a link to a file:

- If the *path* names a symbolic link, *unlink()* removes the link, but doesn't affect the file or directory that the link goes to.
- If the *path* isn't a symbolic link, *unlink()* removes the link and decrements the link count of the file that the link refers to.

  If the link count of the file becomes zero, and no process has the file open, then the space that the file occupies is freed, and no one can access the file anymore.

  If one or more processes have the file open when the last link is removed, the link is removed, but the removal of the file is delayed until all references to it have been closed.

This function is equivalent to *remove()*.

To remove a directory, call *rmdir()*.

Returns:

0	The operation was successful.
Nonzero	The operation failed (*errno* is set).

Errors:

EACCES	Search permission is denied for a component of *path*, or write permission is denied on the directory containing the link to be removed.
EBUSY	The directory named by *path* cannot be unlinked because it's being used by the system or another process, and the target filesystem or resource manager considers this to be an error.
ENAMETOOLONG	The *path* argument exceeds PATH_MAX in length, or a pathname component is longer than NAME_MAX.
ENOENT	The named file doesn't exist, or *path* is an empty string.
ENOSYS	The *unlink()* function isn't implemented for the filesystem specified by *path*.
ENOTDIR	A component of *path* isn't a directory.
EPERM	The file named by *path* is a directory, and either the calling process doesn't have the appropriate privileges, or the target filesystem or resource manager prohibits using *unlink()* on directories.
EROFS	The directory entry to be unlinked resides on a read-only filesystem.

Examples:

```
#include <unistd.h>
#include <stdlib.h>

int main( void )
{
    if( unlink( "vm.tmp" ) ) {
        puts( "Error removing vm.tmp!" );
        return EXIT_FAILURE;
    }

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

chdir(), chmod(), close(), errno, getcwd(), link(), mkdir(), open(), pathmgr_symlink(), pathmgr_unlink(), remove(), rename(), rmdir(), stat(), symlink()

unsetenv()

Remove an environment variable

Synopsis:

```
#include <stdlib.h>

void unsetenv( const char* name );
```

Arguments:

name The name of the environment variable that you want to delete.

Library:

libc

Description:

The *unsetenv()* function removes the environment variable named *name* from the process's environment.

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

The *unsetenv()* function manipulates the environment pointed to by the global *environ* variable.

See also:

clearenv(), getenv(), putenv(), setenv()

usleep()

Suspend a thread for a given number of microseconds

Synopsis:

```
#include <unistd.h>

int usleep( useconds_t useconds );
```

Arguments:

useconds The number of microseconds that you want to process to sleep for. This must be less than 1,000,000.

Library:

libc

Description:

The *usleep()* function suspends the calling thread until *useconds* microseconds of realtime have elapsed, or until a signal that isn't ignored is received. The time spent suspended could be longer than the requested amount due to the scheduling of other, higher-priority threads.

If *useconds* is `0`, *usleep()* has no effect.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EAGAIN No timer resources are available to satisfy the request.

EINVAL The *useconds* argument is too large.

Examples:

```
/*
 * The following program sleeps for the
 * number of microseconds specified in argv[1].
 */
#include <stdlib.h>
#include <unistd.h>

int main( int argc, char **argv )
{
    useconds_t microseconds;

    microseconds = (useconds_t)strtol( argv[1], NULL, 0 );
    if( usleep( microseconds ) == 0 ) {
        return EXIT_SUCCESS;
    }

    return EXIT_FAILURE;
}
```

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

alarm(), *nanosleep()*, *sigaction()*, *sleep()*, *timer_create()*, *timer_delete()*, *timer_getoverrun()*, *timer_gettime()*, *timer_settime()*, *ualarm()*

Record the modification time for a file or directory

Synopsis:

```
#include <sys/types.h>
#include <utime.h>

struct utimbuf {
    time_t   actime;    /* access time */
    time_t   modtime;   /* modification time */
};

int utime( const char* path,
           const struct utimbuf* times );
```

Arguments:

path The path name for the file whose modification time you want to get or set.

times NULL, or a pointer to a **utimbuf** structure where the function can store the modification time.

Library:

libc

Description:

The *utime()* function records the modification time for the file or directory identified by *path*.

If the *times* argument is NULL, the access and modification times of the file or directory are set to the current time. The effective user ID of the process must match the owner of the file or directory, or the process must have write permission to the file or directory, or appropriate privileges in order to use the *utime()* function in this way.

If the *times* argument isn't NULL, its interpreted as a pointer to a **utimbuf** structure, and the access and modification times of the file or directory are set to the values contained in the designated structure. Only the owner of the file or directory, and processes with appropriate

privileges are permitted to use the *utime()* function in this way. The access and modification times are taken from the *actime* and *modtime* fields in this structure.

Returns:

0 Success.

-1 An error occurred; *errno* is set.

Errors:

EACCES Search permission is denied for a component of *path*, or the *times* argument is NULL, and the effective user ID of the process doesn't match the owner of the file, and write access is denied.

ENAMETOOLONG
The argument *path* exceeds PATH_MAX in length, or a pathname component is longer than NAME_MAX.

ENOENT The specified *path* doesn't exist, or *path* is an empty string.

ENOTDIR A component of *path* isn't a directory.

EPERM The *times* argument isn't NULL, and the calling process's effective user ID has write access to the file but doesn't match the owner of the file, and the calling process doesn't have the appropriate privileges.

EROFS The named file resides on a read-only filesystem.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <utime.h>

int main( int argc, char *argv[] )
  {
    if( (utime( argv[1], NULL ) != 0) && (argc > 1) ) {
```

```
        printf( "Unable to set time for %s\n", argv[1] );
    }
    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *futime()*

utimes()

Set a file's access and modification times

Synopsis:

```
#include <sys/time.h>

int utimes( const char * __path,
            const struct timeval * __times );
```

Arguments:

__path The name of the files whose times you want to set.

__times NULL, or an array of **timeval** structures:

- The first array member represents the date and time of last access.
- The second member represents the date and time of last modification.

Library:

libc

Description:

The *utimes()* function sets the access and modification times of the file pointed to by the *__path* argument to the value of the *__times* argument. This function allows time specifications accurate to the microsecond.

The times in the **timeval** structure are measured in seconds and microseconds since the Unix Epoch (00:00:00 January 1, 1970 Coordinated Universal Time (UTC)), although rounding toward the nearest second may occur.

If the *__times* argument is NULL, the access and modification times of the file are set to the current time. The effective user ID of the process must be the same as the owner of the file, or must have write access to the file or superuser privileges to use this call in this manner. On completion, *utimes()* marks the time of the last file status change, *st_ctime*, for update.

Returns:

0 Success.

-1 An error occurred (*errno* is set).

Errors:

EACCES Search permission is denied by a component of the path prefix; or the *__times* argument is NULL and the effective user ID of the process doesn't match the owner of the file and write access is denied.

EFAULT The *__path* or *__times* argument points to an illegal address.

EINTR A signal was caught during the *utimes()* function.

EINVAL The number of microseconds specified in one or both of the **timeval** structures pointed to by *__times* was greater than or equal to 1,000,000 or less than 0.

EIO An I/O error occurred while reading from or writing to the filesystem.

ELOOP Too many symbolic links were encountered in resolving *__path*.

EMULTIHOP Components of *__path* require hopping to multiple remote machines and the filesystem doesn't allow it.

ENAMETOOLONG

The length of the *__path* argument exceeds PATH_MAX or a pathname component is longer than NAME_MAX.

ENOLINK The *__path* argument points to a remote machine and the link to that machine is no longer active.

ENOENT	A component of *__path* doesn't name an existing file or *__path* is an empty string.
ENOTDIR	A component of the path prefix isn't a directory.
EPERM	The *__times* argument isn't NULL and the calling process's effective user ID has write access to the file but doesn't match the owner of the file, and the calling process doesn't have the appropriate privileges.
EROFS	The filesystem containing the file is read-only.
ENAMETOOLONG	Path name resolution of a symbolic link produced an intermediate result whose length exceeds PATH_MAX.

Classification:

Legacy Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

stat()

Synopsis:

```
struct utmp {
    char    ut_user[UT_NAMESIZE];
#define ut_name ut_user
    char    ut_id[4];
    char    ut_line[UT_LINESIZE];
    pid_t   ut_pid;
    short   ut_type;
    struct exit_status {
        short   e_termination;
        short   e_exit;
    } ut_exit;
    short   ut_spare;
    time_t  ut_time;
};
```

Description:

The **utmp** structure describes an entry in a user-information file. The members include:

ut_user The user's login name.

ut_id The line number.

ut_line The device name (console).

ut_pid The process ID.

ut_type The type of entry. The possible values are:

- EMPTY
- RUN_LVL
- BOOT_TIME
- OLD_TIME
- NEW_TIME
- INIT_PROCESS
- LOGIN_PROCESS

- USER_PROCESS
- DEAD_PROCESS
- ACCOUNTING

ut_exit The exit status of a process marked as DEAD_PROCESS. The structure **exit_status** includes at least the following members:

- *e_termination* — the termination status.
- *e_exit* — the exit status.

ut_time The time that this entry was made.

Classification:

Unix

See also:

endutent(), *getutent()*, *getutid()*, *getutline()*, *pututline()*, *setutent()*, *utmpname()*

login in the *Utilities Reference*

utmpname()

Change the name of the user-information file

Synopsis:

```
#include <utmp.h>

void utmpname( char * __filename );
```

Arguments:

__filename The new filename that you want to use.

Library:

libc

Description:

The *utmpname()* function lets you change the name of the file examined from the default file (*_PATH_UTMP*) to any other file. If the file doesn't exist, this won't be apparent until the first attempt to reference the file is made. This function doesn't open the file. It just closes the old file if it's currently open and saves the new file name.

Files:

_PATH_UTMP

Specifies the user information file.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

endutent(), *getutent()*, *getutid()*, *getutline()*, *pututline()*, *setutent()*, **utmp**

login in the *Utilities Reference*

Convert an unsigned integer into a string, using a given base

Synopsis:

```
#include <stdlib.h>

char* utoa( unsigned int value,
            char* buffer,
            int radix );
```

Arguments:

value The value to convert into a string.

buffer A buffer in which the function stores the string. The size of the buffer must be at least:

$$8 \times \texttt{sizeof(int)} + 1$$

bytes when converting values in base 2 (binary).

radix The base to use when converting the number.

Library:

libc

Description:

The *utoa()* function converts the unsigned binary integer *value* into the equivalent string in base *radix* notation, storing the result in the character array pointed to by *buffer*. A null character is appended to the result.

Returns:

A pointer to the result.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

int main( void )
  {
    int base;
    char buffer[18];

    for( base = 2; base <= 16; base = base + 2 )
      printf( "%2d %s\n", base,
           utoa( (unsigned) 12765, buffer, base ) );
    return EXIT_SUCCESS;
  }
```

produces the output:

```
 2 11000111011101
 4 3013131
 6 135033
 8 30735
10 12765
12 7479
14 491b
16 31dd
```

Classification:

QNX 4

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

atoi(), atol(), itoa(), ltoa(), sscanf(), strtol(), strtoul(), ultoa()

va_arg()

Get the next item in a list of variable arguments

Synopsis:

```
#include <stdarg.h>

type va_arg( va_list param,
             type );
```

Arguments:

param	The **va_list** object that you initialized with the *va_start()* macro.
type	The type of the next argument.

Library:

libc

Description:

You can use the *va_arg()* macro to get the next argument in a list of variable arguments.

CAUTION: Take special care when using varargs on some platforms; see "Varargs and coercion," below.

You must use *va_arg()* with the associated macros *va_copy()*, *va_start()* and *va_end()*. A sequence such as:

```
void example( char *dst, ... )
{
    va_list curr_arg;
    int next_arg;

    va_start( curr_arg, dst );
    next_arg = va_arg( curr_arg, int );
    .
    .
    .
```

causes *next_arg* to be assigned the value of the next variable argument. The argument *type* (which is **int** in the example) is the type of the argument originally passed to the function.

The last argument before the ellipsis (**...**) has to be an **int** or a type that doesn't change in size if cast to an **int**. If the argument is promoted, the ANSI/ISO standard says the behavior is undefined, and so depends on the compiler and the library.

You must execute the macro *va_start()* first, in order to initialize the variable *curr_arg* properly, and execute the macro *va_end()* after getting all the arguments.

The data item *curr_arg* is of type **va_list** that contains the information to permit successive acquisitions of the arguments.

The following functions use a "varargs" list:

verr()	*vscanf()*	*vsyslog()*
verrx()	*vslogf()*	*vwarn()*
vfprintf()	*vsnprintf()*	*vwarnx()*
vfscanf()	*vsprintf()*	*vwprintf()*
vfwprintf()	*vsscanf()*	*vwscanf()*
vfwscanf()	*vswprintf()*	
vprintf()	*vswscanf()*	

Varargs and coercion

On some platforms, such as PowerPC, the **va_list** type is an array; on other platforms, such as x86, it isn't. This can lead to problems.

Consider the following example. It seems correct, but on PowerPC platforms, it doesn't print **2**:

```
#include <stdio.h>
#include <stdarg.h>

void handle_foo(char *fmt, va_list *pva) {
   printf("%d\n", va_arg(*pva, int));
}

void vfoo(char *fmt, va_list va) {
```

```
   handle_foo(fmt, &va);
}

void foo(char *fmt, ...) {
   va_list va;

   va_start(va, fmt);
   vfoo(fmt, va);
   va_end(va);
}

int main() {
   foo("", 2);
   return 0;
}
```

The C standard says that prototypes such as *vfoo()* have the array type silently coerced to be a pointer to a base type. This makes things work when you pass an array object to the function. An array-typed expression is converted to a pointer to the first element when used in an rvalue context, so the coercion in the function makes everybody happy.

The problem occurs when you then pass the address of the **va_list** parameter to another function. The function expects a pointer to the array, but what it *really* gets is a pointer to a pointer (because of the original conversion). If you use the **va_list** type in the second function, you won't get the right data.

Here's the example modified so that it works in all cases:

```
#include <stdio.h>
#include <stdarg.h>

void handle_foo(char *fmt, va_list *pva) {
   printf("%d\n", va_arg(*pva, int));
}

void vfoo(char *fmt, va_list va) {
   va_list temp;

   va_copy(temp, va);
   handle_foo(fmt, &temp);
   va_end(temp);
}
```

```
void foo(char *fmt, ...) {
   va_list va;

   va_start(va, fmt);
   vfoo(fmt, va);
   va_end(va);
}

int main() {
   foo("", 2);
   return 0;
}
```

Using *va_copy()* “undoes” the coercion that happens in the parameter list, so that *handle_foo()* gets the proper data.

Returns:

The value of the next variable argument, according to type passed as the second parameter.

Examples:

```
#include <stdio.h>
#include <stdarg.h>
#include <stdlib.h>

static void test_fn( const char *msg,
                     const char *types,
                     ... );

int main( void )
  {
    printf( "VA...TEST\n" );
    test_fn( "PARAMETERS: 1, \"abc\", 546",
         "isi", 1, "abc", 546 );
    test_fn( "PARAMETERS: \"def\", 789",
         "si", "def", 789 );
    return EXIT_SUCCESS;
  }

static void test_fn(
  const char *msg,   /* message to be printed     */
  const char *types, /* parameter types (i,s)     */
  ... )          /* variable arguments     */
  {
    va_list argument;
    int   arg_int;
```

```
    char *arg_string;
    const char *types_ptr;

    types_ptr = types;
    printf( "\n%s -- %s\n", msg, types );
    va_start( argument, types );
    while( *types_ptr != '\0' ) {
      if (*types_ptr == 'i') {
        arg_int = va_arg( argument, int );
        printf( "integer: %d\n", arg_int );
      } else if (*types_ptr == 's') {
        arg_string = va_arg( argument, char * );
        printf( "string:  %s\n", arg_string );
      }
      ++types_ptr;
    }
    va_end( argument );
  }
```

produces the output:

```
VA...TEST

PARAMETERS: 1, "abc", 546 -- isi
integer: 1
string:  abc
integer: 546

PARAMETERS: "def", 789 -- si
string:  def
integer: 789
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

va_arg() is a macro.

See also:

va_copy(), *va_end()*, *va_start()*

va_copy()

Make a copy of a variable argument list

Synopsis:

```
#include <stdarg.h>

void va_copy( va_list d,
              va_list s );
```

Arguments:

d A **va_list** object into which you want to copy the list.

s The **va_list** object that you initialized with the *va_start()* macro and that you want to copy.

Library:

libc

Description:

The *va_copy()* macro creates a copy of a list of variable arguments.

You can use the *va_copy()* macro with the associated macros *va_arg()*, *va_start()*, and *va_end()*, especially to avoid problems on some platforms. For more information, see "Varargs and coercion" in the documentation for *va_arg()*.

Examples:

See *va_arg()*.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

Caveats:

va_copy() is a macro.

See also:

va_arg(), *va_end()*, *va_start()*

va_end()

Finish getting items from a variable argument list

Synopsis:

```
#include <stdarg.h>

void va_end( va_list param );
```

Arguments:

param The **va_list** object that you initialized with the *va_start()* macro.

Library:

libc

Description:

Use the *va_end()* macro to complete the acquisition of arguments from a list of variable arguments. You must use it with the associated macros *va_copy()*, *va_start()*, and *va_arg()*. For more information, see *va_arg()*.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

va_end() is a macro.

See also:

va_arg(), *va_copy()*, *va_start()*

va_start()

Start getting items from a variable argument list

Synopsis:

```
#include <stdarg.h>

void va_start( va_list param,
               previous );
```

Arguments:

param	A **va_list** object that the "varargs" macros can use to locate the arguments.
previous	The argument that immediately precedes the **"..."** notation in the original function definition.

Library:

libc

Description:

Use the *va_start()* macro to start the acquisition of arguments from a list of variable arguments.

You must use the *va_start()* macro with the associated macros *va_arg()*, *va_copy()*, and *va_end()*. For each call to *va_start()*, you must have a matching call to *va_end()*. For more information, see *va_arg()*.

Examples:

See *va_arg()*.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

Caveats:

va_start() is a macro.

See also:

va_arg(), *va_copy()*, *va_end()*

valloc()

Allocate a heap block aligned on a page boundary

Synopsis:

```
#include <stdarg.h>

void * valloc( size_t size);
```

Arguments:

size The size of the block to allocate, in bytes.

Library:

libc

Description:

The *valloc()* function allocates a heap block that's aligned on a page boundary. It's equivalent to:

```
memalign( sysconf( _SC_PAGESIZE ), size );
```

Returns:

See *memalign()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

memalign(), sysconf()

verr(), *verrx()*

Display a formatted error message, and then exit (varargs)

Synopsis:

```
#include <err.h>

void verr( int eval,
           const char *fmt,
           va_list args );

void verrx( int eval,
            const char *fmt,
            va_list args );
```

Arguments:

eval	The value to use as the exit code of the process.
fmt	NULL, or a *printf()*-style string used to format the message.
args	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *err()* and *warn()* family of functions display a formatted error message on *stderr*. For a comparison of the members of this family, see *err()*.

The *verr()* function produces a message that consists of:

- the last component of the program name, followed by a colon and a space
- the formatted message, followed by a colon and a space, if the *fmt* argument isn't NULL
- the string associated with the current value of *errno*
- a newline character.

The *verrx()* function produces a similar message, except that it doesn't include the string associated with *errno*. The message consists of:

- the last component of the program name, followed by a colon and a space
- the formatted message, if the *fmt* argument isn't NULL
- a newline character.

The *verr()* and *verrx()* functions don't return, but exit with the value of the argument *eval*.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

err(), errx(), stderr, strerror(), vwarn(), vwarnx(), warn(), warnx()

vfork()

Spawn a new process and block the parent

Synopsis:

