Xenomai POSIX skin API

2.4.7

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3.1.1 Detailed Description

Thread cancellation.

Cancellation is the mechanism by which a thread can terminate the execution of a Xenomai POSIX skin thread (created with pthread_create()). More precisely, a thread can send a cancellation request to a Xenomai POSIX skin thread and depending on its cancelability type (see pthread_-setcanceltype()) and state (see pthread_setcancelstate()), the target thread can then either ignore the request, honor it immediately, or defer it till it reaches a cancellation point. When threads are first created by pthread_create(), they always defer cancellation requests.

When a thread eventually honors a cancellation request, it behaves as if *pthread_exit(PTHREAD_-CANCELED)* was called. All cleanup handlers are executed in reverse order, finalization functions for thread-specific data are called, and finally the thread stops executing. If the canceled thread was joinable, the return value PTHREAD_CANCELED is provided to whichever thread calls pthread_join() on it. See pthread_exit() for more information.

Cancellation points are the points where the thread checks for pending cancellation requests and performs them. The POSIX threads functions pthread_join(), pthread_cond_wait(), pthread_-cond_timedwait(), pthread_testcancel(), sem_wait(), sem_timedwait(), sigwait(), sigwaitinfo() and sigtimedwait() are cancellation points.

See also:

`Specification.`

Functions

- int pthread_cancel (pthread_t thread)

Cancel a thread.

- void pthread_cleanup_push (cleanup_routine_t *routine, void *arg)

  Register a cleanup handler to be executed at the time of cancellation.

- void pthread_cleanup_pop (int execute)

  Unregister the last registered cleanup handler.

- int pthread_setcanceltype (int type, int *oldtype_ptr)

  Set cancelability type of the current thread.

- int pthread_setcancelstate (int state, int *oldstate_ptr)

  Set cancelability state of the current thread.

- void pthread_testcancel (void)

  Test if a cancellation request is pending.

3.1.2 Function Documentation

3.1.2.1 int pthread_cancel (pthread_t *thread*)

Cancel a thread.

This service sends a cancellation request to the thread *thread* and returns immediately. Depending on the target thread cancelability state (see pthread_setcancelstate()) and type (see pthread_-setcanceltype()), its termination is either immediate, deferred or ignored.

When the cancellation request is handled and before the thread is terminated, the cancellation cleanup handlers (registered with the pthread_cleanup_push() service) are called, then the thread-specific data destructor functions (registered with pthread_key_create()).

Returns:

0 on success;
an error number if:

- ESRCH, the thread *thread* was not found.

See also:

`Specification.`

3.1.2.2 void pthread_cleanup_pop (int *execute*)

Unregister the last registered cleanup handler.

If the calling thread is a Xenomai POSIX skin thread (i.e. created with pthread_create()), this service unregisters the last routine which was registered with pthread_cleanup_push() and call it if *execute* is not null.

If the caller context is invalid (not a Xenomai POSIX skin thread), this service has no effect.

This service may be called at any place, but for maximal portability, should only called in the same lexical scope as the matching call to pthread_cleanup_push().

Parameters:

execute if non zero, the last registered cleanup handler should be executed before it is unregistered.

Valid contexts:

- Xenomai POSIX skin kernel-space thread,
- Xenomai POSIX skin user-space thread (switches to primary mode).

See also:

Specification.

3.1.2.3 void pthread_cleanup_push (cleanup_routine_t * *routine*, void * *arg*)

Register a cleanup handler to be executed at the time of cancellation.

This service registers the given *routine* to be executed a the time of cancellation of the calling thread, if this thread is a Xenomai POSIX skin thread (i.e. created with the pthread_create() service). If the caller context is invalid (not a Xenomai POSIX skin thread), this service has no effect.

If allocation from the system heap fails (because the system heap size is to small), this service fails silently.

The routines registered with this service get called in LIFO order when the calling thread calls pthread_exit() or is canceled, or when it calls the pthread_cleanup_pop() service with a non null argument.

Parameters:

routine the cleanup routine to be registered;

arg the argument associated with this routine.

Valid contexts:

- Xenomai POSIX skin kernel-space thread,
- Xenomai POSIX skin user-space thread (switches to primary mode).

See also:

Specification.

3.1.2.4 int pthread_setcancelstate (int *state*, int * *oldstate_ptr*)

Set cancelability state of the current thread.

This service atomically set the cancelability state of the calling thread and returns its previous value at the address *oldstate_ptr*, if the calling thread is a Xenomai POSIX skin thread (i.e. created with the pthread_create service).

The cancelability state of a POSIX thread may be:

- PTHREAD_CANCEL_ENABLE, meaning that cancellation requests will be handled if received;

- PTHREAD_CANCEL_DISABLE, meaning that cancellation requests will not be handled if received.

Parameters:

state new cancelability state of the calling thread;

oldstate_ptr address where the old cancelability state will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *state* is not a valid cancelability state;
- EPERM, the caller context is invalid.

Valid contexts:

- Xenomai POSIX skin kernel-space thread,
- Xenomai POSIX skin user-space thread (switches to primary mode).

See also:

`Specification.`

3.1.2.5 int pthread_setcanceltype (int *type*, int ∗ *oldtype_ptr*)

Set cancelability type of the current thread.

This service atomically sets the cancelability type of the calling thread, and return its previous value at the address *oldtype_ptr*, if this thread is a Xenomai POSIX skin thread (i.e. was created with the pthread_create() service).

The cancelability type of a POSIX thread may be:

- PTHREAD_CANCEL_DEFERRED, meaning that cancellation requests are only handled in services which are cancellation points;
- PTHREAD_CANCEL_ASYNCHRONOUS, meaning that cancellation requests are handled as soon as they are sent.

Parameters:

type new cancelability type of the calling thread;

oldtype_ptr address where the old cancelability type will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *type* is not a valid cancelability type;
- EPERM, the caller context is invalid.

Valid contexts:

- Xenomai POSIX skin kernel-space thread,

- Xenomai POSIX skin user-space thread (switches to primary mode).

See also:

`Specification.`

3.1.2.6 void pthread_testcancel (void)

Test if a cancellation request is pending.