```
#include <process.h>

pid_t  vfork( void );
```

Library:

libc

Description:

This function spawns a new process and blocks the parent until the child process calls *execve()* or exits (by calling *_exit()* or abnormally).

Returns:

A value of zero to the child process, and (later) the child's process ID in the parent. If an error occurs, no child process is created, and the function returns -1 and sets *errno*.

Errors:

EAGAIN	The system-imposed limit on the total number of processes under execution would be exceeded. This limit is determined when the system is generated.
ENOMEM	There isn't enough memory for the new process.

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	No

Caveats:

To avoid a possible deadlock situation, processes that are children in the middle of a *vfork()* are never sent SIGTTOU or SIGTTIN signals; rather, output or ioctls are allowed and input attempts result in an EOF indication.

See also:

execve(), _exit(), fork(), ioctl(), sigaction(), wait()

vfprintf()

Write formatted output to a file (varargs)

Synopsis:

```
#include <stdio.h>
#include <stdarg.h>

int vfprintf( FILE* fp,
              const char* format,
              va_list arg );
```

Arguments:

fp	The stream to which you want to send the output.
format	A string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vfprintf()* function writes output to the file pointed to by *fp*, under control of the argument *format*.

The *vfprintf()* function is a "varargs" version of *fprintf()*.

Returns:

The number of characters written, or a negative value if an output error occurred (*errno* is set).

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <stdarg.h>
```

```
FILE *LogFile;

/* a general error routine */

void errmsg( char *format, ... )
  {
    va_list arglist;

    fprintf( stderr, "Error: " );
    va_start( arglist, format );
    vfprintf( stderr, format, arglist );
    va_end( arglist );
    if( LogFile != NULL ) {
      fprintf( LogFile, "Error: " );
      va_start( arglist, format );
      vfprintf( LogFile, format, arglist );
      va_end( arglist );
    }
  }

int main( void )
  {
    LogFile = fopen( "error.log", "w" );
    errmsg( "%s %d %s", "Failed", 100, "times" );
    return EXIT_SUCCESS;
  }
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fprintf(), fwprintf(), printf(), snprintf(), sprintf(), swprintf(), va_start(), vfwprintf(), vprintf(), vsnprintf(), vsprintf(), vswprintf(), vwprintf(), wprintf()

vfscanf()

Scan input from a file (varargs)

Synopsis:

```
#include <stdio.h>
#include <stdarg.h>

int vfscanf( FILE *fp,
             const char *format,
             va_list arg );
```

Arguments:

fp	The stream that you want to read from.
format	A string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vfscanf()* function scans input from the file designated by *fp*, under control of the argument *format*.

The *vfscanf()* function is a "varargs" version of *fscanf()*.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF when the scanning is stopped by reaching the end of the input stream before storing any values.

Errors:

If an error occurs, *errno* indicates the type of error.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <stdarg.h>

void ffind( FILE *fp, char *format, ... )
  {
    va_list arglist;

    va_start( arglist, format );
    vfscanf( fp, format, arglist );
    va_end( arglist );
  }

int main( void )
  {
    int day, year;
    char weekday[10], month[12];

    ffind( stdin,
        "%s %s %d %d",
        weekday, month, &day, &year );
    printf( "\n%s, %s %d, %d\n",
        weekday, month, day, year );
    return EXIT_SUCCESS;
  }
```

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fscanf(), fwscanf(), scanf(), sscanf(), swscanf(), va_start(), vfwscanf(), vscanf(), vsscanf(), vswscanf(), vwscanf(), wscanf()

vfwprintf()

Write formatted wide-character output to a file (varargs)

Synopsis:

```
#include <wchar.h>
#include <stdarg.h>

int vfwprintf( FILE * fp,
               const wchar_t * format,
               va_list arg );
```

Arguments:

fp	The stream to which you want to send the output.
format	A wide-character string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vfwprintf()* function writes output to the file pointed to by *fp*, under control of the argument *format*.

The *vfwprint()* function is the wide-character version of *vfprintf()*, and is a “varargs” version of *fwprintf()*.

Returns:

The number of wide characters written, excluding the terminating **NUL**, or a negative number if an error occurred (*errno* is set).

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fprintf(), fwprintf(), printf(), snprintf(), sprintf(), swprintf(), va_start(), vfprintf(), vprintf(), vsnprintf(), vsprintf(), vswprintf(), vwprintf(), wprintf()

vfwscanf()

Scan input from a file (varargs)

Synopsis:

```
#include <wchar.h>
#include <stdarg.h>

int vfwscanf( FILE * fp,
              const wchar_t *format,
              va_list arg );
```

Arguments:

fp	The stream that you want to read from.
format	A wide-character string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vfwscanf()* function scans input from the file designated by *fp*, under control of the argument *format*.

The *vfwscanf()* function is the wide-character version of *vfscanf()*, and is a “varargs” version of *fwscanf()*.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF if the scanning reached the end of the input stream before storing any values.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fscanf(), fwscanf(), scanf(), sscanf(), swscanf(), va_start(), vfscanf(), vscanf(), vsscanf(), vswscanf(), vwscanf(), wscanf()

vprintf()

Write formatted output to standard output (varargs)

Synopsis:

```
#include <stdio.h>
#include <stdarg.h>

int vprintf( const char* format,
             va_list arg );
```

Arguments:

format	A string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vprintf()* function writes output to the file *stdout*, under control of the argument *format*.

The *vprintf()* function is a "varargs" version of *printf()*.

Returns:

The number of characters written, or a negative value if an output error occurred (*errno* is set).

Examples:

Use *vprintf()* in a general error message routine:

```
#include <stdio.h>
#include <stdlib.h>
#include <stdarg.h>
```

```
void errmsg( char* format, ... )
  {
    va_list arglist;

    printf( "Error: " );
    va_start( arglist, format );
    vprintf( format, arglist );
    va_end( arglist );
  }

int main( void )
  {
    errmsg( "%s %d %s", "Failed", 100, "times" );
    return EXIT_SUCCESS;
  }
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, *fprintf()*, *fwprintf()*, *printf()*, *snprintf()*, *sprintf()*, *swprintf()*, *va_start() vfprintf()*, *vfwprintf()*, *vsnprintf()*, *vsprintf()*, *vswprintf()*, *vwprintf()*, *wprintf() vsprintf()*

vscanf()

Scan input from standard input (varargs)

Synopsis:

```
#include <stdio.h>
#include <stdarg.h>

int vscanf( const char * format,
            va_list args );
```

Arguments:

format	A string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.
args	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vscanf()* function scans input from *stdin*, under control of the argument *format*. For information about the *format* string, see the description of *scanf()*.

The *vscanf()* function is a "varargs" version of *scanf()*.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF when the scanning is stopped by reaching the end of the input stream before storing any values.

Errors:

If an error occurs, *errno* indicates the type of error.

Examples:

```
#include <stdio.h>
#include <stdlib.h>
#include <stdarg.h>

void find( char *format, ... )
  {
    va_list arglist;

    va_start( arglist, format );
    vscanf( format, arglist );
    va_end( arglist );
  }

int main( void )
  {
    int day, year;
    char weekday[10], month[12];

    ffind( "%s %s %d %d",
        weekday, month, &day, &year );
    printf( "\n%s, %s %d, %d\n",
        weekday, month, day, year );
    return EXIT_SUCCESS;
  }
```

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fscanf(), fwscanf(), scanf(), sscanf(), swscanf(), va_start(), vfscanf(), vfwscanf(), vsscanf(), vswscanf(), vwscanf(), wscanf()

vslogf()

Send a message to the system logger (varargs)

Synopsis:

```
#include <stdio.h>
#include <sys/slog.h>

int vslogf( int opcode,
            int severity,
            const char * fmt,
            va_list arg );
```

Arguments:

opcode — A combination of a *major* and *minor* code. Create the *opcode* using the **_SLOG_SETCODE(***major***,** *minor***)** macro that's defined in **<sys/slog.h>**.

The *major* and *minor* codes are defined in **<sys/slogcodes.h>**.

severity — The severity of the log message; see "Severity levels," in the documentation for *slogf()*.

fmt — A standard *printf()* string.

arg — A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *slog*()* functions send log messages to the system logger, **slogger**. To send formatted messages, use *vslogf()*. If you have programs that scan log files for specified codes, you can use *slogb()* or *slogi()* to send a block of structures or **int**'s, respectively.

This function is a "varargs" version of *slogf()*.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

slogb(), slogi(), slogf()

`slogger`, **`sloginfo`** in the *Utilities Reference*

vsnprintf()

Write formatted output to a character array, up to a given maximum number of characters (varargs)

Synopsis:

```
#include <stdarg.h>
#include <stdio.h>

int vsnprintf( char* buf,
               size_t count,
               const char* format,
               va_list arg );
```

Arguments:

buf	A pointer to the buffer where you want to function to store the formatted string.
count	The maximum number of characters to store in the buffer, including a terminating null character.
format	A string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vsnprintf()* function formats data under control of the *format* control string and stores the result in *buf*. The maximum number of characters to store, including a terminating null character, is specified by *count*.

The *vsnprintf()* function is a “varargs” version of *snprintf()*.

Returns:

The number of characters that would have been written into the array, not counting the terminating null character, had *count* been large enough. It does this even if *count* is zero; in this case *buf* can be NULL.

If an error occurred, *vsnprintf()* returns a negative value and sets *errno*.

Examples:

Use *vsnprintf()* in a general error message routine:

```
#include <stdio.h>
#include <stdarg.h>
#include <string.h>

char msgbuf[80];

char *fmtmsg( char *format, ... )
{
    va_list arglist;

    va_start( arglist, format );
    strcpy( msgbuf, "Error: " );
    vsnprintf( &msgbuf[7], 80-7, format, arglist );
    va_end( arglist );
    return( msgbuf );
}

int main( void )
{
    char *msg;

    msg = fmtmsg( "%s %d %s", "Failed", 100, "times" );
    printf( "%s\n", msg );

    return 0;
}
```

Classification:

Standard Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Read the *Caveats*
Thread	Yes

Caveats:

It's safe to call *vsnprintf()* in a signal handler if the data isn't floating point.

See also:

errno, *fprintf()*, *fwprintf()*, *printf()*, *snprintf()*, *sprintf()*, *swprintf()*, *va_start()*, *vfprintf()*, *vfwprintf()*, *vprintf()*, *vsprintf()*, *vswprintf()*, *vwprintf()*, *wprintf()*

vsprintf()

Write formatted output to a buffer (varargs)

Synopsis:

```
#include <stdio.h>
#include <stdarg.h>

int vsprintf( char* buf,
              const char* format,
              va_list arg );
```

Arguments:

buf	A pointer to the buffer where you want to function to store the formatted string.
format	A string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vsprintf()* function formats data under control of the *format* control string, and writes the result to *buf*.

The *vsprintf()* function is a “varargs” version of *sprintf()*.

Returns:

The number of characters written, or a negative value if an output error occurred (*errno* is set).

Examples:

Use *vsprintf()* in a general error message routine:

```
#include <stdio.h>
#include <stdarg.h>
#include <stdlib.h>
#include <string.h>

char msgbuf[80];

char *fmtmsg( char *format, ... )
  {
    va_list arglist;

    va_start( arglist, format );
    strcpy( msgbuf, "Error: " );
    vsprintf( &msgbuf[7], format, arglist );
    va_end( arglist );
    return( msgbuf );
  }

int main( void )
  {
    char *msg;

    msg = fmtmsg( "%s %d %s", "Failed", 100, "times" );
    printf( "%s\n", msg );
    return EXIT_SUCCESS;
  }
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Read the *Caveats*
Thread	Yes

Caveats:

It's safe to call *vsprintf()* in a signal handler if the data isn't floating point.

See also:

fprintf(), *fwprintf()*, *printf()*, *snprintf()*, *sprintf()*, *swprintf()*, *va_start()*, *vfprintf()*, *vfwprintf()*, *vprintf()*, *vsnprintf()*, *vswprintf()*, *vwprintf()*, *wprintf()*

Synopsis:

```
#include <stdio.h>
#include <stdarg.h>

int vsscanf( const char* in_string,
             const char* format,
             va_list arg );
```

Arguments:

in_string	The string that you want to read from.
format	A string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vsscanf()* function scans input from the string designated by *in_string*, under control of the argument *format*.

The *vsscanf()* function is a "varargs" version of *sscanf()*.

Returns:

The number of input arguments for which values were successfully scanned and stored is returned, or EOF when the scanning is terminated by reaching the end of the input string.

Examples:

```
#include <stdio.h>
#include <stdarg.h>
#include <stdlib.h>

void sfind( char* string, char* format, ... )
  {
    va_list arglist;

    va_start( arglist, format );
    vsscanf( string, format, arglist );
    va_end( arglist );
  }

int main( void )
  {
    int day, year;
    char weekday[10], month[12];

    sfind( "Monday June 28 1999",
        "%s %s %d %d",
        weekday, month, &day, &year );
    printf( "\n%s, %s %d, %d\n",
        weekday, month, day, year );
    return EXIT_SUCCESS;
  }
```

Classification:

Unix

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Read the *Caveats*
Thread	Yes

Caveats:

It's safe to call *vsscanf()* in a signal handler if the data isn't floating point.

See also:

fscanf(), fwscanf(), scanf(), sscanf(), swscanf(), va_start(), vfscanf(), vfwscanf(), vscanf(), vswscanf(), vwscanf(), wscanf()

vswprintf()

Write wide-character formatted output to a buffer (varargs)

Synopsis:

```
#include <wchar.h>
#include <stdarg.h>

int vswprintf( wchar_t * buf,
               size_t n,
               const wchar_t * format,
               va_list arg );
```

Arguments:

buf	A pointer to the buffer where you want to function to store the formatted string.
n	The maximum number of wide characters to store in the buffer, including a terminating null character.
format	A wide-character string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vswprintf()* function formats data under control of the *format* control string, and writes the result to *buf*.

The *vswprint()* function is the wide-character version of *vsprintf()*, and is a “varargs” version of *swprintf()*.

Returns:

The number of wide characters written, excluding the terminating **NUL**, or a negative number if an error occurred (*errno* is set).

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Read the *Caveats*
Thread	Yes

Caveats:

It's safe to call *vswprintf()* in a signal handler if the data isn't floating point.

See also:

fprintf(), fwprintf(), printf(), snprintf(), sprintf(), swprintf(), va_start(), vfprintf(), vfwprintf(), vprintf(), vsnprintf(), vsprintf(), vwprintf(), wprintf()

vswscanf()

Scan input from a wide-character string (varargs)

Synopsis:

```
#include <wchar.h>
#include <stdarg.h>

int vswscanf( const wchar_t * ws,
              const wchar_t * format,
              va_list arg );
```

Arguments:

ws	The wide-character string that you want to read from.
format	A wide-character string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.
arg	A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vswscanf()* function scans input from the string designated by *ws*, under control of the argument *format*.

The *vswscanf()* function is the wide-character version of *vsscanf()*, and is a "varargs" version of *swscanf()*.

Returns:

The number of input arguments for which values were successfully scanned and stored is returned, or EOF when the scanning is terminated by reaching the end of the input string.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Read the *Caveats*
Thread	Yes

Caveats:

It's safe to call *vswscanf()* in a signal handler if the data isn't floating point.

See also:

fscanf(), *fwscanf()*, *scanf()*, *sscanf()*, *swscanf()*, *va_start()*, *vfscanf()*, *vfwscanf()*, *vscanf()*, *vsscanf()*, *vwscanf()*, *wscanf()*

vsyslog()

Control system log (varargs)

Synopsis:

```
#include <syslog.h>
#include <stdarg.h>

void vsyslog( int priority,
              const char *message,
              va_list args );
```

Arguments:

priority The priority of the message; see "Message levels," in the documentation for *syslog()*.

message The message that you want to write. This message is identical to a *printf()*-format string, except that `%m` is replaced by the current error message (as denoted by the global variable *errno*). A trailing newline is added if none is present.

args A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vsyslog()* function writes *message* to the system message logger. The message is then written to the system console, log files, and logged-in users, or forwarded to other machines as appropriate. (See the **syslogd** command.)

This function is a "varargs" version of *syslog()*.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	No

See also:

closelog(), *openlog()*, *setlogmask()*, *syslog()*

`logger`, **`syslogd`** in the *Utilities Reference*

vwarn(), *vwarnx()*

Formatted error message (varargs)

Synopsis:

```
#include <err.h>

void vwarn( const char *fmt,
            va_list args );

void vwarnx( const char *fmt,
             va_list args );
```

Arguments:

fmt NULL, or a *printf()*-style string used to format the message.

args A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *err()* and *warn()* family of functions display a formatted error message on *stderr*. For a comparison of the members of this family, see *err()*.

The *vwarn()* function produces a message that consists of:

- the last component of the program name, followed by a colon and a space
- the formatted message, followed by a colon and a space, if the *fmt* argument isn't NULL
- the string associated with the current value of *errno*
- a newline character.

The *vwarnx()* function produces a similar message, except that it doesn't include the string associated with *errno*. The message consists of:

- the last component of the program name, followed by a colon and a space
- the formatted message, if the *fmt* argument isn't NULL
- a newline character.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

err(), errx(), stderr, strerror(), verr(), verrx(), warn(), warnx()

vwprintf()

Write formatted output to standard output (varargs)

Synopsis:

```
#include <wchar.h>
#include <stdarg.h>

int vwprintf( const wchar_t * format,
              va_list arg );
```

Arguments:

format A wide-character string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.

arg A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vwprintf()* function writes output to the file *stdout*, under control of the argument *format*.

The *vwprint()* function is the wide-character version of *vprintf()*, and is a "varargs" version of *wprintf()*.

Returns:

The number of characters written, or a negative value if an output error occurred (*errno* is set).

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, fprintf(), fwprintf(), printf(), snprintf(), sprintf(), swprintf(), va_start(), vfprintf(), vfwprintf(), vprintf(), vsnprintf(), vsprintf(), vswprintf(), wprintf()

vwscanf()

Scan wide-character input from standard input (varargs)

Synopsis:

```
#include <wchar.h>
#include <stdarg.h>

int vwscanf( const wchar_t * format,
             va_list arg );
```

Arguments:

format A wide-character string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.

arg A variable-argument list of the additional arguments, which you must have initialized with the *va_start()* macro.

Library:

libc

Description:

The *vwscanf()* function scans input from the file designated by *stdin*, under control of the argument *format*.

The *vwscanf()* function is the wide-character version of *vscanf()*, and is a "varargs" version of *wscanf()*.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF if the scanning reached the end of the input stream before storing any values.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

fscanf(), fwscanf(), scanf(), sscanf(), swscanf(), va_start(), vfscanf(), vfwscanf(), vscanf(), vsscanf(), vswscanf(), wscanf()

wait()

Wait for the status of a terminated child process

Synopsis:

```
#include <sys/types.h>
#include <sys/wait.h>

pid_t wait( int * stat_loc );
```

Arguments:

stat_loc NULL, or a pointer to a location where the function can store the terminating status of the child. For more information, see "Status macros," below.

Library:

libc

Description:

The *wait()* function suspends execution of the calling process until status information from one of its terminated child processes is available, or until the delivery of a signal whose action is either to terminate the process or execute a signal handler. If status information is available prior to the call to *wait()*, the return is immediate.

Status macros

If the *stat_loc* variable is non-NULL, the terminating status of the child process is in the location that it points to. The macros listed below, defined in **<sys/wait.h>**, extract information from *stat_loc*. The *stat_val* argument to these macros is the integer value pointed to by *stat_loc*.

POSIX defines the following macros:

WEXITSTATUS(*stat_val*)

Evaluates to the low-order 8 bits of the termination status of the child process if the value of *WIFEXITED*(*stat_val*) is nonzero.

WIFCONTINUED(*stat_val*)

Evaluates to a nonzero value if the status returned was from a child process that has continued from a job control stop.

WIFEXITED(*stat_val*)

Evaluates to a nonzero value if the status returned was from a normally terminated child process.

WIFSIGNALED(*stat_val*)

Evaluates to nonzero value if the child process terminated from reception of a signal that wasn't caught.

WIFSTOPPED(*stat_val*)

Evaluates to a nonzero value if the status returned is for a child process that's stopped.

WSTOPSIG(*stat_val*)

Evaluates to the number of the signal that caused the child process to stop if the value of *WIFSTOPPED*(*stat_val*) is nonzero.

WTERMSIG(*stat_val*)

Evaluates to the number of the signal that terminated the child process if the value of *WIFSIGNALED*(*stat_val*) is nonzero.

This macro isn't part of a POSIX standard:

WCOREDUMP(*stat_val*)

Evaluates to a nonzero value if the child process left a core dump.

One of the macros *WIFEXITED*(**stat_loc*) and *WIFSIGNALED*(**stat_loc*) evaluates to a nonzero value.

The non-POSIX *waitid()* function gives even more status information than the above macros.

Returns:

The process ID of the terminating child process, or -1 if an error occurred or on delivery of a signal (*errno* is set to EINTR).

Errors:

ECHILD	The calling process has no existing unwaited-for child processes.
EINTR	The function was interrupted by a signal. The value of the location pointed to by *stat_loc* is undefined.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno, *spawn()*, *wait4()*, *waitid()*, *waitpid()*

Synopsis:

```
#include <sys/wait.h>

pid_t wait3( int * stat_loc
             int options,
             struct rusage * resource_usage );
```

Arguments:

stat_loc NULL, or a pointer a location where the function can store the terminating status of the child process. For information about macros that extract information from this status, see "Status macros" in the documentation for *wait()*.

options A combination of zero or more of the following flags:

- WCONTINUED — return the status for any child that was stopped and has been continued.
- WEXITED — wait for the process(es) to exit.
- WNOHANG — return immediately if there are no children to wait for.
- WNOWAIT — keep the process in a waitable state. This doesn't affect the state of the process; the process may be waited for again after this call completion.
- WSTOPPED — wait for and return the process status of any child that has stopped because it received a signal.
- WUNTRACED — report the status of a stopped child process.

resource_usage

NULL, or a pointer to a **rusage** structure where the function can store information about resource usage. For information about this structure, see *getrusage()*.

Library:

libc

Description:

The *wait3()* function allows the calling thread to obtain status information for specified child processes.

The following call:

```
wait3( stat_loc, options, resource_usage );
```

is equivalent to the call:

```
waitpid( (pid_t)-1, stat_loc, options );
```

except that on successful completion, if the *resource_usage* argument to *wait3()* isn't a null pointer, the **rusage** structure that the third argument points to is filled in for the child process identified by the return value.

It's also equivalent to:

```
wait4( (pid_t)-1, stat_loc, options, resource_usage );
```

Returns:

If the status of a child process is available, a value equal to the process ID of the child process for which status is reported.

If a signal is delivered to the calling process, -1 and *errno* is set to EINTR.

Zero if *wait3()* is invoked with WNOHANG set in *options* and at least one child process is specified by *pid* for which status isn't available, and status isn't available for any process specified by *pid*.

Otherwise, (**pid_t**)-1 and *errno* is set.

Errors:

ECHILD	The calling process has no existing unwaited-for child processes, or the set of processes specified by the argument *pid* can never be in the states specified by the argument options.

Classification:

Standard unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

Caveats:

New applications should use *waitpid()*.

See also:

exit(), fork(), pause(), wait4(), waitid(), waitpid()

wait4()

Wait for one or more child process to change its state

Synopsis:

```
#include <sys/types.h>
#include <sys/wait.h>

pid_t wait4( pid_t pid,
             int * stat_loc,
             int options,
             struct rusage * resource_usage );
```

Arguments:

pid The set of child processes that you want to get status information for:

- less than -1 — any child process whose process group ID is equal to the absolute value of *pid*.
- -1 — any child process
- 0 — any child process whose process group ID is equal to that of the calling process.
- greater than 0 — the single child process with this ID.

stat_loc NULL, or a pointer a location where the function can store the terminating status of the child process. For information about macros that extract information from this status, see "Status macros" in the documentation for *wait()*.

options A combination of zero or more of the following flags:

- WCONTINUED — return the status for any child that was stopped and has been continued.
- WEXITED — wait for the process(es) to exit.
- WNOHANG — return immediately if there are no children to wait for.
- WNOWAIT — keep the process in a waitable state. This doesn't affect the state of the process; the process may be waited for again after this call completion.

- WSTOPPED — wait for and return the process status of any child that has stopped because it received a signal.
- WUNTRACED — report the status of a stopped child process.

resource_usage

NULL, or a pointer to a **rusage** structure where the function can store information about resource usage. For information about this structure, see *getrusage()*.

Library:

libc

Description:

The *wait4()* function suspends execution of the calling process until status information from one of its terminated child processes is available, or until the delivery of a signal whose action is either to terminate the process or execute a signal handler. If status information is available prior to the call to *wait4()*, the return is immediate.

The *wait4()* function behaves the same as the *wait()* function when passed a *pid* argument of -1, and the *options* argument has a value of zero.

Only one of the *WIFEXITED*(*stat_val*) and *WIFSIGNALED*(*stat_val*) macros can evaluate to a nonzero value.

The following call:

```
wait3( stat_loc, options, resource_usage );
```

is equivalent to the call:

```
waitpid( (pid_t)-1, stat_loc, options );
```

except that on successful completion, if the *resource_usage* argument to *wait3()* isn't a NULL pointer, the **rusage** structure that the third

argument points to is filled in for the child process identified by the return value.

It's also equivalent to:

```
wait4( (pid_t)-1, stat_loc, options, resource_usage );
```

Returns:

If successful, *wait4()* returns the process id of the terminating child process. If *wait4()* was invoked with WNOHANG set in *options*, it has at least one child process specified by *pid* for which status is not available, and status is not available for any process specified by *pid*, a value of zero is returned. On delivery of a signal *waitpid()* returns -1, and *errno* is set to EINTR.

Errors:

ECHILD	The calling process has no existing unwaited-for child processes that meet the criteria set by *pid*.
EINTR	The function was interrupted by a signal. The value of the location pointed to by *stat_loc* is undefined.
EINVAL	The value of the *options* argument isn't valid.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

exit(), *fork()*, *pause()*, *wait()*, *wait3()*, *waitid()*, *waitpid()*

waitid()

Wait for a child process to change state

Synopsis:

```
#include <sys/wait.h>

int waitid( idtype_t idtype,
            id_t id,
            siginfo_t * infop,
            int options );
```

Arguments:

idtype Which children you want to wait for:

- P_PID — the child with a process ID of **(pid_t)***id*.
- P_PGID — any child with a process group ID equal to **(pid_t)***id*.
- P_ALL — any child; *id* is ignored.

id The process or process group ID that you want to wait for, depending on the value of *idtype*.

infop A pointer to a **siginfo_t** structure, as defined in **<sys/siginfo.h>**, where the function can store the current state of the child; see below.

options A combination of zero or more of the following flags:

- WCONTINUED — return the status for any child that was stopped and has been continued.
- WEXITED — wait for the process(es) to exit.
- WNOHANG — return immediately if there are no children to wait for.
- WNOWAIT — keep the process in a waitable state. This doesn't affect the state of the process; the process may be waited for again after this call completion.
- WSTOPPED — wait for and return the process status of any child that has stopped because it received a signal.
- WUNTRACED — report the status of a stopped child process.

Library:

libc

Description:

The *waitid()* function suspends the calling process until one of its children changes state. It records the current state of a child in the structure pointed to by *infop*. If a child process changed state prior to the call to *waitid()*, *waitid()* returns immediately.

If *waitid()* returns because a child process was found that satisfied the conditions indicated by the arguments *idtype* and *options*, then the structure pointed to by *infop* is filled in by the system with the status of the process. The *si_signo* member is always SIGCHLD.

If *idtype* is P_ALL and *options* is **WEXITED**|**WTRAPPED**, *waitid()* is equivalent to *wait()*.

Returns:

0 One of the children changed its state. If WNOHANG was used, 0 can be returned (indicating no error); however, no children may have changed state if *info->si_pid* is 0.

-1 An error occurred (*errno* is set).

Errors:

ECHILD The set of processes specified by *idtype* and *id* doesn't contain any unwaited-for processes.

EFAULT The *infop* argument points to an illegal address.

EINTR The *waitid()* function was interrupted by a signal.

EINVAL An invalid value was specified for *options*, or *idtype* and *id* specify an invalid set of processes.

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

execl(), *execle()*, *execlp()*, *execlpe()*, *execv()*, *execve()*, *execvp()*, *execvpe()*, *exit()*, *fork()*, *pause()*, *sigaction()*, *signal()*, *wait()*, *wait3()*, *wait4()*, *waitpid()*

Synopsis:

```
#include <sys/types.h>
#include <sys/wait.h>

pid_t waitpid( pid_t pid,
               int * stat_loc,
               int options );
```

Arguments:

pid The set of child processes that you want to get status information for:

- less than -1 — any child process whose process group ID is equal to the absolute value of *pid*.
- -1 — any child process
- 0 — any child process whose process group ID is equal to that of the calling process.
- greater than 0 — the single child process with this ID.

stat_loc NULL, or a pointer a location where the function can store the terminating status of the child process. For information about macros that extract information from this status, see "Status macros" in the documentation for *wait()*.

options A combination of zero or more of the following flags:

- WCONTINUED — return the status for any child that was stopped and has been continued.
- WEXITED — wait for the process(es) to exit.
- WNOHANG — return immediately if there are no children to wait for.
- WNOWAIT — keep the process in a waitable state. This doesn't affect the state of the process; the process may be waited for again after this call completion.

- WSTOPPED — wait for and return the process status of any child that has stopped because it received a signal.
- WUNTRACED — report the status of a stopped child process.

Library:

libc

Description:

The *waitpid()* function suspends execution of the calling process until status information from one of its terminated child processes is available, or until the delivery of a signal whose action is either to terminate the process or execute a signal handler. If status information is available prior to the call to *waitpid()*, the return is immediate.

The *waitpid()* function behaves the same as *wait()* when passed a *pid* argument of -1, and the *options* argument has a value of zero.

Only one of the *WIFEXITED*(*stat_val*) and *WIFSIGNALED*(*stat_val*) macros can evaluate to a nonzero value.

Returns:

The process ID of the terminating child process on success. If *waitpid()* is invoked with WNOHANG set in *options*, it has at least one child process specified by *pid* for which status isn't available, and status isn't available for any process specified by *pid*, a value of zero is returned. On delivery of a signal, *waitpid()* returns -1, and *errno* is set to EINTR.

Errors:

ECHILD	The calling process has no existing unwaited-for child processes that meet the criteria set by *pid*.
EINTR	The function was interrupted by a signal. The value of the location pointed to by *stat_loc* is undefined.

EINVAL The value of the *options* argument isn't valid.

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

spawn(), wait(), wait3(), wait4(), waitid()

warn(), *warnx()*

Formatted error message

Synopsis:

```
#include <err.h>

void warn( const char* fmt, ...);

void warnx( const char* fmt, ...);
```

Arguments:

fmt NULL, or a *printf()*-style string used to format the message.

Additional arguments

As required by the format string.

Library:

libc

Description:

The *err()* and *warn()* family of functions display a formatted error message on *stderr*. For a comparison of the members of this family, see *err()*.

The *warn()* function produces a message that consists of:

- the last component of the program name, followed by a colon and a space
- the formatted message, followed by a colon and a space, if the *fmt* argument isn't NULL
- the string associated with the current value of *errno*
- a newline character.

The *warnx()* function produces a similar message, except that it doesn't include the string associated with *errno*. The message consists of:

- the last component of the program name, followed by a colon and a space
- the formatted message, if the *fmt* argument isn't NULL
- a newline character.

Examples:

Warn of an error:

```
if ((fd = open(raw_device, O_RDONLY, 0)) == -1)
    warnx("%s: %s: trying the block device",
          raw_device, strerror(errno));
if ((fd = open(block_device, O_RDONLY, 0)) == -1)
    warn("%s", block_device);
```

Classification:

Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

err(), *errx()*, *stderr*, *strerror()*, *verr()*, *verrx()*, *vwarn()*, *vwarnx()*

wcrtomb()

Convert a wide-character code to a character

Synopsis:

```
#include <wchar.h>

size_t wcrtomb( char * s,
                wchar_t wc,
                mbstate_t * ps);
```

Arguments:

s NULL, or a pointer to a location where the function can store the multibyte character.

wc The wide character that you want to convert.

ps An internal pointer that lets *wcrtomb()* be a restartable version of *wctomb()*; if *ps* is NULL, *wcrtomb()* uses its own internal variable.

You can call *mbsinit()* to determine the status of this variable.

Library:

libc

Description:

The *wcrtomb()* function determines the number of bytes needed to represent the wide character *wc* as a multibyte character and stores the multibyte character in the location pointed to by *s*, to a maximum of MB_CUR_MAX bytes.

This function is affected by LC_CTYPE.

Returns:

The number of bytes stored, or **(size_t)-1** if the variable *wc* is an invalid wide-character code.

Errors:

EILSEQ	Invalid wide-character code.
EINVAL	The variable *ps* points to an invalid conversion state.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wcscat()

Concatenate two wide-character strings

Synopsis:

```
#include <wchar.h>

wchar_t * wcscat( wchar_t * ws1,
                  const wchar_t * ws2 );
```

Arguments:

ws1, *ws2* The wide-character strings that you want to concatenate.

Library:

libc

Description:

The *wcscat()* function appends a copy of the string pointed to by *ws2*, including the terminating NUL wide character, to the end of the string pointed to by *ws1*. The first wide character of *ws2* overwrites the NUL wide character at the end of *ws1*.

Returns:

The same pointer as *ws1*.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wcschr()

Find the first occurrence of a wide character in a string

Synopsis:

```
#include <wchar.h>

wchar_t * wcschr( const wchar_t * ws,
                  wchar_t wc );
```

Arguments:

ws The wide-character string that you want to search.

wc The wide character that you're looking for.

Library:

libc

Description:

The *wcschr()* function finds the first occurrence of *wc* in the string pointed to by *ws*. The terminating NUL character is considered to be part of the string.

Returns:

A pointer to the located wide character, or NULL if *wc* doesn't occur in the string.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), *strchr()*, *strcspn()*, *strpbrk()*, *strrchr()*, *strspn()*, *strstr()*, *strtok()*, *strtok_r()*, *wcscspn()*, *wcspbrk()*, *wcsrchr()*, *wcsspn()*, *wcsstr()*, *wcstok()*

wcscmp()

Compare two wide-character strings

Synopsis:

```
#include <wchar.h>

int wcscmp( const wchar_t * ws1,
            const wchar_t * ws2 );
```

Arguments:

ws1, ws2 The wide-character strings that you want to compare.

Library:

libc

Description:

The *wcscmp()* function compares the wide-characters strings pointed to by *ws1* and *ws2*.

Returns:

< 0 *ws1* is less than *ws2*.

0 *ws1* is equal to *ws2*.

> 0 *ws1* is greater than *ws2*.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcasecmp(), strcmp(), strcmpi(), strcoll(), stricmp(), strncasecmp(), strncmp(), strnicmp(), wcscoll(), wcsncmp()

wcscoll()

Compare two wide-character strings, using the locale's collating sequence

Synopsis:

```
#include <wchar.h>

int wcscoll( const wchar_t * ws1,
             const wchar_t * ws2 );
```

Arguments:

ws1, ws2 The wide-character strings that you want to compare.

Library:

libc

Description:

The *wcscoll()* function compares the wide-character strings pointed to by *ws1* and *ws2*, using the LC_COLLATE collating sequence selected by the *setlocale()* function.

Returns:

< 0 *ws1* is less than *ws2*.

0 *ws1* is equal to *ws2*.

> 0 *ws1* is greater than *ws2*.

Classification:

ANSI

wcscoll()

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	No

See also:

setlocale(), strcasecmp(), strcmp(), strcmpi(), strcoll(), stricmp(), strncasecmp(), strncmp(), strnicmp(), wcscmp(), wcsncmp()

wcscpy()

Copy a wide-character string

Synopsis:

```
#include <wchar.h>

wchar_t * wcscpy( wchar_t * ws1,
                  const char * ws2 );
```

Arguments:

ws1 A pointer to where you want to copy the string.

ws2 The wide-character string that you want to copy.

Library:

libc

Description:

The *wcscpy()* function copies the string pointed to by *ws2*, including the terminating NUL wide character, into the array pointed to by *ws1*.

This function isn't guaranteed to work properly for copying overlapping strings; use *wmemmove()* instead.

Returns:

The same pointer as *ws1*.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

memmove(), *strcpy()*, *strdup()*, *strncpy()*, *wcsncpy()*, *wmemmove()*

wcscspn()

Count the wide characters at the beginning of a string that aren't in a given character set

Synopsis:

```
#include <wchar.h>

size_t wcscspn( const wchar_t * ws1,
                const wchar_t * ws2 );
```

Arguments:

ws1 The wide-character string that you want to search.

ws2 The set of wide characters you want to look for.

Library:

libc

Description:

The *strspn()* function returns the length of the initial segment of the string pointed to by *ws1* consisting entirely of wide characters *not* from the string pointed to by *ws2*. The terminating NUL isn't considered to be part of *ws2*.

Returns:

The length of the segment.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), *strchr()*, *strcspn()*, *strpbrk()*, *strrchr()*, *strspn()*, *strstr()*, *strtok()*, *strtok_r()*, *wcschr()*, *wcspbrk()*, *wcsrchr()*, *wcsspn()*, *wcsstr()*, *wcstok()*

wcsftime()

Format the time into a wide-character string

Synopsis:

```
#include <wchar.h>

size_t wcsftime( wchar_t * wcs,
                 size_t maxsize,
                 const wchar_t * format,
                 const struct tm * timeptr );
```

Arguments:

wcs	A pointer to a buffer where the function can store the formatted time.
maxsize	The maximum size of the buffer.
format	The format that you want to use for the time; see "Formats," in the description of *strftime()*.
timeptr	A pointer to a **tm** structure that contains the time that you want to format.

Library:

libc

Description:

The *wcsftime()* function is similar to *strftime()*, except that *wcsftime()* works with wide characters.

Returns:

The number of wide characters placed into the array, not including the terminating null character, or 0 if the number of wide characters exceeds *maxsize* (in this case, the string contents are indeterminate).

If an error occurs, *errno* is set.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

asctime(), asctime_r(), ctime(), ctime_r(), sprintf(), strftime(), **tm**, *tzset()*

wcslen()

Compute the length of a wide-character string

Synopsis:

```
#include <wchar.h>

size_t wcslen( const wchar_t * ws );
```

Arguments:

ws The wide-character string whose length you want to calculate.

Library:

libc

Description:

The *wcslen()* function counts the wide characters in the string pointed to by *ws*.

Returns:

The number of wide characters, not counting the terminating NUL.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strlen()

wcsncat()

Concatenate two wide-character strings, up to a maximum length

Synopsis:

```
#include <wchar.h>

wchar_t * wcsncat( wchar_t * ws1,
                   const wchar_t * ws2
                   size_t n );
```

Arguments:

ws1, *ws2*	The wide-character strings that you want to concatenate.
n	The maximum number of wide characters that you want to add from the *ws2* string.

Library:

libc

Description:

The *wcsncat()* function appends a copy of the string pointed to by *ws2*, including the terminating NUL wide character, to the end of the string pointed to by *ws1*. The first character of *ws2* overwrites the NUL wide character at the end of *ws1*. The function writes no more than *n* wide characters from *ws2* and appends a NUL wide character to the result.

Returns:

The same pointer as *ws1*.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wcsncmp()

Compare two wide-character strings, up to a given length

Synopsis:

```
#include <wchar.h>

int wcsncmp( const wchar_t * ws1,
             const wchar_t * ws2,
             size_t n );
```

Arguments:

ws1, *ws2*	The wide-character strings that you want to compare.
n	The maximum number of wide characters that you want to compare.

Library:

libc

Description:

The *wcsncmp()* function compares up *n* wide characters from the strings pointed to by *ws1* and *ws2*.