This function creates a cancellation point if the calling thread is a Xenomai POSIX skin thread (i.e. created with the pthread_create() service).

This function is a cancellation point. It has no effect if cancellation is disabled.

Valid contexts:

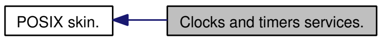
- Xenomai POSIX skin kernel-space thread,
- Xenomai POSIX skin user-space thread (switches to primary mode).

See also:

`Specification.`

3.2 Clocks and timers services.

Collaboration diagram for Clocks and timers services.:



3.2.1 Detailed Description

Clocks and timers services.

Xenomai POSIX skin supports two clocks:

CLOCK_REALTIME maps to the nucleus system clock, keeping time as the amount of time since the Epoch, with a resolution of one system clock tick.

CLOCK_MONOTONIC maps to an architecture-dependent high resolution counter, so is suitable for measuring short time intervals. However, when used for sleeping (with clock_nanosleep()), the CLOCK_MONOTONIC clock has a resolution of one system clock tick, like the CLOCK_-REALTIME clock.

Timer objects may be created with the timer_create() service using either of the two clocks, but the resolution of these timers is one system clock tick, as is the case for clock_nanosleep().

Note:

The duration of the POSIX clock tick depends on the active time base (configurable at compile-time with the constant *CONFIG_XENO_OPT_POSIX_PERIOD*, and at run-time with the *xeno_posix* module parameter *tick_arg*). When the time base is aperiodic (which is the default) the system clock tick is one nanosecond.

See also:

`Specification.`

Functions

- int clock_getres (clockid_t clock_id, struct timespec *res)

  Get the resolution of the specified clock.

- int clock_gettime (clockid_t clock_id, struct timespec *tp)

  Read the specified clock.

- int clock_settime (clockid_t clock_id, const struct timespec *tp)

  Set the specified clock.

- int clock_nanosleep (clockid_t clock_id, int flags, const struct timespec *rqtp, struct timespec *rmtp)

  Sleep some amount of time.

- int nanosleep (const struct timespec *rqtp, struct timespec *rmtp)

  Sleep some amount of time.

- int timer_create (clockid_t clockid, const struct sigevent *__restrict__ evp, timer_t *__-restrict__ timerid)

  Create a timer object.

- int timer_delete (timer_t timerid)

  Delete a timer object.

- int timer_settime (timer_t timerid, int flags, const struct itimerspec *__restrict__ value, struct itimerspec *__restrict__ ovalue)

  Start or stop a timer.

- int timer_gettime (timer_t timerid, struct itimerspec *value)

  Get timer next expiration date and reload value.

- int timer_getoverrun (timer_t timerid)

  Get expiration overruns count since the most recent timer expiration signal delivery.

3.2.2 Function Documentation

3.2.2.1 int clock_getres (clockid_t *clock_id*, struct timespec * *res*)

Get the resolution of the specified clock.

This service returns, at the address *res*, if it is not *NULL*, the resolution of the clock *clock_id*.

For both CLOCK_REALTIME and CLOCK_MONOTONIC, this resolution is the duration of one system clock tick. No other clock is supported.

Parameters:

clock_id clock identifier, either CLOCK_REALTIME or CLOCK_MONOTONIC;

res the address where the resolution of the specified clock will be stored on success.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *clock_id* is invalid;

See also:

`Specification.`

3.2.2.2 int clock_gettime (clockid_t *clock_id*, struct timespec * *tp*)

Read the specified clock.

This service returns, at the address *tp* the current value of the clock *clock_id*. If *clock_id* is:

- CLOCK_REALTIME, the clock value represents the amount of time since the Epoch, with a precision of one system clock tick;

- CLOCK_MONOTONIC, the clock value is given by an architecture-dependent high resolution counter, with a precision independent from the system clock tick duration.

Parameters:

clock_id clock identifier, either CLOCK_REALTIME or CLOCK_MONOTONIC;

tp the address where the value of the specified clock will be stored.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *clock_id* is invalid.

See also:

`Specification.`

3.2.2.3 int clock_nanosleep (clockid_t *clock_id*, int *flags*, const struct timespec ∗ *rqtp*, struct timespec ∗ *rmtp*)

Sleep some amount of time.

This service suspends the calling thread until the wakeup time specified by *rqtp*, or a signal is delivered to the caller. If the flag TIMER_ABSTIME is set in the *flags* argument, the wakeup time is specified as an absolute value of the clock *clock_id*. If the flag TIMER_ABSTIME is not set, the wakeup time is specified as a time interval.

If this service is interrupted by a signal, the flag TIMER_ABSTIME is not set, and *rmtp* is not *NULL*, the time remaining until the specified wakeup time is returned at the address *rmtp*.

The resolution of this service is one system clock tick.

Parameters:

clock_id clock identifier, either CLOCK_REALTIME or CLOCK_MONOTONIC.

flags one of:

- 0 meaning that the wakeup time *rqtp* is a time interval;
- TIMER_ABSTIME, meaning that the wakeup time is an absolute value of the clock *clock_id*.

rqtp address of the wakeup time.

rmtp address where the remaining time before wakeup will be stored if the service is interrupted by a signal.

Returns:

0 on success;
an error number if:

- EPERM, the caller context is invalid;
- ENOTSUP, the specified clock is unsupported;
- EINVAL, the specified wakeup time is invalid;
- EINTR, this service was interrupted by a signal.

Valid contexts:

- Xenomai kernel-space thread,
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

Referenced by nanosleep().

3.2.2.4 int clock_settime (clockid_t *clock_id*, const struct timespec * *tp*)

Set the specified clock.

This allow setting the CLOCK_REALTIME clock.

Parameters:

clock_id the id of the clock to be set, only CLOCK_REALTIME is supported.

tp the address of a struct timespec specifying the new date.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *clock_id* is not CLOCK_REALTIME;
- EINVAL, the date specified by *tp* is invalid.

See also:

`Specification.`

3.2.2.5 int nanosleep (const struct timespec * *rqtp*, struct timespec * *rmtp*)

Sleep some amount of time.