Returns:

< 0	*ws1* is less than *ws2*.
0	*ws1* is equal to *ws2*.
> 0	*ws1* is greater than *ws2*.

Classification:

ANSI

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strcasecmp(), strcmp(), strcmpi(), strcoll(), stricmp(), strncasecmp(), strncmp(), strnicmp(), wcscmp(), wcscoll()

wcsncpy()

Copy a wide-character string, to a maximum length

Synopsis:

```
#include <wchar.h>

wchar_t * wcsncpy( wchar_t * ws1,
                   const char * ws2,
                   size_t n );
```

Arguments:

ws1 A pointer to where you want to copy the wide-character string.

ws2 The wide-character string that you want to copy.

n The maximum number of wide characters that you want to copy.

Library:

libc

Description:

The *wcsncpy()* function copies the string pointed to by *ws2*, including the terminating NUL wide character, into the array pointed to by *ws1*, to a maximum of *n* wide characters. It adds NUL characters if *ws2* has fewer than *n* characters but doesn't add a NUL if *ws2* has more.

This function isn't guaranteed to work properly for copying overlapping strings; use *wmemmove()* instead.

Returns:

The same pointer as *ws1*.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memmove(), strcpy(), strdup(), strncpy(), wcscpy(), wmemmove()

wcspbrk()

Find the first wide character in a string that's in a given character set

Synopsis:

```
#include <wchar.h>

wchar_t * wcspbrk( const wchar_t * ws1,
                   const wchar_t * ws2 );
```

Arguments:

ws1 The wide-character string that you want to search.

ws2 The set of wide characters you want to look for.

Library:

libc

Description:

The *wcspbrk()* function locates the first occurrence in the string pointed to by *ws1* of *any* wide character from the string pointed to by *ws2*.

Returns:

A pointer to the located character, or NULL if no character from *ws2* occurs in *ws1*.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), *strchr()*, *strcspn()*, *strpbrk()*, *strrchr()*, *strspn()*, *strstr()*, *strtok()*, *strtok_r()*, *wcschr()*, *wcscspn()*, *wcsrchr()*, *wcsspn()*, *wcsstr()*, *wcstok()*

wcsrchr()

Find the last occurrence of a wide character in a string

Synopsis:

```
#include <wchar.h>

wchar_t * wcsrchr( const wchar_t * ws,
                   wchar_t wc );
```

Arguments:

ws The wide-character string that you want to search.

wc The wide character that you're looking for.

Library:

libc

Description:

The *wcsrchr()* function finds the last occurrence of *wc* in the string pointed to by *ws*. The terminating NUL character is considered to be part of the string.

Returns:

A pointer to the located wide character, or NULL if *wc* doesn't occur in the string.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), *strchr()*, *strcspn()*, *strpbrk()*, *strrchr()*, *strspn()*, *strstr()*, *strtok()*, *strtok_r()*, *wcschr()*, *wcscspn()*, *wcspbrk()*, *wcsspn()*, *wcsstr()*, *wcstok()*

wcsrtombs()

Convert a wide-character string into a multibyte character string (restartable)

Synopsis:

```
#include <wchar.h>

size_t wcsrtombs( char * dst,
                  const wchar_t ** src,
                  size_t len,
                  mbstate_t * ps);
```

Arguments:

dst A pointer to a buffer where the function can store the multibyte-character string.

src A pointer to the wide-character string that you want to convert.

len The maximum number of multibyte characters to store.

ps An internal pointer that lets *wcsrtombs()* be a restartable version of *wcstombs()*; if *ps* is NULL, *wcsrtombs()* uses its own internal variable.

You can call *mbsinit()* to determine the status of this variable.

Library:

libc

Description:

The *wcsrtombs()* function converts a string of wide-characters pointed to by *src* into the corresponding multi-byte characters pointed to by *dst*. No more than *len* bytes are stored, including the terminating NULL character.

The function converts each character as if by a call to *wctomb()* and stops early if:

- A sequence of bytes doesn't conform to a valid character.

- Converting the next character would exceed the limit of *len* total bytes.

The *wcsrtombs()* function uses *ps* to make it thread safe; if *ps* is a NULL pointer, *wcsrtombs()* uses its own internal pointer.

Returns:

The number of total bytes successfully converted, not including the terminating NULL byte, or `(size_t)-1` if an invalid wide-character code was found.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wcsspn()

Count the wide characters at the beginning of a string that are in a given character set

Synopsis:

```
#include <wchar.h>

size_t wcsspn( const wchar_t * ws1,
               const wchar_t * ws2 );
```

Arguments:

ws1 The wide-character string that you want to search.

ws2 The set of wide characters you want to look for.

Library:

libc

Description:

The *wcsspn()* function returns the length of the initial segment of the string pointed to by *ws1* consisting entirely of wide characters from the string pointed to by *ws2*. The terminating NUL isn't considered to be part of *ws2*.

Returns:

The length of the segment.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), *strchr()*, *strcspn()*, *strpbrk()*, *strrchr()*, *strspn()*, *strstr()*, *strtok()*, *strtok_r()*, *wcschr()*, *wcscspn()*, *wcspbrk()*, *wcsrchr()*, *wcsstr()*, *wcstok()*

wcsstr()

Find one wide-character string inside another

Synopsis:

```
#include <wchar.h>

wchar_t * wcsstr( const wchar_t * ws1,
                  const wchar_t * ws2 );
```

Arguments:

ws1 The wide-character string that you want to search.

ws2 The wide-character string that you're looking for.

Library:

libc

Description:

The *wcsstr()* function locates the first occurrence in the string pointed to by *ws1* of the sequence of wide characters, excluding the terminating NUL, in the string pointed to by *ws2*.

Returns:

A pointer to the located string, NULL if the string wasn't found, or the same pointer as *ws1* if *ws2* points to a zero-length string.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memchr(), *strchr()*, *strcspn()*, *strpbrk()*, *strrchr()*, *strspn()*, *strstr()*, *strtok()*, *strtok_r()*, *wcschr()*, *wcscspn()*, *wcspbrk()*, *wcsrchr()*, *wcsspn()*, *wcstok()*

wcstod(), *wcstof()*, *wcstold()*

Convert a wide-character string into a double, float, or long double

Synopsis:

```
#include <wchar.h>

double wcstod( const wchar_t * ptr,
               wchar_t ** endptr );

float wcstof( const wchar_t * ptr,
              wchar ** endptr );

long double wcstold( const wchar_t * ptr,
                     wchar ** endptr );
```

Arguments:

nptr	A pointer to the string to parse.
endptr	If this argument isn't NULL, the function stores in it a pointer to the first unrecognized character found in the string.

Library:

libc

Description:

These functions convert a wide-character string to a number:

- *wcstod()* function converts it to a **double**
- *wcstof()* converts it to a **float**
- *wcstold()* to a **long double**.

These functions recognize strings containing the following:

- optional white space
- an optional plus or minus sign
- a sequence of digits containing an optional decimal point

- an optional **e** or **E**, followed by an optionally signed sequence of digits.

The functions expect the string to have a plus or minus sign, followed by one of these forms:

- A sequence of decimal digits, optionally followed by a radix character, optionally followed by an exponent part.
- A **0x** or **0X** followed by a sequence of hexadecimal digits, optionally followed by a radix character, optionally followed by a binary exponent part.
- The case-insensitive string **INF** or **INFINITY**.
- The case-insensitive string **NAN** or **NAN(***n-wchar-sequence***)** where *n-wchar-sequence* may be a digit, a nondigit, a n-wchar-sequence digit or a n-wchar-sequence nondigit.

The value is correctly rounded if the subject is hexadecimal and FLT_RADIX is 2.

The radix character is locale specific, depending upon LC_NUMERIC.

The conversion ends at the first unrecognized character. If *endptr* isn't NULL, a pointer to the unrecognized wide character is stored in the object *endptr* points to.

Because 0 is a valid return that is also used for an error, you should set *errno* to 0 before calling these functions, and check *errno* again afterward. These functions don't change *errno* on success.

Returns:

The converted value. If the correct value would cause overflow, plus or minus HUGE_VAL is returned according to the sign, and *errno* is set to ERANGE. If the correct value would cause underflow, then zero is returned, and *errno* is set to ERANGE.

Zero is returned when the input string can't be converted. When an error occurs, *errno* indicates the error detected.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

errno

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wcstoimax(), wcstoumax()

Convert a wide-character string into an integer

Synopsis:

```
#include <inttypes.h>

intmax_t wcstoimax ( const wchar_t * nptr,
                     wchar_t ** endptr,
                     int base );

uintmax_t wcstoumax ( const wchar_t * nptr,
                      wchar_t ** endptr,
                      int base );
```

Arguments:

nptr A pointer to the string to parse.

endptr If this argument isn't NULL, the function stores in it a pointer to the first unrecognized character found in the string.

base The base of the number being parsed:

- If *base* is zero, the first characters after the optional sign determine the base used for the conversion. If the first characters are **0x** or **0X** the digits are treated as hexadecimal. If the first character is **0**, the digits are treated as octal. Otherwise, the digits are treated as decimal.
- If *base* isn't zero, it must have a value between 2 and 36. The letters a-z and A-Z represent the values 10 through 35. Only those letters whose designated values are less than *base* are permitted. If the value of *base* is 16, the characters **0x** or **0X** may optionally precede the sequence of letters and digits.

Library:

libc

Description:

The *wcstoimax()* and *wcstoumax()* functions are the same as the *wcstol(), wcstoll(), wcstoul(),* and *wcstoull()* functions except that they return objects of type **intmax_t** and **uintmax_t**.

Returns:

The converted value.

If the correct value causes an overflow, (INTMAX_MAX | UINTMAX_MAX or INTMAX_MIN) is returned according to the sign and *errno* is set to ERANGE. If *base* is out of range, zero is returned and *errno* is set to EINVAL.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

strtol(), wcstol(), wcstoul()

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

Synopsis:

```
#include <wchar.h>

wchar_t * wcstok( wchar_t * ws1,
                  const wchar_t * ws2,
                  wchar_t ** ptr );
```

Arguments:

ws1 NULL, or the wide-character string that you want to break into tokens; see below.

ws2 A set of the wide characters that separate the tokens.

ptr The address of a pointer to a **wchar_t** object, which the function can use to store information necessary for it to continue scanning the same string.

Library:

libc

Description:

The function *wcstok()* breaks the wide-character string pointed to by *ws1* into a sequence of tokens, each of which is delimited by a wide character from the string pointed to by *ws2*.

In the first call to *wcstok()*, *ws1* must point to a null-terminated string, *ws2* must point to a null-terminated string of separator wide characters, and *ptr* is ignored. The *wcstok()* function returns a pointer to the first wide character of the first token, writes a NUL wide character into *ws1* immediately following the returned token, and updates *ptr*.

In subsequent calls, *ws1* must be NULL, and *ptr* must be unchanged from the previous call so that subsequent calls will move through the string *ws1*, returning successive tokens until no tokens remain. The separator string *ws2* may differ from call to call. When no tokens remain in *ws1*, a NULL pointer is returned.

Returns:

A pointer to the token found, or NULL if no token was found.

Classification:

POSIX 1003.1

wcstok()

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

memchr(), strchr(), strcspn(), strpbrk(), strrchr(), strset(), strspn(), strstr(), strtok(), strtok_r(), wcschr(), wcscspn(), wcspbrk(), wcsrchr(), wcsspn(), wcsstr()

wcstol(), wcstoll()

Convert a wide-character string into a long integer

Synopsis:

```
#include <stdlib.h>

long wcstol( const wchar_t * ptr,
             wchar_t ** endptr,
             int base );

long long wcstoll( const wchar_t * ptr,
                   wchar_t ** endptr,
                   int base );
```

Arguments:

ptr A pointer to the string to parse.

endptr If this argument isn't NULL, the function stores in it a pointer to the first unrecognized character found in the string.

base The base of the number being parsed:

- If *base* is zero, the first characters after the optional sign determine the base used for the conversion. If the first characters are **0x** or **0X** the digits are treated as hexadecimal. If the first character is **0**, the digits are treated as octal. Otherwise, the digits are treated as decimal.
- If *base* isn't zero, it must have a value between 2 and 36. The letters a-z and A-Z represent the values 10 through 35. Only those letters whose designated values are less than *base* are permitted. If the value of *base* is 16, the characters **0x** or **0X** may optionally precede the sequence of letters and digits.

Library:

libc

Description:

The *wcstol()* function converts the string pointed to by *ptr* into a **long**; *wcstoll()* converts the string into a **long long**.

These functions recognize strings that contain the following:

- optional white space
- an optional plus or minus sign
- a sequence of digits and letters.

The conversion ends at the first unrecognized wide character. If *endptr* isn't NULL, a pointer to the unrecognized wide character is stored in the object *endptr* points to.

Returns:

The converted value.

If the correct value causes an overflow, LONG_MAX | LONGLONG_MAX or LONG_MIN | LONGLONG_MIN is returned according to the sign, and *errno* is set to ERANGE. If *base* is out of range, zero is returned and *errno* is set to EDOM.

Errors:

ERANGE	The value is not representable
EINVAL	The value for *base* is not supported or no conversion could be performed.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

errno

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wcstombs()

Convert a wide-character string into a multibyte character string

Synopsis:

```
#include <stdlib.h>

size_t wcstombs( char* s,
                 const wchar_t* pwcs,
                 size_t n );
```

Arguments:

s	A pointer to a buffer where the function can store the multibyte-character string.
pwcs	The wide-character string that you want to convert.
n	The maximum number of bytes to store.

Library:

libc

Description:

The *wcstombs()* function converts a sequence of wide character codes from the array pointed to by *pwcs* into a sequence of multibyte characters, and stores them in the array pointed to by *s*. It stops if a multibyte character exceeds the limit of *n* total bytes, or if the NUL character is stored. At most *n* bytes of the array pointed to by *s* are modified.

The *wcsrtombs()* function is a restartable version of *wcstombs()*.

Returns:

The number of array elements modified, not including the terminating zero code, if present, or **(size_t)-1** if an invalid multibyte character is encountered.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

wchar_t wbuffer[] = {
    0x0073,
    0x0074,
    0x0072,
    0x0069,
    0x006e,
    0x0067,
    0x0000
  };

int main( void )
  {
    char    mbsbuffer[50];
    int     i, len;

    len = wcstombs( mbsbuffer, wbuffer, 50 );
    if( len != -1 ) {
      for( i = 0; i < len; i++ )
        printf( "/%4.4x", wbuffer[i] );
      printf( "\n" );
      mbsbuffer[len] = '\0';
      printf( "%s(%d)\n", mbsbuffer, len );
    }
    return EXIT_SUCCESS;
  }
```

produces the output:

```
/0073/0074/0072/0069/006e/0067
string(6)
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	Yes
Thread	Yes

See also:

mblen(), *mbtowc()*, *mbstowcs()*, *wcsrtombs()*, *wctomb()*

Convert a wide-character string into an unsigned long integer

Synopsis:

```
#include <stdlib.h>

long wcstoul( const wchar_t * ptr,
              wchar_t ** endptr,
              int base );

long long wcstoull( const wchar_t * ptr,
                    char** endptr,
                    int base );
```

Arguments:

ptr A pointer to the string to parse.

endptr If this argument isn't NULL, the function stores in it a pointer to the first unrecognized character found in the string.

base The base of the number being parsed:

- If *base* is zero, the first characters after the optional sign determine the base used for the conversion. If the first characters are **0x** or **0X** the digits are treated as hexadecimal. If the first character is **0**, the digits are treated as octal. Otherwise, the digits are treated as decimal.
- If *base* isn't zero, it must have a value between 2 and 36. The letters a-z and A-Z represent the values 10 through 35. Only those letters whose designated values are less than *base* are permitted. If the value of *base* is 16, the characters **0x** or **0X** may optionally precede the sequence of letters and digits.

Library:

libc

Description:

These functions convert a wide-character string into a number:

- *wcstoul()* converts the string into an **unsigned long**
- *wcstoull()* converts it into a **unsigned long long**.

These functions recognize a string containing optional white space, followed by a sequence of digits and letters. The conversion ends at the first unrecognized character. A pointer to that character is stored in the object *endptr* points to, if *endptr* isn't NULL.

If *base* is zero, the first characters determine the base used for the conversion. If the first characters are **0x** or **0X** the digits are treated as hexadecimal. If the first character is **0**, the digits are treated as octal. Otherwise, the digits are treated as decimal.

If *base* isn't zero, it must have a value of between 2 and 36. The letters a-z and A-Z represent the values 10 through 35. Only those letters whose designated values are less than *base* are permitted. If the value of *base* is 16, the characters **0x** or **0X** may optionally precede the sequence of letters and digits.

Returns:

The converted value.

If the correct value causes an overflow, ULONG_MAX | ULONGLONG_MAX is returned and *errno* is set to ERANGE. If *base* is out of range, zero is returned and *errno* is set to **EDOM**.

Errors:

ERANGE	The value is not representable
EINVAL	The value for *base* is not supported or no conversion could be performed.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

errno

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wcscxfrm()

Transform one wide-character string into another, to a given length

Synopsis:

```
#include <wchar.h>

int wcscfrm( wchar_t * ws1,
             const wchar_t * ws2,
             size_t n );
```

Arguments:

ws1	The string that you want to transform.
ws2	The string that you want to place in *dst*.
n	The maximum number of characters to transform.

Library:

libc

Description:

The *wcsxfrm()* function transforms the string pointed to by *ws2* to the buffer pointed to by *ws1*, to a maximum of *n* wide-characters, including the terminating null. The two strings shouldn't overlap.

A call to *wcscmp()* returns the same result for two strings transformed by *wcsxfrm()* as *wcscoll()* would return for the original versions of the strings.

☞ This function doesn't report errors in its returns; set *errno* to 0, call *wcsxfrm()*, and then check *errno* again.

Returns:

The length of the transformed wide-character string. If this value is greater than *n*, the contents of *ws1* are indeterminate.

Classification:

ANSI

wcscxfrm()

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

setlocale(), strxfrm()

wctob()

Convert a wide character to a single-byte code

Synopsis:

```
#include <wchar.h>

int wctob( wint_t c );
```

Arguments:

c The wide character that you want to convert.

Library:

libc

Description:

The *wctob()* function returns the single-byte representation of a wide character.

This function is affected by LC_CTYPE.

Returns:

The single-byte representation, or EOF if *c* isn't a valid single-byte character.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wctomb()

Convert a wide character into a multibyte character

Synopsis:

```
#include <stdlib.h>
int wctomb( char * s,
            wchar_t wc );
```

Arguments:

s NULL, or a pointer to a location where the function can store the multibyte character.

wc The wide character that you want to convert.

Library:

libc

Description:

The *wctomb()* function determines the number of bytes required to represent the multibyte character corresponding to the code contained in *wc*. If *s* isn't NULL, the multibyte character representation is stored in the array it points to. At most MB_CUR_MAX characters are stored.

Returns:

- If *s* is NULL:

  0 The *wctomb()* function uses locale specific multibyte character encoding that's not state-dependent.

  >0 The function is state-dependent.

- If *s* isn't NULL:

  -1 If the value of *wchar* doesn't correspond to a valid multibyte character.

  x The number of bytes that comprise the multibyte character corresponding to the value of *wchar*.

Examples:

```
#include <stdio.h>
#include <stdlib.h>

wchar_t wchar = { 0x0073 };
char    mbbuffer[MB_CUR_MAX];

int main( void )
  {
    int len;

    printf( "Character encodings do %shave "
        "state-dependent \nencoding.\n",
        ( wctomb( NULL, 0 ) )
        ? "" : "not " );

    len = wctomb( mbbuffer, wchar );
    mbbuffer[len] = '\0';
    printf( "%s(%d)\n", mbbuffer, len );
    return EXIT_SUCCESS;
  }
```

This produces the output:

```
Character encodings do not have state-dependent
encoding.
s(1)
```

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

"String manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wctrans()

Define a wide-character mapping

Synopsis:

```
#include <wctype.h>

wctrans_t wctrans(const char *property);
```

Arguments:

property The type of mapping; see below.