This service suspends the calling thread until the wakeup time specified by *rqtp*, or a signal is delivered. The wakeup time is specified as a time interval.

If this service is interrupted by a signal and *rmtp* is not *NULL*, the time remaining until the specified wakeup time is returned at the address *rmtp*.

The resolution of this service is one system clock tick.

Parameters:

rqtp address of the wakeup time.

rmtp address where the remaining time before wakeup will be stored if the service is interrupted by a signal.

Return values:

0 on success;

-1 with *errno* set if:

- EPERM, the caller context is invalid;
- EINVAL, the specified wakeup time is invalid;
- EINTR, this service was interrupted by a signal.

Valid contexts:

- Xenomai kernel-space thread,
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

References clock_nanosleep().

3.2.2.6 int timer_create (clockid_t *clockid*, const struct sigevent *__restrict__ *evp*, timer_t *__restrict__ *timerid*)

Create a timer object.

This service creates a time object using the clock *clockid*.

If *evp* is not *NULL*, it describes the notification mechanism used on timer expiration. Only notification via signal delivery is supported (member *sigev_notify* of *evp* set to *SIGEV_SIGNAL*). The signal will be sent to the thread starting the timer with the timer_settime() service. If *evp* is *NULL*, the SIGALRM signal will be used.

Note that signals sent to user-space threads will cause them to switch to secondary mode.

If this service succeeds, an identifier for the created timer is returned at the address *timerid*. The timer is unarmed until started with the timer_settime() service.

Parameters:

clockid clock used as a timing base;

evp description of the asynchronous notification to occur when the timer expires;

timerid address where the identifier of the created timer will be stored on success.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, the clock *clockid* is invalid;
- EINVAL, the member *sigev_notify* of the **sigevent** structure at the address *evp* is not SIGEV_SIGNAL;
- EINVAL, the member *sigev_signo* of the **sigevent** structure is an invalid signal number;
- EAGAIN, the maximum number of timers was exceeded, recompile with a larger value.

See also:

`Specification.`

3.2.2.7 int timer_delete (timer_t *timerid*)

Delete a timer object.

This service deletes the timer *timerid*.

Parameters:

timerid identifier of the timer to be removed;

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *timerid* is invalid;
- EPERM, the timer *timerid* does not belong to the current process.

See also:

`Specification.`

3.2.2.8 int timer_getoverrun (timer_t *timerid*)

Get expiration overruns count since the most recent timer expiration signal delivery.

This service returns *timerid* expiration overruns count since the most recent timer expiration signal delivery. If this count is more than *DELAYTIMER_MAX* expirations, *DELAYTIMER_MAX* is returned.

Parameters:

timerid Timer identifier.

Returns:

the overruns count on success;
-1 with *errno* set if:

- EINVAL, *timerid* is invalid;
- EPERM, the timer *timerid* does not belong to the current process.

See also:

`Specification.`

3.2.2.9 int timer_gettime (timer_t *timerid*, struct itimerspec ∗ *value*)

Get timer next expiration date and reload value.

This service stores, at the address *value*, the expiration date (member *it_value*) and reload value (member *it_interval*) of the timer *timerid*. The values are returned as time intervals, and as multiples of the system clock tick duration (see note in section Clocks and timers services for details on the duration of the system clock tick). If the timer was not started, the returned members *it_value* and *it_interval* of *value* are zero.

Parameters:

timerid timer identifier;

value address where the timer expiration date and reload value are stored on success.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *timerid* is invalid;
- EPERM, the timer *timerid* does not belong to the current process.

See also:

`Specification.`

3.2.2.10 int timer_settime (timer_t *timerid*, int *flags*, const struct itimerspec *__restrict__ *value*, struct itimerspec *__restrict__ *ovalue*)

Start or stop a timer.

This service sets a timer expiration date and reload value of the timer *timerid*. If *ovalue* is not *NULL*, the current expiration date and reload value are stored at the address *ovalue* as with timer_gettime().

If the member *it_value* of the **itimerspec** structure at *value* is zero, the timer is stopped, otherwise the timer is started. If the member *it_interval* is not zero, the timer is periodic. The current thread must be a POSIX skin thread (created with pthread_create()) and will be notified via signal of timer expirations. Note that these notifications will cause user-space threads to switch to secondary mode.

When starting the timer, if *flags* is TIMER_ABSTIME, the expiration value is interpreted as an absolute date of the clock passed to the timer_create() service. Otherwise, the expiration value is interpreted as a time interval.

Expiration date and reload value are rounded to an integer count of system clock ticks (see note in section Clocks and timers services for details on the duration of the system tick).

Parameters:

timerid identifier of the timer to be started or stopped;

flags one of 0 or TIMER_ABSTIME;

value address where the specified timer expiration date and reload value are read;

ovalue address where the specified timer previous expiration date and reload value are stored if not *NULL*.

Return values:

0 on success;

-1 with *errno* set if:

- EPERM, the caller context is invalid;
- EINVAL, the specified timer identifier, expiration date or reload value is invalid;
- EPERM, the timer *timerid* does not belong to the current process.

Valid contexts:

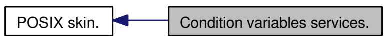
- Xenomai kernel-space POSIX skin thread,
- kernel-space thread cancellation cleanup routine,
- Xenomai POSIX skin user-space thread (switches to primary mode),
- user-space thread cancellation cleanup routine.

See also:

`Specification.`

3.3 Condition variables services.

Collaboration diagram for Condition variables services.:



3.3.1 Detailed Description

Condition variables services.

A condition variable is a synchronization object that allows threads to suspend execution until some predicate on shared data is satisfied. The basic operations on conditions are: signal the condition (when the predicate becomes true), and wait for the condition, suspending the thread execution until another thread signals the condition.

A condition variable must always be associated with a mutex, to avoid the race condition where a thread prepares to wait on a condition variable and another thread signals the condition just before the first thread actually waits on it.

Before it can be used, a condition variable has to be initialized with pthread_cond_init(). An attribute object, which reference may be passed to this service, allows to select the features of the created condition variable, namely the *clock* used by the pthread_cond_timedwait() service (*CLOCK_REALTIME* is used by default), and whether it may be shared between several processes (it may not be shared by default, see pthread_condattr_setpshared()).