Library:

libc

Description:

The *wctrans()* function determines a mapping rule for wide-character codes according to the category LC_CTYPE, particularly for use with *towctrans()*.

The following mappings are defined in all locales, although additional classes may be defined for LC_CTYPE:

- tolower
- toupper

Use *setlocale()* to modify the category LC_CTYPE.

Returns:

An object that you can use in a call to *towctrans()*, or 0 if the specified character mapping isn't valid for the current locale.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

towctrans()

String manipulation functions

Wide-character functions

Synopsis:

```
#include <wctype.h>

wctype_t wctype( const char * property );
```

Arguments:

property A string that defines the property of the class; see below.

Library:

libc

Description:

The *wctype()* function determines a classification rule for wide-character codes according to the category LC_CTYPE, particularly for use with *iswctype()*.

Some classes are defined in all locales, although additional classes may be defined for LC_CTYPE. Use *setlocale()* to modify the category LC_CTYPE.

Defined Classes:

alnum	digit	punct
alpha	graph	space
blank	lower	upper
cntrl	print	xdigit

Returns:

A **wctype_t** object that you can use in a call to *iswctype()*, or 0 if the character class name isn't valid for the current locale.

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

setlocale()

"Character manipulation functions" and "Wide-character functions" in the summary of functions chapter.

wmemchr()

Locate the first occurrence of a wide character in a buffer

Synopsis:

```
#include <wchar.h>

wchar_t * wmemchr( const wchar_t * ws,
                   wchar_t wc,
                   size_t n );
```

Arguments:

ws	The buffer that you want to search.
wc	The character that you're looking for.
n	The number of wide characters to search in the buffer.

Library:

libc

Description:

The *wmemchr()* function locates the first occurrence of *wc* in the first *n* wide characters of the buffer pointed to by *ws*.

The *wmemchr()* function is locale-independent and treats all **wchar_t** values identically, even if they're null or invalid characters.

Returns:

A pointer to the located character, or NULL if *wc* couldn't be found.

Classification:

ANSI

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), memcmp(), memcpy(), memicmp(), memmove(), memset()
wcschr(), wcsrchr(), wmemcmp(), wmemcpy(), wmemmove(), wmemset()

wmemcmp()

Compare the wide characters in two buffers

Synopsis:

```
#include <wchar.h>

int wmemcmp( const wchar_t * ws1,
             const wchar_t * ws2,
             size_t n );
```

Arguments:

ws1, *ws2*	The wide-character strings that you want to compare.
n	The number of wide characters to compare.

Library:

libc

Description:

The *wmemcmp()* function compares *n* wide characters of the buffer pointed to by *ws1* to those in the buffer pointed to by *ws2*.

Returns:

<0	*ws1* is less than *ws2*.
0	*ws1* is equal to *ws2*.
>0	*ws1* is greater than *ws2*.

Classification:

ANSI

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), memcmp(), memcpy(), memicmp(), memmove(), memset()
wcscmp(), wcsncmp(), wmemchr(), wmemcpy(), wmemmove(), wmemset()

wmemcpy()

Copy wide characters from one buffer to another

Synopsis:

```
#include <wchar.h>

wchar_t * wmemcpy( wchar_t * ws1,
                   const wchar_t * ws2,
                   size_t n );
```

Arguments:

ws1	A pointer to the buffer that you want to copy the wide characters into.
ws2	A pointer to the buffer that you want to copy the wide characters from.
n	The number of wide characters to copy.

Library:

libc

Description:

The *wmemcpy()* function copies *n* wide characters from the buffer pointed to by *ws2* into the buffer pointed to by *ws1*.

The *wmemcpy()* function is locale-independent and treats all **wchar_t** values identically, even if they're null or invalid characters.

Copying overlapping buffers isn't guaranteed to work; use *wmemmove()* to copy buffers that overlap.

Returns:

A pointer to the destination buffer (i.e the same pointer as *ws1*).

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), memcmp(), memcpy(), memicmp(), memmove(), memset()
wcscpy(), wcsncpy(), wmemchr(), wmemcmp(), wmemmove(), wmemset()

wmemmove()

Copy wide characters from one buffer to another

Synopsis:

```
#include <wchar.h>

wchar_t * wmemmove( wchar_t * ws1,
                    const wchar_t * ws2,
                    size_t n );
```

Arguments:

ws1	A pointer to where you want the function to copy the data.
ws2	A pointer to the buffer that you want to copy data from.
n	The number of wide characters to copy.

Library:

libc

Description:

The *memmove()* function copies *n* wide characters from the buffer pointed to by *ws2* to the buffer pointed to by *ws1*. This function copies overlapping regions safely.

The *wmemmove()* function is locale-independent and treats all **wchar_t** values identically, even if they're null or invalid characters.

☞ Use *wmemcpy()* for greater speed when copying buffers that don't overlap.

Returns:

A pointer to the destination buffer (i.e. the same pointed as *ws1*).

Classification:

ANSI

Safety	
Cancellation point	No
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), memcmp(), memcpy(), memicmp(), memmove(), memset()
wmemchr(), wmemcmp(), wmemcpy(), wmemset()

wmemset()

Set wide characters in memory

Synopsis:

```
#include <wchar.h>

wchar_t * wmemset( wchar_t * ws,
                   wchar_t wc,
                   size_t n
```

Arguments:

ws	A pointer to the memory that you want to set.
wc	The value that you want to store in each wide character.
length	The number of wide characters to set.

Library:

libc

Description:

The *memset()* function fills *n* wide characters starting at *ws* with the value *wc*.

The *wmemset()* function is locale-independent and treats all **wchar_t** values identically, even if they're null or invalid wide characters.

Returns:

A pointer to the destination buffer (i.e. the same pointer as *ws*).

Classification:

ANSI

Safety	
Cancellation point	No

continued...

Safety	
Interrupt handler	Yes
Signal handler	Yes
Thread	Yes

See also:

memccpy(), memcmp(), memcpy(), memicmp(), memmove(), memset()
wmemchr(), wmemcmp(), wmemcpy(), wmemmove()

wordexp()

Perform word expansions

Synopsis:

```
#include <wordexp.h>

int wordexp( const char * words,
             wordexp_t * pwordexp,
             int flags );
```

Library:

libc

Description:

The C bindings for performing word expansions aren't currently supported.

Returns:

-1 to indicate an error (*errno* is set).

Errors:

WRDE_NOSYS

The *wordexp()* function isn't currently supported.

Classification:

POSIX 1003.1a

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

glob(), globfree(), wordfree()

wordfree()

Free a word expansion buffer

Synopsis:

```
#include <wordexp.h>

void wordfree( wordexp_t * pwordexp );
```

Library:

libc

Description:

The C bindings for performing word expansions aren't currently supported.

Classification:

POSIX 1003.1a

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

glob(), globfree(), wordexp()

wprintf()

Write formatted output to stdout

Synopsis:

```
#include <wchar.h>

int wprintf( const char* format,
             ... );
```

Arguments:

format A wide-character string that specifies the format of the output. The formatting string determines what additional arguments you need to provide. For more information, see *printf()*.

Library:

libc

Description:

The *wprintf()* function writes output to the *stdout* stream, under control of the argument *format*. It's the wide-character version of *printf()*.

Returns:

The number of characters written, or a negative value if an output error occurred (*errno* is set).

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

errno, *fprintf()*, *fwprintf()*, *printf()*, *snprintf()*, *sprintf()*, *swprintf()*, *vfprintf()*, *vfwprintf()*, *vprintf()*, *vsnprintf()*, *vsprintf()*, *vswprintf()*, *vwprintf()*

write()

Write bytes to a file

Synopsis:

```
#include <unistd.h>

ssize_t write( int fildes,
               const void* buf,
               size_t nbyte );
```

Arguments:

fildes	The file descriptor for the file you want to write in.
buf	A pointer to a buffer that contains the data you want to write.
nbyte	The number of bytes to write.

Library:

libc

Description:

The *write()* function attempts to write *nbyte* bytes to the file associated with the open file descriptor, *fildes*, from the buffer pointed to by *buf*.

If *nbyte* is zero, *write()* returns zero, and has no other effect.

On a regular file or other file capable of seeking, and if O_APPEND isn't set, *write()* starts at a position in the file given by the file offset associated with *fildes*. If O_APPEND is set, the file offset is set to the end of file before each write operation. Before successfully returning from *write()*, the file offset is incremented by the number of bytes actually written. On a regular file, if this incremented file offset is greater than the length of the file, the length of the file is set to this file offset.

Note that the *write()* call ignores advisory locks that may have been set by the *fcntl()* function.

On a file not capable of seeking, *write()* starts at the current position.

If *write()* requests that more bytes be written than there's room for (for example, all blocks on a disk are already allocated), only as many bytes as there's room for are written. For example, if there's only room for 80 more bytes in a file, a write of 512 bytes would return 80. The next write of a nonzero number of bytes would give a failure return (except as noted below).

When *write()* returns successfully, its return value is the number of bytes actually written to the file. This number is never greater then *nbyte*, although it may be less than *nbyte* under certain circumstances detailed below.

If *write()* is interrupted by a signal before it has written any data, it returns a value of -1, and *errno* is set to EINTR. However, if *write()* is interrupted by a signal after it has successfully written some data, it returns the number of bytes written.

If the value of *nbyte* is greater than INT_MAX, *write()* returns -1 and sets *errno* to EINVAL. See **<limits.h>**.

Write requests to a pipe (or FIFO) are handled the same as a regular file, with the following exceptions:

- There's no file offset associated with a pipe, therefore each write request appends to the end of the pipe.
- Write requests of PIPE_BUF bytes or less aren't interleaved with data from other processes doing writes on the same pipe. Writes of greater than PIPE_BUF bytes may have data interleaved, on arbitrary boundaries, with writes by other processes, whether or not the O_NONBLOCK flag is set.
- If the O_NONBLOCK flag is clear, a write request may cause the process to block, but on normal completion it returns *nbyte*.

- If the O_NONBLOCK flag is set, write requests are handled differently, in the following ways:
  - The *write()* function doesn't block the process.
  - Write requests for PIPE_BUF bytes or less either succeed completely and return *nbyte*, or return -1 and *errno* is set to EAGAIN.

  If you call *write()* with *nbyte* greater than PIPE_BUF bytes, it either transfers what it can and returns the number of bytes written, or transfers no data, returning -1 and setting *errno* to EAGAIN. Also, if *nbyte* is greater than PIPE_BUF bytes and all data previously written to the pipe has been read (that is, the pipe is empty), *write()* transfers at least PIPE_BUF bytes.

When attempting to write to a file (other than a pipe or FIFO) that supports nonblocking writes and can't accept the data immediately:

- If the O_NONBLOCK flag is clear, *write()* blocks until the data can be accepted.
- If the O_NONBLOCK flag is set, *write()* doesn't block the process. If some data can be written without blocking the process, *write()* transfers what it can and returns the number of bytes written. Otherwise, it returns -1 and sets *errno* to EAGAIN.

If *write()* is called with the file offset beyond the end-of-file, the file is extended to the current file offset with the intervening bytes filled with zeroes. This is a useful technique for pregrowing a file.

If *write()* succeeds, the *st_ctime* and *st_mtime* fields of the file are marked for update.

Returns:

The number of bytes written, or -1 if an error occurred (*errno* is set).

Errors:

EAGAIN	The O_NONBLOCK flag is set for the file descriptor, and the process would be delayed in the write operation.
EBADF	The file descriptor, *fildes*, isn't a valid file descriptor open for writing.
EFBIG	The file is a regular file, where *nbytes* is greater than 0, and the starting position is greater than or equal to the offset maximum associated with the file.
EINTR	The write operation was interrupted by a signal, and either no data was transferred, or the resource manager responsible for that file doesn't report partial transfers.
EIO	A physical I/O error occurred (for example, a bad block on a disk). The precise meaning is device-dependent.
ENOSPC	There's no free space remaining on the device containing the file.
ENOSYS	The *write()* function isn't implemented for the filesystem specified by *filedes*.
EPIPE	An attempt was made to write to a pipe (or FIFO) that isn't open for reading by any process. A SIGPIPE signal is also sent to the process.

Examples:

```
#include <stdio.h>
#include <fcntl.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <stdlib.h>

char buffer[] = { "A text record to be written" };

int main( void )
{
    int  fd;
    int  size_written;
```

```
    /* open a file for output          */
    /* replace existing file if it exists */
    fd = creat( "myfile.dat", S_IRUSR | S_IWUSR );

    /* write the text              */
    size_written = write( fd, buffer,
              sizeof( buffer ) );

    /* test for error              */
    if( size_written != sizeof( buffer ) ) {
        perror( "Error writing myfile.dat" );
        return EXIT_FAILURE;
    }

    /* close the file              */
    close( fd );

    return EXIT_SUCCESS;
}
```

Classification:

POSIX 1003.1

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

close(), creat(), dup(), dup2(), errno, fcntl(), lseek(), open(), pipe(), read(), readv(), select(), writev()

writeblock()

Write blocks of data to a file

Synopsis:

```
#include <unistd.h>

int writeblock( int fd,
                size_t blksize,
                unsigned block,
                int numblks,
                const void *buff );
```

Arguments:

fd	The file descriptor for the file you want to write in.
blksize	The number of bytes in each block of data.
block	The block number from which to start writing. Blocks are numbered starting at 0.
numblks	The number of blocks to write.
buff	A pointer to a buffer that contains the blocks of data that you want to write.

Library:

libc

Description:

The *writeblock()* function writes *numblks* blocks of data to the file associated with the open file descriptor, *fd*, from the buffer pointed to by *buff*, starting at block number *block*.

This function is useful for direct updating of raw blocks on a block special device (for example, raw disk blocks), but you can also use it for high-speed updating (for example, of database files). The speed gain is through the combined seek/write implicit in this call.

If *numblks* is zero, *writeblock()* returns zero, and has no other results.

If successful, *writeblock()* returns the number of blocks actually written to the disk associated with *fd*. This number is never greater than *numblks*, but could be less than *numblks* if one of the following occurs:

- The process attempts to write more blocks than implementation limits allow to be written in a single atomic operation.
- A write error occurred after writing at least one block, and you set one of the sync flags (O_SYNC or O_DSYNC — see *open()*) when you opened the file.

If a write error occurs on the first block and one of the sync flags is set, *writeblock()* returns -1 and sets *errno* to EIO.

If one of the sync flags is set, *writeblock()* doesn't return until the blocks are actually transferred to the disk. If neither of the flags is set, *writeblock()* places the blocks in the cache and schedules them for writing as soon as possible, but returns before the writing takes place.

In the latter instance, it's impossible for the application to know if the write succeeded or not (due to system failures or bad disk blocks). Using the sync flags significantly impacts the performance of *writeblock()*, but guarantees that the data can be recovered.

Returns:

The number of blocks actually written. If an error occurred, *writeblock()* returns -1, sets *errno* to indicate the error, and doesn't change the contents of the buffer pointed to by *buff*.

Errors:

EBADF	The *fd* argument isn't a valid file descriptor that's open for writing a block-oriented device.
EIO	A physical write error occurred on the first block, and either O_DSYNC or O_SYNC is set.

EINVAL The starting position is invalid (0 or negative), or beyond the end of the file.

Classification:

QNX Neutrino

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

open(), *readblock()*, *write()*

writev()

Write bytes to a file

Synopsis:

```
#include <sys/uio.h>

ssize_t writev( int fildes,
                const iov_t* iov,
                int iovcnt );
```

Arguments:

fildes	The file descriptor for the file you want to write in.
iov	An array of **iov_t** objects that contain the data that you want to write.
iovcnt	The number of elements in the array.

Library:

libc

Description:

The *writev()* function performs the same action as *write()*, but gathers the output data from the *iovcnt* buffers specified by the members of the *iov* array: *iov[0]*, *iov[1]*, . . . , *iov[iovcnt-1]*.

For *writev()*, the **iov_t** structure contains the following members:

iov_base	Base address of a memory area from which data should be written.
iov_len	The length of the memory area.

The *writev()* function always writes a complete area before proceeding to the next.

The maximum number of entries in the *iov* array is UIO_MAXIOV.

Note that *writev()* ignores advisory locks that may have been set by the *fcntl()* function.

If *writev()* is interrupted by a signal before it has written any data, it returns a value of -1, and *errno* is set to EINTR. However, if *writev()* is interrupted by a signal after it has successfully written some data, it will return the number of bytes written.

For more details, see the *write()* function.

Returns:

The number of bytes written, or -1 if an error occurs (*errno* is set).

Errors:

EAGAIN	The O_NONBLOCK flag is set for the file descriptor, and the process would be delayed in the write operation.
EBADF	The file descriptor, *fildes*, isn't a valid file descriptor open for writing.
EFBIG	The file is a regular file, where *nbytes* is greater than 0, and the starting position is greater than or equal to the offset maximum associated with the file.
EINTR	The write operation was interrupted by a signal, and either no data was transferred, or the resource manager responsible for that file doesn't report partial transfers.
EINVAL	The *iovcnt* argument is less than or equal to 0, or greater than UIO_MAXIOV.
EIO	A physical I/O error occurred (for example, a bad block on a disk). The precise meaning is device-dependent.
ENOSPC	There is no free space remaining on the device containing the file.
ENOSYS	The *write()* function isn't implemented for the filesystem specified by *filedes*.

EPIPE	An attempt was made to write to a pipe (or FIFO) that isn't open for reading by any process. A SIGPIPE signal is also sent to the process.

Classification:

Standard Unix

Safety	
Cancellation point	Yes
Interrupt handler	No
Signal handler	Yes
Thread	Yes

See also:

close(), creat(), dup(), dup2(), errno, fcntl(), lseek(), open(), pipe(), read(), readv(), select(), write()

Synopsis:

```
#include <wchar.h>

int wscanf( const char * format,
            ... );
```

Arguments:

format A wide-character string that specifies the format of the input. For more information, see *scanf()*. The formatting string determines what additional arguments you need to provide.

Library:

libc

Description:

The *wscanf()* function scans input from *stdin* under control of the *format* argument, assigning values to the remaining arguments. It is the wide-character version of *scanf()* and uses the same conversions.

Returns:

The number of input arguments for which values were successfully scanned and stored, or EOF if the scanning reached the end of the input stream before storing any values.

Classification:

ANSI

Safety	
Cancellation point	Yes
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

fscanf(), fwscanf(), scanf(), sscanf(), swscanf(), vfscanf(), vfwscanf(), vscanf(), vsscanf(), vswscanf(), vwscanf()

y0(), y0f()

Compute a Bessel function of the second kind

Synopsis:

```
#include <math.h>

double y0( double x );

float y0f( float x );
```

Arguments:

x The number that you want to compute the Bessel function for.

Library:

libbessel

Description:

Compute the Bessel function of the second kind for *x*.

Returns:

The result of the Bessel function of *x*.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Classification:

y0() is standard Unix; *y0f()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No

continued...

Safety	
Signal handler	No
Thread	Yes

See also:

errno, *j0()*, *j1()*, *jn()*, *y1()*, *yn()*

y1(), y1f()

Compute a Bessel function of the second kind

Synopsis:

```
#include <math.h>

double y1( double x );

float y1f( float x );
```

Arguments:

x The number that you want to compute the Bessel function for.

Library:

libbessel

Description:

Compute the Bessel function of the second kind for *x*.

Returns:

The result of the Bessel function of *x*.

If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Examples:

```
#include <stdlib.h>
#include <stdio.h>
#include <math.h>

int main( void )
{
    double x, y, z;

    x = j0( 2.4 );
    y = y1( 1.58 );
    z = jn( 3, 2.4 );
```

```
    printf( "j0(2.4) = %f, y1(1.58) = %f\n", x, y );
    printf( "jn(3,2.4) = %f\n", z );

    return EXIT_SUCCESS;
}
```

Classification:

y1() is standard Unix; *y1f()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, j0(), j1(), jn(), y0(), yn()

yn(), ynf()

Compute a Bessel function of the second kind

Synopsis:

```
#include <math.h>

double yn( int n,
           double x );

float ynf( int n,
           float x );
```

Arguments:

n, *x*	The numbers that you want to compute the Bessel function for.