Note that only pthread_cond_init() may be used to initialize a condition variable, using the static initializer *PTHREAD_COND_INITIALIZER* is not supported.

Functions

- int pthread_cond_init (pthread_cond_t *cnd, const pthread_condattr_t *attr)

  Initialize a condition variable.
- int pthread_cond_destroy (pthread_cond_t *cnd)

  Destroy a condition variable.
- int pthread_cond_wait (pthread_cond_t *cnd, pthread_mutex_t *mx)

  Wait on a condition variable.
- int pthread_cond_timedwait (pthread_cond_t *cnd, pthread_mutex_t *mx, const struct timespec *abstime)

  Wait a bounded time on a condition variable.
- int pthread_cond_signal (pthread_cond_t *cnd)

  Signal a condition variable.
- int pthread_cond_broadcast (pthread_cond_t *cnd)

  Broadcast a condition variable.
- int pthread_condattr_init (pthread_condattr_t *attr)

  Initialize a condition variable attributes object.

- int pthread_condattr_destroy (pthread_condattr_t *attr)
  Destroy a condition variable attributes object.
- int pthread_condattr_getclock (const pthread_condattr_t *attr, clockid_t *clk_id)
  Get the clock selection attribute from a condition variable attributes object.
- int pthread_condattr_setclock (pthread_condattr_t *attr, clockid_t clk_id)
  Set the clock selection attribute of a condition variable attributes object.
- int pthread_condattr_getpshared (const pthread_condattr_t *attr, int *pshared)
  Get the process-shared attribute from a condition variable attributes object.
- int pthread_condattr_setpshared (pthread_condattr_t *attr, int pshared)
  Set the process-shared attribute of a condition variable attributes object.

3.3.2 Function Documentation

3.3.2.1 int pthread_cond_broadcast (pthread_cond_t * *cnd*)

Broadcast a condition variable.

This service unblocks all threads blocked on the condition variable *cnd*.

Parameters:

cnd the condition variable to be signalled.

Returns:

0 on succes,
an error number if:

- EINVAL, the condition variable is invalid;
- EPERM, the condition variable is not process-shared and does not belong to the current process.

See also:

Specification.

3.3.2.2 int pthread_cond_destroy (pthread_cond_t * *cnd*)

Destroy a condition variable.

This service destroys the condition variable *cnd*, if no thread is currently blocked on it. The condition variable becomes invalid for all condition variable services (they all return the EINVAL error) except pthread_cond_init().

Parameters:

cnd the condition variable to be destroyed.

Returns:

0 on succes,
an error number if:

- EINVAL, the condition variable *cnd* is invalid;
- EPERM, the condition variable is not process-shared and does not belong to the current process;
- EBUSY, some thread is currently using the condition variable.

See also:

`Specification.`

3.3.2.3 int pthread_cond_init (pthread_cond_t * *cnd*, const pthread_condattr_t * *attr*)

Initialize a condition variable.

This service initializes the condition variable *cnd*, using the condition variable attributes object *attr*. If *attr* is *NULL* or this service is called from user-space, default attributes are used (see pthread_condattr_init()).

Parameters:

cnd the condition variable to be initialized;

attr the condition variable attributes object.

Returns:

0 on succes,
an error number if:

- EINVAL, the condition variable attributes object *attr* is invalid or uninitialized;
- EBUSY, the condition variable *cnd* was already initialized;
- ENOMEM, insufficient memory exists in the system heap to initialize the condition variable, increase CONFIG_XENO_OPT_SYS_HEAPSZ.

See also:

`Specification.`

3.3.2.4 int pthread_cond_signal (pthread_cond_t * *cnd*)

Signal a condition variable.

This service unblocks one thread blocked on the condition variable *cnd*.

If more than one thread is blocked on the specified condition variable, the highest priority thread is unblocked.

Parameters:

cnd the condition variable to be signalled.

Returns:

0 on succes,
an error number if:

- EINVAL, the condition variable is invalid;
- EPERM, the condition variable is not process-shared and does not belong to the current process.

See also:

`Specification.`

3.3.2.5 int pthread_cond_timedwait (pthread_cond_t * *cnd*, pthread_mutex_t * *mx*, const struct timespec * *abstime*)

Wait a bounded time on a condition variable.

This service is equivalent to pthread_cond_wait(), except that the calling thread remains blocked on the condition variable *cnd* only until the timeout specified by *abstime* expires.

The timeout *abstime* is expressed as an absolute value of the *clock* attribute passed to pthread_-cond_init(). By default, *CLOCK_REALTIME* is used.

Parameters:

cnd the condition variable to wait for;

mx the mutex associated with *cnd*;

abstime the timeout, expressed as an absolute value of the clock attribute passed to pthread_-cond_init().

Returns:

0 on success,
an error number if:

- EPERM, the caller context is invalid;
- EPERM, the specified condition variable is not process-shared and does not belong to the current process;
- EINVAL, the specified condition variable, mutex or timeout is invalid;
- EINVAL, another thread is currently blocked on *cnd* using another mutex than *mx*;
- EPERM, the specified mutex is not owned by the caller;
- ETIMEDOUT, the specified timeout expired.

Valid contexts:

- Xenomai kernel-space thread;
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

3.3.2.6 int pthread_cond_wait (pthread_cond_t * *cnd*, pthread_mutex_t * *mx*)

Wait on a condition variable.

This service atomically unlocks the mutex *mx*, and block the calling thread until the condition variable *cnd* is signalled using pthread_cond_signal() or pthread_cond_broadcast(). When the condition is signaled, this service re-acquire the mutex before returning.

Spurious wakeups occur if a signal is delivered to the blocked thread, so, an application should not assume that the condition changed upon successful return from this service.

Even if the mutex *mx* is recursive and its recursion count is greater than one on entry, it is unlocked before blocking the caller, and the recursion count is restored once the mutex is re-acquired by this service before returning.

Once a thread is blocked on a condition variable, a dynamic binding is formed between the condition vairable *cnd* and the mutex *mx*; if another thread calls this service specifying *cnd* as a condition variable but another mutex than *mx*, this service returns immediately with the EINVAL status.

This service is a cancellation point for Xenomai POSIX skin threads (created with the pthread_-create() service). When such a thread is cancelled while blocked in a call to this service, the mutex *mx* is re-acquired before the cancellation cleanup handlers are called.

Parameters:

cnd the condition variable to wait for;

mx the mutex associated with *cnd*.

Returns:

0 on success,
an error number if:

- EPERM, the caller context is invalid;
- EINVAL, the specified condition variable or mutex is invalid;
- EPERM, the specified condition variable is not process-shared and does not belong to the current process;
- EINVAL, another thread is currently blocked on *cnd* using another mutex than *mx*;
- EPERM, the specified mutex is not owned by the caller.

Valid contexts:

- Xenomai kernel-space thread;
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

3.3.2.7 int pthread_condattr_destroy (pthread_condattr_t * *attr*)

Destroy a condition variable attributes object.

This service destroys the condition variable attributes object *attr*. The object becomes invalid for all condition variable services (they all return EINVAL) except pthread_condattr_init().

Parameters:

> ***attr*** the initialized mutex attributes object to be destroyed.

Returns:

> 0 on success;
> an error number if:
>
> - EINVAL, the mutex attributes object *attr* is invalid.

See also:

> `Specification.`

3.3.2.8 int pthread_condattr_getclock (const pthread_condattr_t * *attr*, clockid_t * *clk_id*)

Get the clock selection attribute from a condition variable attributes object.

This service stores, at the address *clk_id*, the value of the *clock* attribute in the condition variable attributes object *attr*.

See pthread_cond_timedwait() documentation for a description of the effect of this attribute on a condition variable. The clock ID returned is *CLOCK_REALTIME* or *CLOCK_MONOTONIC*.

Parameters:

> ***attr*** an initialized condition variable attributes object,
>
> ***clk_id*** address where the *clock* attribute value will be stored on success.

Returns:

> 0 on success,
> an error number if:
>
> - EINVAL, the attribute object *attr* is invalid.

See also:

> `Specification.`

3.3.2.9 int pthread_condattr_getpshared (const pthread_condattr_t * *attr*, int * *pshared*)

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

This service stores, at the address *pshared*, the value of the *pshared* attribute in the condition variable attributes object *attr*.

The *pshared* attribute may only be one of *PTHREAD_PROCESS_PRIVATE* or *PTHREAD_-PROCESS_SHARED*. See pthread_condattr_setpshared() for the meaning of these two constants.

Parameters:

> ***attr*** an initialized condition variable attributes object.
>
> ***pshared*** address where the value of the *pshared* attribute will be stored on success.

Returns:

0 on success,
an error number if:

- EINVAL, the *pshared* address is invalid;
- EINVAL, the condition variable attributes object *attr* is invalid.

See also:

`Specification.`

3.3.2.10 int pthread_condattr_init (pthread_condattr_t ∗ *attr*)

Initialize a condition variable attributes object.

This services initializes the condition variable attributes object *attr* with default values for all attributes. Default value are:

- for the *clock* attribute, *CLOCK_REALTIME*;
- for the *pshared* attribute *PTHREAD_PROCESS_PRIVATE*.

If this service is called specifying a condition variable attributes object that was already initialized, the attributes object is reinitialized.

Parameters:

attr the condition variable attributes object to be initialized.

Returns:

0 on success;
an error number if:

- ENOMEM, the condition variable attribute object pointer *attr* is *NULL*.

See also:

`Specification.`

3.3.2.11 int pthread_condattr_setclock (pthread_condattr_t ∗ *attr*, clockid_t *clk_id*)

Set the clock selection attribute of a condition variable attributes object.

This service set the *clock* attribute of the condition variable attributes object *attr*.

See pthread_cond_timedwait() documentation for a description of the effect of this attribute on a condition variable.

Parameters:

attr an initialized condition variable attributes object,

clk_id value of the *clock* attribute, may be *CLOCK_REALTIME* or *CLOCK_MONOTONIC*.

Returns:

0 on success,
an error number if:

- EINVAL, the condition variable attributes object *attr* is invalid;
- EINVAL, the value of *clk_id* is invalid for the *clock* attribute.

See also:

`Specification.`

3.3.2.12 int pthread_condattr_setpshared (pthread_condattr_t * *attr*, int *pshared*)

Set the process-shared attribute of a condition variable attributes object.

This service set the *pshared* attribute of the condition variable attributes object *attr*.

Parameters:

attr an initialized condition variable attributes object.

pshared value of the *pshared* attribute, may be one of:

- PTHREAD_PROCESS_PRIVATE, meaning that a condition variable created with the attributes object *attr* will only be accessible by threads within the same process as the thread that initialized the condition variable;
- PTHREAD_PROCESS_SHARED, meaning that a condition variable created with the attributes object *attr* will be accessible by any thread that has access to the memory where the condition variable is allocated.

Returns:

0 on success,
an error status if:

- EINVAL, the condition variable attributes object *attr* is invalid;
- EINVAL, the value of *pshared* is invalid.

See also:

`Specification.`

3.4 Interruptions management services.

Collaboration diagram for Interruptions management services.:

3.4.1 Detailed Description

Interruptions management services.

The services described here allow applications written using the POSIX skin to handle interrupts, either in kernel-space or in user-space.

Note however, that it is recommended to use the standardized driver API of the RTDM skin (see rtdm).

Functions

- int pthread_intr_attach_np (pthread_intr_t ∗intrp, unsigned irq, xnisr_t isr, xniack_t iack)
  Create and attach an interrupt object.
- int pthread_intr_detach_np (pthread_intr_t intr)
  Destroy an interrupt object.
- int pthread_intr_control_np (pthread_intr_t intr, int cmd)
  Control the state of an interrupt channel.
- int pthread_intr_wait_np (pthread_intr_t intr, const struct timespec ∗to)
  Wait for the next interruption.

3.4.2 Function Documentation

3.4.2.1 int pthread_intr_attach_np (pthread_intr_t ∗ *intrp*, unsigned *irq*, xnisr_t *isr*, xniack_t *iack*)

Create and attach an interrupt object.