Library:

libbessel

Description:

Compute the Bessel function of the second kind for *n* and *x*.

Returns:

The result of the Bessel function of *n* and *x*.

☞ If an error occurs, these functions return 0, but this is also a valid mathematical result. If you want to check for errors, set *errno* to 0, call the function, and then check *errno* again. These functions don't change *errno* if no errors occurred.

Classification:

yn() is standard Unix; *ynf()* is ANSI (draft)

Safety	
Cancellation point	No
Interrupt handler	No
Signal handler	No
Thread	Yes

See also:

errno, j0(), j1(), jn(), y0(), y1()

Appendix A

SOCKS — A Basic Firewall

In this appendix. . .

About SOCKS

SOCKS is a package consisting of a proxy server, client programs (**rftp** and **rtelnet**), and a library (**libsocks**) for adapting other applications into new client programs.

The original SOCKS was written by David Koblas (**koblas@netcom.com**). The SOCKS protocol has changed over time. The client library shipped as of printing corresponds to SOCKS v4.2. Since the server and the clients must use the same SOCKS protocol, this library doesn't work with servers of previous releases; clients compiled with these libraries won't work with older servers.

How to SOCKSify a client

☞ If your client is using UDP to transfer data, you can't use SOCKS. To see if your client uses UDP, search for the string "SOCK_DGRAM" in your source.

1. At or near the beginning of *main()*, you can add a call to *SOCKSinit()*.

   You can omit this step; the only reason for calling *SOCKSinit()* directly is to associate a name with your SOCKS client (rather than the generic "SOCKSclient" default string).

2. Add the following options to your compile commands:

   ```
   -Dconnect=Rconnect -Dgetsockname=Rgetsockname \
   -Dbind=Rbind -Daccept=Raccept -Dlisten=Rlisten \
   -Drcmd=Rrcmd -Dselect=Rselect
   ```

   If you're using a **Makefile**, add these options to the definition of macro CFLAGS.

   These options replace calls to certain functions with versions that use the SOCKS server:

Non-SOCKS function:	SOCKS function:
accept()	*Raccept()*
bind()	*Rbind()*
connect()	*Rconnect()*
getsockname()	*Rgetsockname()*
listen()	*Rlisten()*
rcmd()	*Rrcmd()*
select()	*Rselect()*

3 Link against the SOCKS library by adding **`-l socks`** to your link line.

If you're using a **`Makefile`**, simply add this information to the definition of the macro LDFLAGS.

For most programs, the above steps should be sufficient to SOCKSify the package. If the above doesn't work, you may need to look at things a little more closely. The next section describes how the SOCKS library expects to be used.

What SOCKS expects

The SOCKS library covers only some of the socket functions, which must be called in a particular order:

You must use TCP; SOCKS doesn't support UDP.

1 The first socket function invoked must be either *connect()* or *rcmd()*.

2 If you call *connect()* on a nonblocking socket, no I/O can occur on that socket until another *connect()*, with the same arguments, returns -1 and sets *errno* to EISCONN. This is required even if you use *select()* on write to check the readiness of that socket.

☞

While a connection is still pending, don't try to start another connection via *connect()*, or start a sequence of *bind()*, *getsockname()*, *listen()*, and *accept()*.

3 You must call *bind()* after a successful *connect()* call to a host for a specific service.

4 You must follow the call to *bind()* by calls to *getsockname()*, *listen()*, and *accept()*, in that order.

Most client programs fit these assumptions very well and can be SOCKSified without changing the code at all using the steps described in "How to SOCKSify a client."

Some client programs use a *bind()* before each *connect()*. If the *bind()* is used to claim a specific port or a specific network interface, the current SOCKS library can't accommodate such use. Very often though, such a *bind()* call is there for no specific reason and may simply be deleted.

Appendix B

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Remote Procedure Call (RPC)

SNMPv2

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SOCKS

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Appendix C

Summary of Safety Information

In this appendix. . .

Cancellation points

The following functions are cancellation points:

ConnectAttach()
ConnectAttach_r()
ConnectDetach()
ConnectDetach_r()
ConnectServerInfo()
ConnectServerInfo_r()
InterruptWait()
InterruptWait_r()
MsgSend()
MsgSend_r()
MsgSendsv()
MsgSendsv_r()
MsgSendv()
MsgSendv_r()
MsgSendvs()
MsgSendvs_r()
SignalSuspend()
SignalSuspend_r()
SignalWaitinfo()
SignalWaitinfo_r()
SyncCondvarSignal()
SyncCondvarSignal_r()
SyncCondvarWait()
SyncCondvarWait_r()
ThreadJoin()
ThreadJoin_r()
accept()
aio_suspend()
cfgopen()
chsize()
clock_nanosleep()
close()
closedir()
closelog()
connect()
creat()
creat64()
delay()
devctl()
dispatch_block()
dispatch_unblock()
dlclose()
dlopen()
ds_clear()
ds_create()
ds_deregister()
ds_flags()
ds_get()
ds_register()
ds_set()
endgrent()
endhostent()
endnetent()
endprotoent()
endpwent()
endservent()
endspent()
endutent()
eof()
err()
errx()
fcfgopen()
fchown()
fclose()
fcloseall()
fdopen()

fflush()
fgetc()
fgetchar()
fgets()
fgetspent()
fgetwc()
fgetws()
flushall()
fopen()
fopen64()
forkpty()
fprintf()
fputc()
fputchar()
fputs()
fputwc()
fputws()
fread()
freopen()
freopen64()
fscanf()
fsync()
ftell()
ftello()
ftw()
ftw64()
fwide()
fwprintf()
fwrite()
fwscanf()
getaddrinfo()
getc()
getc_unlocked()
getchar()
getchar_unlocked()
getcwd()
getgrent()
getgrgid()
getgrgid_r()
getgrnam()
getgrnam_r()
getgrouplist()
gethostbyaddr()
gethostbyaddr_r()
gethostbyname()
gethostbyname2()
gethostbyname_r()
gethostent()
gethostent_r()
gethostname()
getifaddrs()
getlogin()
getlogin_r()
getnameinfo()
getnetbyaddr()
getnetbyname()
getnetent()
getopt()
getpass()
getpeername()
getprotobyname()
getprotobynumber()
getprotoent()
getpwent()
getpwnam()
getpwnam_r()
getpwuid()
getpwuid_r()
gets()
getservbyname()
getservbyport()
getservent()
getsockname()
getsockopt()

getspent()
getspent_r()
getspnam()
getspnam_r()
getutent()
getutid()
getutline()
getw()
getwc()
getwchar()
getwd()
glob()
herror()
if_indextoname()
if_nameindex()
if_nametoindex()
initstate()
input_line()
iofunc_attr_lock()
iofunc_attr_trylock()
isfdtype()
listen()
login_tty()
ltrunc()
message_attach()
message_connect()
message_detach()
mknod()
mkstemp()
mktemp()
modem_open()
modem_read()
modem_script()
modem_write()
mount()
mq_receive()
mq_send()
mq_timedreceive()
mq_timedsend()
msync()
name_attach()
name_close()
name_detach()
name_open()
nanosleep()
nap()
napms()
nbaconnect()
nbaconnect_result()
netmgr_ndtostr()
netmgr_strtond()
nftw()
nftw64()
open()
open64()
opendir()
openfd()
openlog()
openpty()
pathfind()
pathfind_r()
pathmgr_symlink()
pathmgr_unlink()
pause()
pccard_arm()
pccard_attach()
pccard_detach()
pccard_info()
pccard_lock()
pccard_raw_read()
pccard_unlock()
pci_attach()
pci_attach_device()
pci_detach()

pci_detach_device()
pci_find_class()
pci_find_device()
pci_irq_routing_options()
pci_map_irq()
pci_present()
pci_read_config()
pci_read_config16()
pci_read_config32()
pci_read_config8()
pci_rescan_bus()
pci_write_config()
pci_write_config16()
pci_write_config32()
pci_write_config8()
pclose()
perror()
poll()
popen()
pread()
pread64()
printf()
pthread_cond_timedwait()
pthread_cond_wait()
pthread_join()
pthread_rwlock_rdlock()
pthread_rwlock_timedrdlock()
pthread_rwlock_timedwrlock()
pthread_rwlock_tryrdlock()
pthread_rwlock_trywrlock()
pthread_rwlock_wrlock()
pthread_sleepon_lock()
pthread_sleepon_timedwait()
pthread_sleepon_wait()
pthread_testcancel()
pulse_attach()
putc()
putc_unlocked()
putchar()
putchar_unlocked()
puts()
putspent()
pututline()
putw()
putwc()
putwchar()
pwrite()
pwrite64()
rcmd()
read()
read_main_config_file()
readblock()
readcond()
readdir()
readv()
realpath()
recv()
recvfrom()
recvmsg()
remove()
rename()
res_init()
res_mkquery()
res_query()
res_querydomain()
res_search()
res_send()
resmgr_attach()
resmgr_block()
resmgr_context_alloc()
resmgr_context_free()
resmgr_detach()
resmgr_devino()
resmgr_handler()

rewind()
rewinddir()
rresvport()
rsrcdbmgr_attach()
rsrcdbmgr_create()
rsrcdbmgr_destroy()
rsrcdbmgr_detach()
rsrcdbmgr_devno_attach()
rsrcdbmgr_devno_detach()
rsrcdbmgr_query()
ruserok()
scandir()
scanf()
sctp_bindx()
sctp_connectx()
sctp_getladdrs()
sctp_getpaddrs()
sctp_peeloff()
sctp_recvmsg()
sctp_sendmsg()
seekdir()
select_attach()
select_detach()
sem_timedwait()
sem_wait()
send()
sendmsg()
sendto()
setgrent()
setgroups()
sethostname()
setnetent()
setprotoent()
setpwent()
setservent()
setsockopt()
setutent()
shm_ctl()
shutdown()
sigpause()
sigsuspend()
sigtimedwait()
sigwait()
sigwaitinfo()
sleep()
slogb()
slogf()
slogi()
snmp_close()
snmp_open()
snmp_read()
snmp_send()
snmp_timeout()
sockatmark()
socket()
socketpair()
sopen()
sopenfd()
sysctl()
syslog()
system()
tcdrain()
tell()
tell64()
telldir()
thread_pool_control()
thread_pool_destroy()
thread_pool_limits()
thread_pool_start()
tmpfile()
tmpfile64()
tmpnam()
truncate()
umount()

ungetc()
ungetwc()
unlink()
usleep()
utmpname()
verr()
verrx()
vfscanf()
vfwscanf()
vscanf()
vslogf()
vsyslog()
vwarn()
vwarnx()
vwscanf()
wait()
wait3()
wait4()
waitid()
waitpid()
warn()
warnx()
wordexp()
wprintf()
write()
writeblock()
writev()
wscanf()

See the "Caveats" section for the following functions for more information:

dispatch_handler()
fcntl()
spawnl()
spawnle()
spawnlp()
spawnlpe()
spawnv()
spawnve()
spawnvp()
spawnvpe()

Interrupt handlers

It's safe to call the following functions from an interrupt handler:

ENDIAN_BE16()
ENDIAN_BE32()
ENDIAN_BE64()
ENDIAN_LE16()
ENDIAN_LE32()
ENDIAN_LE64()
ENDIAN_RET16()
ENDIAN_RET32()
ENDIAN_RET64()
ENDIAN_SWAP16()
ENDIAN_SWAP32()
ENDIAN_SWAP64()
GETIOVBASE()
GETIOVLEN()
InterruptDisable()
InterruptEnable()
InterruptLock()
InterruptMask()

InterruptUnlock()
InterruptUnmask()
ND_NODE_CMP()
SETIOV()
SYSPAGE_CPU_ENTRY()
SYSPAGE_ENTRY()
UNALIGNED_PUT16()
UNALIGNED_PUT32()
UNALIGNED_PUT64()
UNALIGNED_RET16()
UNALIGNED_RET32()
UNALIGNED_RET64()
_RESMGR_NPARTS()
_RESMGR_PTR()
_RESMGR_STATUS()
abs()
alphasort()
atoh()
atoi()
atol()
atoll()
atomic_add()
atomic_add_value()
atomic_clr()
atomic_clr_value()
atomic_set()
atomic_set_value()
atomic_sub()
atomic_sub_value()
atomic_toggle()
atomic_toggle_value()
basename()
bcmp()
bcopy()
bsearch()
bzero()
div()
gai_strerror()
htonl()
htons()
hwi_find_item()
hwi_find_tag()
hwi_off2tag()
hwi_tag2off()
in16()
in16s()
in32()
in32s()
in8()
in8s()
inbe16()
inbe32()
inle16()
inle32()
ipsec_get_policylen()
ipsec_strerror()
isalnum()
isalpha()
isascii()
iscntrl()
isdigit()
isgraph()
islower()
isprint()
ispunct()
isspace()
isupper()
iswalnum()
iswalpha()
iswcntrl()
iswdigit()
iswgraph()
iswlower()
iswprint()

iswpunct()
iswspace()
iswupper()
iswxdigit()
isxdigit()
itoa()
lltoa()
lsearch()
ltoa()
max()
memccpy()
memchr()
memcmp()
memcpy()
memcpyv()
memicmp()
memmove()
memset()
min()
nanospin_count()
nsec2timespec()
ntohl()
ntohs()
offsetof()
out16()
out16s()
out32()
out32s()
out8()
out8s()
outbe16()
outbe32()
outle16()
outle32()
rindex()
setdomainname()
sigaddset()
sigdelset()
sigemptyset()
sigfillset()
sigismember()
sigmask()
straddstr()
strcasecmp()
strcat()
strchr()
strcmp()
strcmpi()
strcoll()
strcpy()
strcspn()
stricmp()
strlen()
strlwr()
strncasecmp()
strncat()
strncmp()
strncpy()
strnicmp()
strnset()
strpbrk()
strrchr()
strrev()
strsep()
strset()
strspn()
strstr()
strtoimax()
strtok_r()
strtol()
strtoll()
strtoul()
strtoull()
strtoumax()

strupr()
strxfrm()
swab()
timespec2nsec()
tolower()
toupper()
towctrans()
towlower()
towupper()
ulltoa()
ultoa()
utoa()
va_arg()
va_copy()
va_end()
va_start()
wcscat()
wcschr()
wcscmp()
wcscpy()
wcscspn()
wcslen()
wcsncat()
wcsncmp()
wcsncpy()
wcspbrk()
wcsrchr()
wcsspn()
wcsstr()
wcstoimax()
wcstol()
wcstoll()
wcstoul()
wcstoull()
wcstoumax()
wctrans()
wctype()
wmemchr()
wmemcmp()
wmemcpy()
wmemmove()
wmemset()

See the “Caveats” section for the following functions for more information:

TraceEvent()
nanospin()
nanospin_ns()
nanospin_ns_to_count()

Signal handlers

It’s safe to call the following functions from a signal handler:

ChannelCreate()
ChannelCreate_r()
ChannelDestroy()
ChannelDestroy_r()
ClockAdjust()
ClockAdjust_r()
ClockCycles()
ClockId()
ClockId_r()
ClockPeriod()

ClockPeriod_r()
ClockTime()
ClockTime_r()
ConnectAttach()
ConnectAttach_r()
ConnectClientInfo()
ConnectClientInfo_r()
ConnectDetach()
ConnectDetach_r()
ConnectFlags()
ConnectFlags_r()
ConnectServerInfo()
ConnectServerInfo_r()
DebugBreak()
DebugKDBreak()
DebugKDOutput()
ENDIAN_BE16()
ENDIAN_BE32()
ENDIAN_BE64()
ENDIAN_LE16()
ENDIAN_LE32()
ENDIAN_LE64()
ENDIAN_RET16()
ENDIAN_RET32()
ENDIAN_RET64()
ENDIAN_SWAP16()
ENDIAN_SWAP32()
ENDIAN_SWAP64()
GETIOVBASE()
GETIOVLEN()
InterruptAttach()
InterruptAttachEvent()
InterruptAttachEvent_r()
InterruptAttach_r()
InterruptDetach()
InterruptDetach_r()
InterruptDisable()
InterruptEnable()
InterruptHookIdle()
InterruptHookTrace()
InterruptLock()
InterruptMask()
InterruptUnlock()
InterruptUnmask()
InterruptWait()
InterruptWait_r()
MsgDeliverEvent()
MsgDeliverEvent_r()
MsgError()
MsgError_r()
MsgInfo()
MsgInfo_r()
MsgKeyData()
MsgKeyData_r()
MsgRead()
MsgRead_r()
MsgReadv()
MsgReadv_r()
MsgReceive()
MsgReceivePulse()
MsgReceivePulse_r()
MsgReceivePulsev()
MsgReceivePulsev_r()
MsgReceive_r()
MsgReceivev()
MsgReceivev_r()
MsgReply()
MsgReply_r()
MsgReplyv()
MsgReplyv_r()
MsgSend()
MsgSendPulse()
MsgSendPulse_r()
MsgSend_r()

MsgSendnc()
MsgSendnc_r()
MsgSendsv()
MsgSendsv_r()
MsgSendsvnc()
MsgSendsvnc_r()
MsgSendv()
MsgSendv_r()
MsgSendvnc()
MsgSendvnc_r()
MsgSendvs()
MsgSendvs_r()
MsgSendvsnc()
MsgSendvsnc_r()
MsgVerifyEvent()
MsgVerifyEvent_r()
MsgWrite()
MsgWrite_r()
MsgWritev()
MsgWritev_r()
ND_NODE_CMP()
SETIOV()
SYSPAGE_CPU_ENTRY()
SYSPAGE_ENTRY()
SchedGet()
SchedGet_r()
SchedInfo()
SchedInfo_r()
SchedSet()
SchedSet_r()
SchedYield()
SchedYield_r()
SignalAction()
SignalAction_r()
SignalKill()
SignalKill_r()
SignalProcmask()
SignalProcmask_r()
SignalSuspend()
SignalSuspend_r()
SignalWaitinfo()
SignalWaitinfo_r()
SyncCondvarSignal()
SyncCondvarSignal_r()
SyncCondvarWait()
SyncCondvarWait_r()
SyncCtl()
SyncCtl_r()
SyncDestroy()
SyncDestroy_r()
SyncMutexEvent()
SyncMutexEvent_r()
SyncMutexLock()
SyncMutexLock_r()
SyncMutexRevive()
SyncMutexRevive_r()
SyncMutexUnlock()
SyncMutexUnlock_r()
SyncSemPost()
SyncSemPost_r()
SyncSemWait()
SyncSemWait_r()
SyncTypeCreate()
SyncTypeCreate_r()
ThreadCancel()
ThreadCancel_r()
ThreadCreate()
ThreadCreate_r()
ThreadCtl()
ThreadCtl_r()
ThreadDestroy()
ThreadDestroy_r()
ThreadDetach()
ThreadDetach_r()