This service creates and attaches an interrupt object.

In kernel-space:

This service installs *isr* as the handler for the interrupt *irq*. If *iack* is not null it is a custom interrupt acknowledge routine.

When called upon reception of an interrupt, the *isr* function is passed the address of an underlying **xnintr_t** object, and should use the macro *PTHREAD_IDESC()* to get the **pthread_intr_t** object. The meaning of the *isr* and *iack* function and what they should return is explained in xnintr_init() documentation.

This service is a non-portable extension of the POSIX interface.

Parameters:

intrp address where the created interrupt object identifier will be stored on success;

irq IRQ channel;

isr interrupt handling routine;

iack if not *NULL*, optional interrupt acknowledge routine.

In user-space:

The prototype of this service is :

int pthread_intr_attach_np (pthread_intr_t *intrp, unsigned irq, int mode);

This service causes the installation of a default interrupt handler which unblocks any Xenomai user-space interrupt server thread blocked in a call to pthread_intr_wait_np(), and returns a value depending on the *mode* parameter.

Parameters:

intrp and *irq* have the same meaning as in kernel-space; *mode* is a bitwise OR of the following values:

- PTHREAD_IPROPAGATE, meaning that the interrupt should be propagated to lower priority domains;
- PTHREAD_INOAUTOENA, meaning that the interrupt should not be automatically re-enabled.

This service is intended to be used in conjunction with the pthread_intr_wait_np() service.

The return values are identical in kernel-space and user-space.

Return values:

0 on success;

-1 with *errno* set if:

- ENOSYS, kernel-space Xenomai POSIX skin was built without support for interrupts, use RTDM or enable CONFIG_XENO_OPT_POSIX_INTR in kernel configuration;
- ENOMEM, insufficient memory exists in the system heap to create the interrupt object, increase CONFIG_XENO_OPT_SYS_HEAPSZ;
- EINVAL, a low-level error occured while attaching the interrupt;
- EBUSY, an interrupt handler was already registered for the irq line *irq*.

References pthread_intr_detach_np().

3.4.2.2 int pthread_intr_control_np (pthread_intr_t *intr*, int *cmd*)

Control the state of an interrupt channel.

This service allow to enable or disable an interrupt channel.

This service is a non-portable extension of the POSIX interface.

Parameters:

intr identifier of the interrupt to be enabled or disabled.

cmd one of PTHREAD_IENABLE or PTHREAD_IDISABLE.

Return values:

0 on success;

-1 with *errno* set if:

- ENOSYS, kernel-space Xenomai POSIX skin was built without support for interrupts, use RTDM or enable CONFIG_XENO_OPT_POSIX_INTR in kernel configuration;
- EINVAL, the identifier *intr* or *cmd* is invalid;
- EPERM, the interrupt *intr* does not belong to the current process.

3.4.2.3 int pthread_intr_detach_np (pthread_intr_t *intr*)

Destroy an interrupt object.

This service destroys the interrupt object *intr*. The memory allocated for this object is returned to the system heap, so further references using the same object identifier are not guaranteed to fail.

If a user-space interrupt server is blocked in a call to pthread_intr_wait_np(), it is unblocked and the blocking service returns with an error of EIDRM.

This service is a non-portable extension of the POSIX interface.

Parameters:

intr identifier of the interrupt object to be destroyed.

Return values:

0 on success;

-1 with *errno* set if:

- ENOSYS, kernel-space Xenomai POSIX skin was built without support for interrupts, use RTDM or enable CONFIG_XENO_OPT_POSIX_INTR in kernel configuration;
- EINVAL, the interrupt object *intr* is invalid;
- EPERM, the interrupt *intr* does not belong to the current process.

Referenced by pthread_intr_attach_np().

3.4.2.4 int pthread_intr_wait_np (pthread_intr_t *intr*, const struct timespec * *to*)

Wait for the next interruption.

This service is used by user-space interrupt server threads, to wait, if no interrupt is pending, for the next interrupt.

This service is a cancelation point. If a thread is canceled while blocked in a call to this service, no interruption notification is lost.

This service is a non-portable extension of the POSIX interface.

Parameters:

intr interrupt object identifier;

to if not *NULL*, timeout, expressed as a time interval.

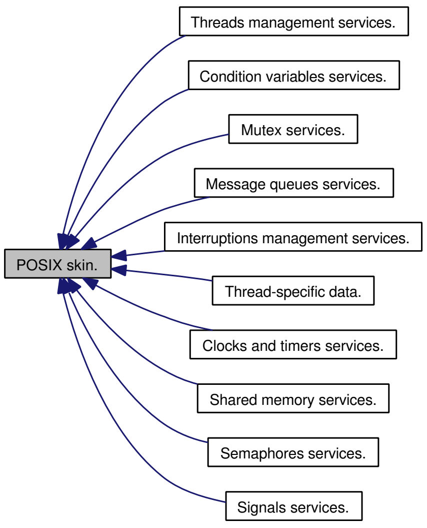
Returns:

the number of interrupt received on success;
-1 with *errno* set if:

- ENOSYS, kernel-space Xenomai POSIX skin was built without support for interrupts, use RTDM or enable CONFIG_XENO_OPT_POSIX_INTR in kernel configuration;
- EIDRM, the interrupt object was deleted;
- EPERM, the interrupt *intr* does not belong to the current process;
- ETIMEDOUT, the timeout specified by *to* expired;
- EINTR, pthread_intr_wait_np() was interrupted by a signal.

3.5 POSIX skin.

Collaboration diagram for POSIX skin.:



3.5.1 Detailed Description

Xenomai POSIX skin is an implementation of a small subset of the Single Unix specification over Xenomai generic RTOS core.

The following table gives equivalence between native API services and POSIX services.

Native API services	POSIX API services
alarm	Clocks and timers services.
cond	Condition variables services.
event	no direct equivalence, see Condition variables services.
native_heap	Shared memory services.
interrupt	Interruptions management services.
mutex	Mutex services.
pipe	no direct equivalence, see Message queues services.
native_queue	Message queues services.
semaphore	Semaphores services.
task	Threads management services.
native_timer	Clocks and timers services.

Modules

- Clocks and timers services.

  Clocks and timers services.

- Condition variables services.

  Condition variables services.

- Interruptions management services.

  Interruptions management services.

- Message queues services.

  Message queues services.

- Mutex services.

  Mutex services.

- Semaphores services.

  Semaphores services.

- Shared memory services.

  Shared memory services.

- Signals services.

  Signals management services.

- Threads management services.

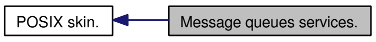
  Threads management services.

- Thread-specific data.

  Thread-specific data.

3.6 Message queues services.

Collaboration diagram for Message queues services.:



3.6.1 Detailed Description

Message queues services.

A message queue allow exchanging data between real-time threads. For a POSIX message queue, maximum message length and maximum number of messages are fixed when it is created with mq_open().

Functions

- mqd_t mq_open (const char ∗name, int oflags,...)

  Open a message queue.
- int mq_close (mqd_t fd)

  Close a message queue.
- int mq_unlink (const char ∗name)

  Unlink a message queue.
- int mq_send (mqd_t fd, const char ∗buffer, size_t len, unsigned prio)

  Send a message to a message queue.
- int mq_timedsend (mqd_t fd, const char ∗buffer, size_t len, unsigned prio, const struct timespec ∗abs_timeout)

  Attempt, during a bounded time, to send a message to a message queue.
- ssize_t mq_receive (mqd_t fd, char ∗buffer, size_t len, unsigned ∗priop)

  Receive a message from a message queue.
- ssize_t mq_timedreceive (mqd_t fd, char ∗__restrict__ buffer, size_t len, unsigned ∗__-restrict__ priop, const struct timespec ∗__restrict__ abs_timeout)

  Attempt, during a bounded time, to receive a message from a message queue.
- int mq_getattr (mqd_t fd, struct mq_attr ∗attr)

  Get the attributes object of a message queue.
- int mq_setattr (mqd_t fd, const struct mq_attr ∗__restrict__ attr, struct mq_attr ∗__restrict__ oattr)

  Set flags of a message queue.
- int mq_notify (mqd_t fd, const struct sigevent ∗evp)

  Register the current thread to be notified of message arrival at an empty message queue.

3.6.2 Function Documentation

3.6.2.1 int mq_close (mqd_t *fd*)

Close a message queue.

This service closes the message queue descriptor *fd*. The message queue is destroyed only when all open descriptors are closed, and when unlinked with a call to the mq_unlink() service.

Parameters:

fd message queue descriptor.

Return values:

0 on success;

-1 with *errno* set if:

- EBADF, *fd* is an invalid message queue descriptor;
- EPERM, the caller context is invalid.

Valid contexts:

- kernel module initialization or cleanup routine;
- kernel-space cancellation cleanup routine;
- user-space thread (Xenomai threads switch to secondary mode);
- user-space cancellation cleanup routine.

See also:

`Specification.`

3.6.2.2 int mq_getattr (mqd_t *fd*, struct mq_attr * *attr*)

Get the attributes object of a message queue.

This service stores, at the address *attr*, the attributes of the messages queue descriptor *fd*.

The following attributes are set:

- *mq_flags*, flags of the message queue descriptor *fd*;
- *mq_maxmsg*, maximum number of messages in the message queue;
- *mq_msgsize*, maximum message size;
- *mq_curmsgs*, number of messages currently in the queue.

Parameters:

fd message queue descriptor;

attr address where the message queue attributes will be stored on success.

Return values:

0 on success;

-1 with *errno* set if:

- EBADF, *fd* is not a valid descriptor.

See also:

`Specification.`

3.6.2.3 int mq_notify (mqd_t *fd*, const struct sigevent ∗ *evp*)

Register the current thread to be notified of message arrival at an empty message queue.

If *evp* is not *NULL* and is the address of a **sigevent** structure with the *sigev_notify* member set to SIGEV_SIGNAL, the current thread will be notified by a signal when a message is sent to the message queue *fd*, the queue is empty, and no thread is blocked in call to mq_receive() or mq_timedreceive(). After the notification, the thread is unregistered.

If *evp* is *NULL* or the *sigev_notify* member is SIGEV_NONE, the current thread is unregistered.

Only one thread may be registered at a time.

If the current thread is not a Xenomai POSIX skin thread (created with pthread_create()), this service fails.

Note that signals sent to user-space Xenomai POSIX skin threads will cause them to switch to secondary mode.

Parameters:

fd message queue descriptor;

evp pointer to an event notification structure.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *evp* is invalid;
- EPERM, the caller context is invalid;
- EBADF, *fd* is not a valid message queue descriptor;
- EBUSY, another thread is already registered.

Valid contexts:

- Xenomai kernel-space POSIX skin thread,
- Xenomai user-space POSIX skin thread (switches to primary mode).

See also:

`Specification.`

3.6.2.4 mqd_t mq_open (const char ∗ *name*, int *oflags*, ...)

Open a message queue.

This service establishes a connection between the message queue named *name* and the calling context (kernel-space as a whole, or user-space process).

One of the following values should be set in *oflags:*

- O_RDONLY, meaning that the returned queue descriptor may only be used for receiving messages;
- O_WRONLY, meaning that the returned queue descriptor may only be used for sending messages;
- O_RDWR, meaning that the returned queue descriptor may be used for both sending and receiving messages.

If no message queue named *name* exists, and *oflags* has the *O_CREAT* bit set, the message queue is created by this function, taking two more arguments:

- a *mode* argument, of type **mode_t**, currently ignored;
- an *attr* argument, pointer to an **mq_attr** structure, specifying the attributes of the new message queue.

If *oflags* has the two bits *O_CREAT* and *O_EXCL* set and the message queue alread exists, this service fails.

If the O_NONBLOCK bit is set in *oflags*, the mq_send(), mq_receive(), mq_timedsend() and mq_-timedreceive() services return *-1* with *errno* set to EAGAIN instead of blocking their caller.