ThreadJoin()
ThreadJoin_r()
TimerAlarm()
TimerAlarm_r()
TimerCreate()
TimerCreate_r()
TimerDestroy()
TimerDestroy_r()
TimerInfo()
TimerInfo_r()
TimerSettime()
TimerSettime_r()
TimerTimeout()
TimerTimeout_r()
TraceEvent()
UNALIGNED_PUT16()
UNALIGNED_PUT32()
UNALIGNED_PUT64()
UNALIGNED_RET16()
UNALIGNED_RET32()
UNALIGNED_RET64()
_RESMGR_NPARTS()
_RESMGR_PTR()
_RESMGR_STATUS()
_exit()
_intr_v86()
_sfree()
abs()
access()
aio_cancel()
aio_error()
aio_fsync()
aio_read()
aio_return()
aio_suspend()
aio_write()
alarm()
alloca()
alphasort()
asctime()
asctime_r()
atoh()
atoi()
atol()
atoll()
atomic_add()
atomic_add_value()
atomic_clr()
atomic_clr_value()
atomic_set()
atomic_set_value()
atomic_sub()
atomic_sub_value()
atomic_toggle()
atomic_toggle_value()
basename()
bcmp()
bcopy()
bsearch()
btowc()
bzero()
cfgetispeed()
cfgetospeed()
cfgopen()
cfmakeraw()
cfsetispeed()
cfsetospeed()
chdir()
chmod()
chown()
chsize()
clock()
clock_getcpuclockid()
clock_getres()

clock_gettime()
clock_nanosleep()
clock_settime()
close()
confstr()
creat()
creat64()
ctime()
ctime_r()
daemon()
delay()
devctl()
dirname()
dispatch_block()
dispatch_unblock()
div()
dn_comp()
dn_expand()
ds_clear()
ds_create()
ds_deregister()
ds_flags()
ds_get()
ds_register()
ds_set()
dup()
dup2()
eaccess()
encrypt()
eof()
err()
errx()
execle()
execve()
execvpe()
fcfgopen()
fchmod()
fchown()
fcntl()
fdatasync()
ffs()
fileno()
flink()
flock()
fnmatch()
fork()
forkpty()
fpathconf()
fseek()
fseeko()
fsetpos()
fstat()
fstat64()
fstatvfs()
fstatvfs64()
fsync()
ftime()
ftruncate()
ftruncate64()
ftrylockfile()
ftw()
ftw64()
futime()
fwide()
gai_strerror()
getdomainname()
getdtablesize()
getegid()
geteuid()
getgid()
getgrouplist()
getgroups()
gethostname()
getitimer()

getpgid()
getpgrp()
getpid()
getppid()
getprio()
getrlimit()
getrlimit64()
getrusage()
getsubopt()
gettimeofday()
getuid()
getw()
getwd()
glob()
globfree()
gmtime_r()
hsearch()
hstrerror()
htonl()
htons()
hwi_find_item()
hwi_find_tag()
hwi_off2tag()
hwi_tag2off()
in16()
in16s()
in32()
in32s()
in8()
in8s()
inbe16()
inbe32()
index()
inet6_option_*()
inet6_rthdr_*()
inet_addr()
inet_aton()
inet_lnaof()
inet_makeaddr()
inet_netof()
inet_network()
inet_ntop()
inet_pton()
inle16()
inle32()
iofdinfo()
iofunc_attr_init()
iofunc_attr_lock()
iofunc_attr_trylock()
iofunc_attr_unlock()
iofunc_check_access()
iofunc_chmod()
iofunc_chmod_default()
iofunc_chown()
iofunc_chown_default()
iofunc_client_info()
iofunc_close_dup()
iofunc_close_dup_default()
iofunc_close_ocb()
iofunc_close_ocb_default()
iofunc_devctl()
iofunc_devctl_default()
iofunc_fdinfo()
iofunc_fdinfo_default()
iofunc_func_init()
iofunc_link()
iofunc_lock()
iofunc_lock_calloc()
iofunc_lock_default()
iofunc_lock_free()
iofunc_lock_ocb_default()
iofunc_lseek()
iofunc_lseek_default()
iofunc_mknod()

iofunc_mmap()
iofunc_mmap_default()
iofunc_notify()
iofunc_notify_remove()
iofunc_notify_trigger()
iofunc_ocb_attach()
iofunc_ocb_calloc()
iofunc_ocb_detach()
iofunc_ocb_free()
iofunc_open()
iofunc_open_default()
iofunc_openfd()
iofunc_openfd_default()
iofunc_pathconf()
iofunc_pathconf_default()
iofunc_read_default()
iofunc_read_verify()
iofunc_readlink()
iofunc_rename()
iofunc_space_verify()
iofunc_stat()
iofunc_stat_default()
iofunc_sync()
iofunc_sync_default()
iofunc_sync_verify()
iofunc_time_update()
iofunc_unblock()
iofunc_unblock_default()
iofunc_unlink()
iofunc_unlock_ocb_default()
iofunc_utime()
iofunc_utime_default()
iofunc_write_default()
ionotify()
ipsec_get_policylen()
ipsec_strerror()
isalnum()
isalpha()
isascii()
iscntrl()
isdigit()
isfdtype()
isgraph()
islower()
isprint()
ispunct()
isspace()
isupper()
iswalnum()
iswalpha()
iswcntrl()
iswctype()
iswdigit()
iswgraph()
iswlower()
iswprint()
iswpunct()
iswspace()
iswupper()
iswxdigit()
isxdigit()
itoa()
kill()
killpg()
labs()
lchown()
ldiv()
lfind()
link()
lio_listio()
lltoa()
localtime_r()
lockf()
login_tty()

longjmp()
lsearch()
lseek()
lseek64()
lstat()
lstat64()
ltoa()
max()
mblen()
mbrlen()
mbrtowc()
mbsinit()
mbsrtowcs()
mbstowcs()
mbtowc()
mem_offset()
mem_offset64()
memalign()
memccpy()
memchr()
memcmp()
memcpy()
memcpyv()
memicmp()
memmove()
memset()
min()
mkdir()
mkfifo()
mknod()
mkstemp()
mktemp()
mktime()
mmap()
mmap64()
mmap_device_io()
mmap_device_memory()
modem_open()
modem_write()
mount()
mprotect()
mq_timedreceive()
mq_timedsend()
msync()
munmap()
munmap_device_io()
munmap_device_memory()
name_close()
name_open()
nanospin()
nanospin_calibrate()
nanospin_count()
nanospin_ns()
nanospin_ns_to_count()
nap()
napms()
nbaconnect_result()
netmgr_ndtostr()
netmgr_remote_nd()
netmgr_strtond()
nftw()
nftw64()
nice()
nsec2timespec()
ntohl()
ntohs()
offsetof()
open()
open64()
openfd()
openpty()
out16()
out16s()
out32()

out32s()
out8()
out8s()
outbe16()
outbe32()
outle16()
outle32()
pathconf()
pathfind()
pathfind_r()
pathmgr_symlink()
pathmgr_unlink()
pause()
pccard_arm()
pccard_attach()
pccard_detach()
pccard_info()
pccard_lock()
pccard_raw_read()
pccard_unlock()
pci_attach()
pci_attach_device()
pci_detach()
pci_detach_device()
pci_find_class()
pci_find_device()
pci_irq_routing_options()
pci_map_irq()
pci_present()
pci_read_config()
pci_read_config16()
pci_read_config32()
pci_read_config8()
pci_rescan_bus()
pci_write_config()
pci_write_config16()
pci_write_config32()
pci_write_config8()
pipe()
posix_mem_offset()
posix_mem_offset64()
posix_memalign()
pread()
pread64()
procmgr_daemon()
procmgr_event_notify()
procmgr_event_trigger()
procmgr_guardian()
pthread_abort()
pthread_atfork()
pthread_attr_destroy()
pthread_attr_getdetachstate()
pthread_attr_getguardsize()
pthread_attr_getinheritsched()
pthread_attr_getschedparam()
pthread_attr_getschedpolicy()
pthread_attr_getscope()
pthread_attr_getstackaddr()
pthread_attr_getstacklazy()
pthread_attr_getstacksize()
pthread_attr_init()
pthread_attr_setdetachstate()
pthread_attr_setguardsize()
pthread_attr_setinheritsched()
pthread_attr_setschedparam()
pthread_attr_setschedpolicy()
pthread_attr_setscope()
pthread_attr_setstackaddr()
pthread_attr_setstacklazy()
pthread_attr_setstacksize()
pthread_barrier_destroy()
pthread_barrier_init()
pthread_barrier_wait()
pthread_barrierattr_destroy()

pthread_barrierattr_getpshared()
pthread_barrierattr_init()
pthread_barrierattr_setpshared()
pthread_cancel()
pthread_cleanup_pop()
pthread_cleanup_push()
pthread_cond_broadcast()
pthread_cond_destroy()
pthread_cond_init()
pthread_cond_signal()
pthread_cond_timedwait()
pthread_cond_wait()
pthread_condattr_destroy()
pthread_condattr_getclock()
pthread_condattr_getpshared()
pthread_condattr_init()
pthread_condattr_setclock()
pthread_condattr_setpshared()
pthread_create()
pthread_detach()
pthread_equal()
pthread_exit()
pthread_getconcurrency()
pthread_getcpuclockid()
pthread_getschedparam()
pthread_getspecific()
pthread_join()
pthread_key_delete()
pthread_kill()
pthread_mutex_destroy()
pthread_mutex_getprioceiling()
pthread_mutex_init()
pthread_mutex_lock()
pthread_mutex_setprioceiling()
pthread_mutex_timedlock()
pthread_mutex_trylock()
pthread_mutex_unlock()
pthread_mutexattr_destroy()
pthread_mutexattr_getprioceiling()
pthread_mutexattr_getprotocol()
pthread_mutexattr_getpshared()
pthread_mutexattr_getrecursive()
pthread_mutexattr_gettype()
pthread_mutexattr_init()
pthread_mutexattr_setprioceiling()
pthread_mutexattr_setprotocol()
pthread_mutexattr_setpshared()
pthread_mutexattr_setrecursive()
pthread_mutexattr_settype()
pthread_once()
pthread_rwlock_destroy()
pthread_rwlock_init()
pthread_rwlock_rdlock()
pthread_rwlock_timedrdlock()
pthread_rwlock_timedwrlock()
pthread_rwlock_tryrdlock()
pthread_rwlock_trywrlock()
pthread_rwlock_unlock()
pthread_rwlock_wrlock()
pthread_rwlockattr_destroy()
pthread_rwlockattr_getpshared()
pthread_rwlockattr_init()
pthread_rwlockattr_setpshared()
pthread_self()
pthread_setcancelstate()
pthread_setcanceltype()
pthread_setconcurrency()
pthread_setschedparam()
pthread_sigmask()
pthread_sleepon_broadcast()
pthread_sleepon_lock()
pthread_sleepon_signal()
pthread_sleepon_timedwait()
pthread_sleepon_unlock()

pthread_sleepon_wait()
pthread_spin_destroy()
pthread_spin_init()
pthread_spin_lock()
pthread_spin_trylock()
pthread_spin_unlock()
pthread_testcancel()
pthread_timedjoin()
putw()
pwrite()
pwrite64()
qnx_crypt()
raise()
rand()
rand_r()
random()
rdchk()
re_comp()
re_exec()
read()
readblock()
readcond()
readdir_r()
readlink()
readv()
realpath()
regerror()
rename()
resmgr_msgread()
resmgr_msgreadv()
resmgr_msgwrite()
resmgr_msgwritev()
resmgr_pathname()
rewinddir()
rindex()
rmdir()
rsrcdbmgr_attach()
rsrcdbmgr_create()
rsrcdbmgr_destroy()
rsrcdbmgr_detach()
rsrcdbmgr_devno_attach()
rsrcdbmgr_devno_detach()
rsrcdbmgr_query()
scandir()
sched_get_priority_adjust()
sched_get_priority_max()
sched_get_priority_min()
sched_getparam()
sched_getscheduler()
sched_rr_get_interval()
sched_setparam()
sched_setscheduler()
sched_yield()
sem_close()
sem_destroy()
sem_getvalue()
sem_open()
sem_post()
sem_timedwait()
sem_trywait()
sem_unlink()
sem_wait()
setdomainname()
setegid()
seteuid()
setgid()
sethostname()
setitimer()
setjmp()
setpgid()
setpgrp()
setprio()
setregid()
setreuid()

setrlimit()
setrlimit64()
setsid()
settimeofday()
setuid()
setutent()
shm_ctl()
shm_open()
shm_unlink()
sigaction()
sigaddset()
sigblock()
sigdelset()
sigemptyset()
sigfillset()
sigismember()
siglongjmp()
sigmask()
signal()
sigpause()
sigpending()
sigprocmask()
sigqueue()
sigsetjmp()
sigsetmask()
sigsuspend()
sigtimedwait()
sigunblock()
sigwait()
sigwaitinfo()
sleep()
slogb()
slogf()
slogi()
snprintf()
sopenfd()
spawn()
sprintf()
srand()
srand48()
sscanf()
stat()
stat64()
statvfs()
statvfs64()
straddstr()
strcasecmp()
strcat()
strchr()
strcmp()
strcmpi()
strcoll()
strcpy()
strcspn()
strerror()
strftime()
stricmp()
strlen()
strlwr()
strncasecmp()
strncat()
strncmp()
strncpy()
strnicmp()
strnset()
strpbrk()
strrchr()
strrev()
strsep()
strset()
strsignal()
strspn()
strstr()
strtod()

strtoimax()
strtok_r()
strtol()
strtoll()
strtoul()
strtoull()
strtoumax()
strupr()
strxfrm()
swab()
swprintf()
swscanf()
symlink()
sync()
sysconf()
sysmgr_reboot()
tcdrain()
tcdropline()
tcflow()
tcflush()
tcgetattr()
tcgetpgrp()
tcgetsid()
tcgetsize()
tcinject()
tcischars()
tcsendbreak()
tcsetattr()
tcsetpgrp()
tcsetsize()
tell()
tell64()
time()
timer_create()
timer_delete()
timer_getexpstatus()
timer_getoverrun()
timer_gettime()
timer_settime()
timer_timeout()
timer_timeout_r()
times()
timespec2nsec()
tolower()
toupper()
towctrans()
towlower()
towupper()
truncate()
ttyname_r()
ualarm()
ulltoa()
ultoa()
umask()
uname()
unlink()
unsetenv()
usleep()
utime()
utimes()
utmpname()
utoa()
va_arg()
va_copy()
va_end()
va_start()
valloc()
verr()
verrx()
vslogf()
vwarn()
vwarnx()
wait()
wait3()

wait4()
waitid()
waitpid()
warn()
warnx()
wcrtomb()
wcscat()
wcschr()
wcscmp()
wcscoll()
wcscpy()
wcscspn()
wcscxfrm()
wcsftime()
wcslen()
wcsncat()
wcsncmp()
wcsncpy()
wcspbrk()
wcsrchr()
wcsrtombs()
wcsspn()
wcsstr()
wcstod()
wcstof()
wcstoimax()
wcstok()
wcstol()
wcstold()
wcstoll()
wcstombs()
wcstoul()
wcstoull()
wcstoumax()
wctob()
wctomb()
wctrans()
wctype()
wmemchr()
wmemcmp()
wmemcpy()
wmemmove()
wmemset()
wordexp()
wordfree()
write()
writeblock()
writev()

See the “Caveats” section for the following functions for more information:

abort()
modem_read()
modem_script()
vsnprintf()
vsprintf()
vsscanf()
vswprintf()
vswscanf()

Multithreaded programs

CAUTION: It *isn't* safe to call these functions from a multithreaded program.

Raccept()
Rbind()
Rconnect()
Rgetsockname()
Rlisten()
Rrcmd()
Rselect()
SOCKSinit()
bindresvport()
crypt()
daemon()
drand48()
endgrent()
endhostent()
endnetent()
endprotoent()
endpwent()
endservent()
endspent()
endutent()
fgetspent()
getaddrinfo()
getc_unlocked()
getchar_unlocked()
getenv()
getgrent()
getgrgid()
getgrnam()
gethostbyaddr()
gethostbyname()
gethostbyname2()
gethostent()
getlogin()
getnameinfo()
getnetbyaddr()
getnetbyname()
getnetent()
getopt()
getpass()
getprotobyname()
getprotobynumber()
getprotoent()
getpwent()
getpwnam()
getpwuid()
getservbyname()
getservbyport()
getservent()
gmtime()
herror()
inet_ntoa()
initgroups()
initstate()
input_line()
ioctl()
lcong48()
localtime()
lrand48()
lstat()
lstat64()
mrand48()
pclose()
popen()
putc_unlocked()
putchar_unlocked()
putenv()

putspent()
rand()
random()
rcmd()
read_main_config_file()
readdir()
res_init()
res_mkquery()
res_query()
res_querydomain()
res_search()
res_send()
ruserok()
seekdir()
select()
setenv()
setgrent()
setgroups()
sethostent()
setkey()
setlogmask()
setnetent()
setprotoent()
setpwent()
setservent()
setspent()
setstate()
sigblock()
snmp_close()
snmp_free_pdu()
snmp_open()
snmp_pdu_create()
snmp_read()
snmp_select_info()
snmp_send()
snmp_timeout()
sockatmark()
srandom()
strtok()
syslog()
telldir()
tempnam()
ttyname()
vfork()
vsyslog()
wcscoll()

See the “Caveats” section for the following functions for more information:

ctermid()
modem_read()
modem_script()
tmpnam()

Glossary

A20 gate

On x86-based systems, a hardware component that forces the A20 address line on the bus to zero, regardless of the actual setting of the A20 address line on the processor. This component is in place to support legacy systems, but the QNX Neutrino OS doesn't require any such hardware. Note that some processors, such as the 386EX, have the A20 gate hardware built right into the processor itself — our IPL will disable the A20 gate as soon as possible after startup.

adaptive

Scheduling algorithm whereby a thread's priority is decayed by 1. See also **FIFO**, **round robin**, and **sporadic**.

atomic

Of or relating to atoms. :-)

In operating systems, this refers to the requirement that an operation, or sequence of operations, be considered *indivisible*. For example, a thread may need to move a file position to a given location and read data. These operations must be performed in an atomic manner; otherwise, another thread could preempt the original thread and move the file position to a different location, thus causing the original thread to read data from the second thread's position.

attributes structure

Structure containing information used on a per-resource basis (as opposed to the **OCB**, which is used on a per-open basis).

This structure is also known as a **handle**. The structure definition is fixed (`iofunc_attr_t`), but may be extended. See also **mount structure**.

bank-switched

A term indicating that a certain memory component (usually the device holding an **image**) isn't entirely addressable by the processor. In this case, a hardware component manifests a small portion (or "window") of the device onto the processor's address bus. Special

commands have to be issued to the hardware to move the window to different locations in the device. See also **linearly mapped**.

base layer calls

Convenient set of library calls for writing resource managers. These calls all start with *resmgr_*()*. Note that while some base layer calls are unavoidable (e.g. *resmgr_pathname_attach()*), we recommend that you use the **POSIX layer calls** where possible.

BIOS/ROM Monitor extension signature

A certain sequence of bytes indicating to the BIOS or ROM Monitor that the device is to be considered an "extension" to the BIOS or ROM Monitor — control is to be transferred to the device by the BIOS or ROM Monitor, with the expectation that the device will perform additional initializations.

On the x86 architecture, the two bytes 0x55 and 0xAA must be present (in that order) as the first two bytes in the device, with control being transferred to offset 0x0003.

block-integral

The requirement that data be transferred such that individual structure components are transferred in their entirety — no partial structure component transfers are allowed.

In a resource manager, directory data must be returned to a client as **block-integral** data. This means that only complete **`struct dirent`** structures can be returned — it's inappropriate to return partial structures, assuming that the next _IO_READ request will "pick up" where the previous one left off.

bootable

An image can be either bootable or **nonbootable**. A bootable image is one that contains the startup code that the IPL can transfer control to.

bootfile

The part of an OS image that runs the **startup code** and the Neutrino microkernel.

budget

In **sporadic** scheduling, the amount of time a thread is permitted to execute at its normal priority before being dropped to its low priority.

buildfile

A text file containing instructions for **`mkifs`** specifying the contents and other details of an **image**, or for **`mkefs`** specifying the contents and other details of an embedded filesystem image.

canonical mode

Also called edited mode or "cooked" mode. In this mode the character device library performs line-editing operations on each received character. Only when a line is "completely entered" — typically when a carriage return (CR) is received — will the line of data be made available to application processes. Contrast **raw mode**.

channel

A kernel object used with message passing.

In QNX Neutrino, message passing is directed towards a **connection** (made to a channel); threads can receive messages from channels. A thread that wishes to receive messages creates a channel (using *ChannelCreate()*), and then receives messages from that channel (using *MsgReceive()*). Another thread that wishes to send a message to the first thread must make a connection to that channel by "attaching" to the channel (using *ConnectAttach()*) and then sending data (using *MsgSend()*).

CIFS

Common Internet File System (aka SMB) — a protocol that allows a client workstation to perform transparent file access over a network to a Windows 95/98/NT server. Client file access calls are converted to

CIFS protocol requests and are sent to the server over the network. The server receives the request, performs the actual filesystem operation, and sends a response back to the client.

CIS

Card Information Structure — a data block that maintains information about flash configuration. The CIS description includes the types of memory devices in the regions, the physical geometry of these devices, and the partitions located on the flash.

combine message

A resource manager message that consists of two or more messages. The messages are constructed as combine messages by the client's C library (e.g. *stat()*, *readblock()*), and then handled as individual messages by the resource manager.

The purpose of combine messages is to conserve network bandwidth and/or to provide support for atomic operations. See also **connect message** and **I/O message**.

connect message

In a resource manager, a message issued by the client to perform an operation based on a pathname (e.g. an `io_open` message). Depending on the type of connect message sent, a context block (see **OCB**) may be associated with the request and will be passed to subsequent I/O messages. See also **combine message** and **I/O message**.

connection

A kernel object used with message passing.

Connections are created by client threads to "connect" to the channels made available by servers. Once connections are established, clients can *MsgSendv()* messages over them. If a number of threads in a process all attach to the same channel, then the one connection is shared among all the threads. Channels and connections are identified within a process by a small integer.

The key thing to note is that connections and file descriptors (**FD**) are one and the same object. See also **channel** and **FD**.

context

Information retained between invocations of functionality.

When using a resource manager, the client sets up an association or **context** within the resource manager by issuing an *open()* call and getting back a file descriptor. The resource manager is responsible for storing the information required by the context (see **OCB**). When the client issues further file-descriptor based messages, the resource manager uses the OCB to determine the context for interpretation of the client's messages.

cooked mode

See **canonical mode**.

core dump

A file describing the state of a process that terminated abnormally.

critical section

A code passage that *must* be executed "serially" (i.e. by only one thread at a time). The simplest from of critical section enforcement is via a **mutex**.

deadlock

A condition in which one or more threads are unable to continue due to resource contention. A common form of deadlock can occur when one thread sends a message to another, while the other thread sends a message to the first. Both threads are now waiting for each other to reply to the message. Deadlock can be avoided by good design practices or massive kludges — we recommend the good design approach.

device driver

A process that allows the OS and application programs to make use of the underlying hardware in a generic way (e.g. a disk drive, a network interface). Unlike OSs that require device drivers to be tightly bound into the OS itself, device drivers for QNX Neutrino are standard processes that can be started and stopped dynamically. As a result, adding device drivers doesn't affect any other part of the OS — drivers can be developed and debugged like any other application. Also, device drivers are in their own protected address space, so a bug in a device driver won't cause the entire OS to shut down.

DNS

Domain Name Service — an Internet protocol used to convert ASCII domain names into IP addresses. In QNX native networking, **`dns`** is one of **Qnet**'s builtin resolvers.

dynamic bootfile

An OS image built on the fly. Contrast **static bootfile**.

dynamic linking

The process whereby you link your modules in such a way that the Process Manager will link them to the library modules before your program runs. The word "dynamic" here means that the association between your program and the library modules that it uses is done *at load time*, not at linktime. Contrast **static linking**. See also **runtime loading**.

edge-sensitive

One of two ways in which a **PIC** (Programmable Interrupt Controller) can be programmed to respond to interrupts. In edge-sensitive mode, the interrupt is "noticed" upon a transition to/from the rising/falling edge of a pulse. Contrast **level-sensitive**.

edited mode

See **canonical mode**.

EOI

End Of Interrupt — a command that the OS sends to the PIC after processing all Interrupt Service Routines (ISR) for that particular interrupt source so that the PIC can reset the processor's In Service Register. See also **PIC** and **ISR**.

EPROM

Erasable Programmable Read-Only Memory — a memory technology that allows the device to be programmed (typically with higher-than-operating voltages, e.g. 12V), with the characteristic that any bit (or bits) may be individually programmed from a 1 state to a 0 state. To change a bit from a 0 state into a 1 state can only be accomplished by erasing the *entire* device, setting *all* of the bits to a 1 state. Erasing is accomplished by shining an ultraviolet light through the erase window of the device for a fixed period of time (typically 10-20 minutes). The device is further characterized by having a limited number of erase cycles (typically 10e5 - 10e6). Contrast **flash** and **RAM**.

event

A notification scheme used to inform a thread that a particular condition has occurred. Events can be signals or pulses in the general case; they can also be unblocking events or interrupt events in the case of kernel timeouts and interrupt service routines. An event is delivered by a thread, a timer, the kernel, or an interrupt service routine when appropriate to the requestor of the event.

FD

File Descriptor — a client must open a file descriptor to a resource manager via the *open()* function call. The file descriptor then serves as a handle for the client to use in subsequent messages. Note that a file descriptor is the exact same object as a connection ID (*coid*, returned by *ConnectAttach()*).

FIFO

First In First Out — a scheduling algorithm whereby a thread is able to consume CPU at its priority level without bounds. See also **adaptive**, **round robin**, and **sporadic**.

flash memory

A memory technology similar in characteristics to **EPROM** memory, with the exception that erasing is performed electrically instead of via ultraviolet light, and, depending upon the organization of the flash memory device, erasing may be accomplished in blocks (typically 64k bytes at a time) instead of the entire device. Contrast **EPROM** and **RAM**.

FQNN

Fully Qualified NodeName — a unique name that identifies a QNX Neutrino node on a network. The FQNN consists of the nodename plus the node domain tacked together.

garbage collection

Aka space reclamation, the process whereby a filesystem manager recovers the space occupied by deleted files and directories.

HA

High Availability — in telecommunications and other industries, HA describes a system's ability to remain up and running without interruption for extended periods of time.

handle

A pointer that the resource manager base library binds to the pathname registered via *resmgr_attach()*. This handle is typically used to associate some kind of per-device information. Note that if you use the *iofunc_*()* **POSIX layer calls**, you must use a particular *type* of handle — in this case called an **attributes structure**.

image

In the context of embedded QNX Neutrino systems, an “image” can mean either a structure that contains files (i.e. an OS image) or a structure that can be used in a read-only, read/write, or read/write/reclaim FFS-2-compatible filesystem (i.e. a flash filesystem image).

interrupt

An event (usually caused by hardware) that interrupts whatever the processor was doing and asks it do something else. The hardware will generate an interrupt whenever it has reached some state where software intervention is required.

interrupt handler

See **ISR**.

interrupt latency

The amount of elapsed time between the generation of a hardware interrupt and the first instruction executed by the relevant interrupt service routine. Also designated as “T_{il}”. Contrast **scheduling latency**.

interrupt service routine

See **ISR**.

interrupt service thread

A thread that is responsible for performing thread-level servicing of an interrupt.

Since an **ISR** can call only a very limited number of functions, and since the amount of time spent in an ISR should be kept to a minimum, generally the bulk of the interrupt servicing work should be done by a thread. The thread attaches the interrupt (via *InterruptAttach()* or *InterruptAttachEvent()*) and then blocks (via *InterruptWait()*), waiting for the ISR to tell it to do something (by returning an event of type SIGEV_INTR). To aid in minimizing

scheduling latency, the interrupt service thread should raise its priority appropriately.

I/O message

A message that relies on an existing binding between the client and the resource manager. For example, an _IO_READ message depends on the client's having previously established an association (or **context**) with the resource manager by issuing an *open()* and getting back a file descriptor. See also **connect message**, **context**, **combine message**, and **message**.

I/O privity

A particular privilege, that, if enabled for a given thread, allows the thread to perform I/O instructions (such as the x86 assembler **`in`** and **`out`** instructions). By default, I/O privity is disabled, because a program with it enabled can wreak havoc on a system. To enable I/O privity, the thread must be running as **`root`**, and call *ThreadCtl()*.

IPC

Interprocess Communication — the ability for two processes (or threads) to communicate. QNX Neutrino offers several forms of IPC, most notably native messaging (synchronous, client/server relationship), POSIX message queues and pipes (asynchronous), as well as signals.

IPL

Initial Program Loader — the software component that either takes control at the processor's reset vector (e.g. location 0xFFFFFFF0 on the x86), or is a BIOS extension. This component is responsible for setting up the machine into a usable state, such that the startup program can then perform further initializations. The IPL is written in assembler and C. See also **BIOS extension signature** and **startup code**.

IRQ

Interrupt Request — a hardware request line asserted by a peripheral to indicate that it requires servicing by software. The IRQ is handled by the **PIC**, which then interrupts the processor, usually causing the processor to execute an **Interrupt Service Routine (ISR)**.

ISR

Interrupt Service Routine — a routine responsible for servicing hardware (e.g. reading and/or writing some device ports), for updating some data structures shared between the ISR and the thread(s) running in the application, and for signalling the thread that some kind of event has occurred.

kernel

See **microkernel**.

level-sensitive

One of two ways in which a **PIC** (Programmable Interrupt Controller) can be programmed to respond to interrupts. If the PIC is operating in level-sensitive mode, the IRQ is considered active whenever the corresponding hardware line is active. Contrast **edge-sensitive**.

linearly mapped

A term indicating that a certain memory component is entirely addressable by the processor. Contrast **bank-switched**.

message

A parcel of bytes passed from one process to another. The OS attaches no special meaning to the content of a message — the data in a message has meaning for the sender of the message and for its receiver, but for no one else.

Message passing not only allows processes to pass data to each other, but also provides a means of synchronizing the execution of several processes. As they send, receive, and reply to messages, processes

undergo various “changes of state” that affect when, and for how long, they may run.

microkernel

A part of the operating system that provides the minimal services used by a team of optional cooperating processes, which in turn provide the higher-level OS functionality. The microkernel itself lacks filesystems and many other services normally expected of an OS; those services are provided by optional processes.

mount structure

An optional, well-defined data structure (of type **`iofunc_mount_t`**) within an *iofunc_*()* structure, which contains information used on a per-mountpoint basis (generally used only for filesystem resource managers). See also **attributes structure** and **OCB**.

mountpoint

The location in the pathname space where a resource manager has “registered” itself. For example, the serial port resource manager registers mountpoints for each serial device (**`/dev/ser1`**, **`/dev/ser2`**, etc.), and a CD-ROM filesystem may register a single mountpoint of **`/cdrom`**.

mutex

Mutual exclusion lock, a simple synchronization service used to ensure exclusive access to data shared between threads. It is typically acquired (*pthread_mutex_lock()*) and released (*pthread_mutex_unlock()*) around the code that accesses the shared data (usually a **critical section**). See also **critical section**.

name resolution

In a QNX Neutrino network, the process by which the **Qnet** network manager converts an **FQNN** to a list of destination addresses that the transport layer knows how to get to.

name resolver

Program code that attempts to convert an **FQNN** to a destination address.

NDP

Node Discovery Protocol — proprietary QNX Software Systems protocol for broadcasting name resolution requests on a QNX Neutrino LAN.

network directory

A directory in the pathname space that's implemented by the **Qnet** network manager.

Neutrino

Name of an OS developed by QNX Software Systems.

NFS

Network FileSystem — a TCP/IP application that lets you graft remote filesystems (or portions of them) onto your local namespace. Directories on the remote systems appear as part of your local filesystem and all the utilities you use for listing and managing files (e.g. `ls`, `cp`, `mv`) operate on the remote files exactly as they do on your local files.

NMI

Nonmaskable Interrupt — an interrupt that can't be masked by the processor. We don't recommend using an NMI!

Node Discovery Protocol

See **NDP**.

node domain

A character string that the **Qnet** network manager tacks onto the nodename to form an **FQNN**.

nodename

A unique name consisting of a character string that identifies a node on a network.

nonbootable

A nonbootable OS image is usually provided for larger embedded systems or for small embedded systems where a separate, configuration-dependent setup may be required. Think of it as a second “filesystem” that has some additional files on it. Since it’s nonbootable, it typically won’t contain the OS, startup file, etc. Contrast **bootable**.

OCB

Open Control Block (or Open Context Block) — a block of data established by a resource manager during its handling of the client’s *open()* function. This context block is bound by the resource manager to this particular request, and is then automatically passed to all subsequent I/O functions generated by the client on the file descriptor returned by the client’s *open()*.

package filesystem

A virtual filesystem manager that presents a customized view of a set of files and directories to a client. The “real” files are present on some medium; the package filesystem presents a virtual view of selected files to the client.

pathname prefix

See **mountpoint**.

pathname space mapping

The process whereby the Process Manager maintains an association between resource managers and entries in the pathname space.

persistent

When applied to storage media, the ability for the medium to retain information across a power-cycle. For example, a hard disk is a persistent storage medium, whereas a ramdisk is not, because the data is lost when power is lost.

Photon microGUI

The proprietary graphical user interface built by QNX Software Systems.

PIC

Programmable Interrupt Controller — hardware component that handles IRQs. See also **edge-sensitive**, **level-sensitive**, and **ISR**.

PID

Process ID. Also often *pid* (e.g. as an argument in a function call).

POSIX

An IEEE/ISO standard. The term is an acronym (of sorts) for Portable Operating System Interface — the "X" alludes to "UNIX", on which the interface is based.

POSIX layer calls

Convenient set of library calls for writing resource managers. The POSIX layer calls can handle even more of the common-case messages and functions than the **base layer calls**. These calls are identified by the *iofunc_*()* prefix. In order to use these (and we strongly recommend that you do), you must also use the well-defined POSIX-layer **attributes** (`iofunc_attr_t`), **OCB** (`iofunc_ocb_t`), and (optionally) **mount** (`iofunc_mount_t`) structures.

preemption

The act of suspending the execution of one thread and starting (or resuming) another. The suspended thread is said to have been "preempted" by the new thread. Whenever a lower-priority thread is

actively consuming the CPU, and a higher-priority thread becomes READY, the lower-priority thread is immediately preempted by the higher-priority thread.

prefix tree

The internal representation used by the Process Manager to store the pathname table.

priority inheritance

The characteristic of a thread that causes its priority to be raised or lowered to that of the thread that sent it a message. Also used with mutexes. Priority inheritance is a method used to prevent **priority inversion**.

priority inversion

A condition that can occur when a low-priority thread consumes CPU at a higher priority than it should. This can be caused by not supporting priority inheritance, such that when the lower-priority thread sends a message to a higher-priority thread, the higher-priority thread consumes CPU *on behalf of* the lower-priority thread. This is solved by having the higher-priority thread inherit the priority of the thread on whose behalf it's working.

process

A nonschedulable entity, which defines the address space and a few data areas. A process must have at least one **thread** running in it — this thread is then called the first thread.

process group

A collection of processes that permits the signalling of related processes. Each process in the system is a member of a process group identified by a process group ID. A newly created process joins the process group of its creator.

process group ID

The unique identifier representing a process group during its lifetime. A process group ID is a positive integer. The system may reuse a process group ID after the process group dies.

process group leader

A process whose ID is the same as its process group ID.

process ID (PID)

The unique identifier representing a process. A PID is a positive integer. The system may reuse a process ID after the process dies, provided no existing process group has the same ID. Only the Process Manager can have a process ID of 1.

pty

Pseudo-TTY — a character-based device that has two “ends”: a master end and a slave end. Data written to the master end shows up on the slave end, and vice versa. These devices are typically used to interface between a program that expects a character device and another program that wishes to use that device (e.g. the shell and the **`telnet`** daemon process, used for logging in to a system over the Internet).

pulses

In addition to the synchronous Send/Receive/Reply services, QNX Neutrino also supports fixed-size, nonblocking messages known as pulses. These carry a small payload (four bytes of data plus a single byte code). A pulse is also one form of **event** that can be returned from an ISR or a timer. See *MsgDeliverEvent()* for more information.

Qnet

The native network manager in QNX Neutrino.

QoS

Quality of Service — a policy (e.g. **`loadbalance`**) used to connect nodes in a network in order to ensure highly dependable transmission. QoS is an issue that often arises in high-availability (**HA**) networks as well as realtime control systems.

RAM

Random Access Memory — a memory technology characterized by the ability to read and write any location in the device without limitation. Contrast **flash** and **EPROM**.

raw mode

In raw input mode, the character device library performs no editing on received characters. This reduces the processing done on each character to a minimum and provides the highest performance interface for reading data. Also, raw mode is used with devices that typically generate binary data — you don't want any translations of the raw binary stream between the device and the application. Contrast **canonical mode**.

replenishment

In **sporadic** scheduling, the period of time during which a thread is allowed to consume its execution **budget**.

reset vector

The address at which the processor begins executing instructions after the processor's reset line has been activated. On the x86, for example, this is the address 0xFFFFFFF0.

resource manager

A user-level server program that accepts messages from other programs and, optionally, communicates with hardware. QNX Neutrino resource managers are responsible for presenting an interface to various types of devices, whether actual (e.g. serial ports, parallel ports, network cards, disk drives) or virtual (e.g. **`/dev/null`**, a network filesystem, and pseudo-ttys).

In other operating systems, this functionality is traditionally associated with **device drivers**. But unlike device drivers, QNX Neutrino resource managers don't require any special arrangements with the kernel. In fact, a resource manager looks just like any other user-level program. See also **device driver**.

RMA

Rate Monotonic Analysis — a set of methods used to specify, analyze, and predict the timing behavior of realtime systems.

round robin

Scheduling algorithm whereby a thread is given a certain period of time to run. Should the thread consume CPU for the entire period of its timeslice, the thread will be placed at the end of the ready queue for its priority, and the next available thread will be made READY. If a thread is the only thread READY at its priority level, it will be able to consume CPU again immediately. See also **adaptive**, **FIFO**, and **sporadic**.

runtime loading

The process whereby a program decides *while it's actually running* that it wishes to load a particular function from a library. Contrast **static linking**.

scheduling latency

The amount of time that elapses between the point when one thread makes another thread READY and when the other thread actually gets some CPU time. Note that this latency is almost always at the control of the system designer.

Also designated as "T_{sl}". Contrast **interrupt latency**.

session

A collection of process groups established for job control purposes. Each process group is a member of a session. A process belongs to the session that its process group belongs to. A newly created process

joins the session of its creator. A process can alter its session membership via *setsid()*. A session can contain multiple process groups.

session leader

A process whose death causes all processes within its process group to receive a SIGHUP signal.

software interrupts

Similar to a hardware interrupt (see **interrupt**), except that the source of the interrupt is software.

sporadic

Scheduling algorithm whereby a thread's priority can oscillate dynamically between a "foreground" or normal priority and a "background" or low priority. A thread is given an execution **budget** of time to be consumed within a certain **replenishment** period. See also **adaptive**, **FIFO**, and **round robin**.

startup code

The software component that gains control after the IPL code has performed the minimum necessary amount of initialization. After gathering information about the system, the startup code transfers control to the OS.

static bootfile

An image created at one time and then transmitted whenever a node boots. Contrast **dynamic bootfile**.

static linking

The process whereby you combine your modules with the modules from the library to form a single executable that's entirely self-contained. The word "static" implies that it's not going to change — *all* the required modules are already combined into one.

system page area

An area in the kernel that is filled by the startup code and contains information about the system (number of bytes of memory, location of serial ports, etc.) This is also called the SYSPAGE area.

thread

The schedulable entity under QNX Neutrino. A thread is a flow of execution; it exists within the context of a **process**.

timer

A kernel object used in conjunction with time-based functions. A timer is created via *timer_create()* and armed via *timer_settime()*. A timer can then deliver an **event**, either periodically or on a one-shot basis.

timeslice

A period of time assigned to a **round-robin** or **adaptive** scheduled thread. This period of time is small (on the order of tens of milliseconds); the actual value shouldn't be relied upon by any program (it's considered bad design).

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