The following arguments of the **mq_attr** structure at the address *attr* are used when creating a message queue:

- *mq_maxmsg* is the maximum number of messages in the queue (128 by default);
- *mq_msgsize* is the maximum size of each message (128 by default).

name may be any arbitrary string, in which slashes have no particular meaning. However, for portability, using a name which starts with a slash and contains no other slash is recommended.

Parameters:

name name of the message queue to open;

oflags flags.

Returns:

a message queue descriptor on success;
-1 with *errno* set if:

- ENAMETOOLONG, the length of the *name* argument exceeds 64 characters;
- EEXIST, the bits *O_CREAT* and *O_EXCL* were set in *oflags* and the message queue already exists;
- ENOENT, the bit *O_CREAT* is not set in *oflags* and the message queue does not exist;
- ENOSPC, allocation of system memory failed, or insufficient memory exists in the system heap to create the queue, try increasing CONFIG_XENO_OPT_SYS_HEAPSZ;
- EPERM, attempting to create a message queue from an invalid context;
- EINVAL, the *attr* argument is invalid;

- EMFILE, too many descriptors are currently open.

Valid contexts:

When creating a message queue, only the following contexts are valid:

- kernel module initialization or cleanup routine;
- user-space thread (Xenomai threads switch to secondary mode).

See also:

`Specification.`

3.6.2.5 ssize_t mq_receive (mqd_t *fd*, char * *buffer*, size_t *len*, unsigned * *priop*)

Receive a message from a message queue.

If the message queue *fd* is not empty and if *len* is greater than the *mq_msgsize* of the message queue, this service copies, at the address *buffer*, the queued message with the highest priority.

If the queue is empty and the flag *O_NONBLOCK* is not set for the descriptor *fd*, the calling thread is suspended until some message is sent to the queue. If the queue is empty and the flag *O_NONBLOCK* is set for the descriptor *fd*, this service returns immediately a value of -1 with *errno* set to EAGAIN.

Parameters:

fd the queue descriptor;

buffer the address where the received message will be stored on success;

len *buffer* length;

priop address where the priority of the received message will be stored on success.

Returns:

the message length, and copy a message at the address *buffer* on success;
-1 with no message unqueued and *errno* set if:

- EBADF, *fd* is not a valid descriptor open for reading;
- EMSGSIZE, the length *len* is lesser than the message queue *mq_msgsize* attribute;
- EAGAIN, the queue is empty, and the flag *O_NONBLOCK* is set for the descriptor *fd*;
- EPERM, the caller context is invalid;
- EINTR, the service was interrupted by a signal.

Valid contexts:

- Xenomai kernel-space thread,
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

3.6.2.6 int mq_send (mqd_t *fd*, const char * *buffer*, size_t *len*, unsigned *prio*)

Send a message to a message queue.

If the message queue *fd* is not full, this service sends the message of length *len* pointed to by the argument *buffer*, with priority *prio*. A message with greater priority is inserted in the queue before a message with lower priority.

If the message queue is full and the flag *O_NONBLOCK* is not set, the calling thread is suspended until the queue is not full. If the message queue is full and the flag *O_NONBLOCK* is set, the message is not sent and the service returns immediately a value of -1 with *errno* set to EAGAIN.

Parameters:

fd message queue descriptor;

buffer pointer to the message to be sent;

len length of the message;

prio priority of the message.

Returns:

0 and send a message on success;
-1 with no message sent and *errno* set if:

- EBADF, *fd* is not a valid message queue descriptor open for writing;
- EMSGSIZE, the message length *len* exceeds the *mq_msgsize* attribute of the message queue;
- EAGAIN, the flag O_NONBLOCK is set for the descriptor *fd* and the message queue is full;
- EPERM, the caller context is invalid;
- EINTR, the service was interrupted by a signal.

Valid contexts:

- Xenomai kernel-space thread,
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

3.6.2.7 int mq_setattr (mqd_t *fd*, const struct mq_attr *__restrict__ *attr*, struct mq_attr *__restrict__ *oattr*)

Set flags of a message queue.

This service sets the flags of the *fd* descriptor to the value of the member *mq_flags* of the **mq_attr** structure pointed to by *attr*.

The previous value of the message queue attributes are stored at the address *oattr* if it is not *NULL*.

Only setting or clearing the O_NONBLOCK flag has an effect.

Parameters:

fd message queue descriptor;

attr pointer to new attributes (only *mq_flags* is used);

oattr if not *NULL*, address where previous message queue attributes will be stored on success.

Return values:

0 on success;

-1 with *errno* set if:

- EBADF, *fd* is not a valid message queue descriptor.

See also:

Specification.

3.6.2.8 ssize_t mq_timedreceive (mqd_t *fd*, char *__restrict__ *buffer*, size_t *len*, unsigned *__restrict__ *priop*, const struct timespec *__restrict__ *abs_timeout*)

Attempt, during a bounded time, to receive a message from a message queue.

This service is equivalent to mq_receive(), except that if the flag *O_NONBLOCK* is not set for the descriptor *fd* and the message queue is empty, the calling thread is only suspended until the timeout *abs_timeout* expires.

Parameters:

fd the queue descriptor;

buffer the address where the received message will be stored on success;

len *buffer* length;

priop address where the priority of the received message will be stored on success.

abs_timeout the timeout, expressed as an absolute value of the CLOCK_REALTIME clock.

Returns:

the message length, and copy a message at the address *buffer* on success;
-1 with no message unqueued and *errno* set if:

- EBADF, *fd* is not a valid descriptor open for reading;
- EMSGSIZE, the length *len* is lesser than the message queue *mq_msgsize* attribute;
- EAGAIN, the queue is empty, and the flag *O_NONBLOCK* is set for the descriptor *fd*;
- EPERM, the caller context is invalid;
- EINTR, the service was interrupted by a signal;
- ETIMEDOUT, the specified timeout expired.

Valid contexts:

- Xenomai kernel-space thread,
- Xenomai user-space thread (switches to primary mode).

See also:

Specification.

3.6.2.9 int mq_timedsend (mqd_t *fd*, const char * *buffer*, size_t *len*, unsigned *prio*, const struct timespec * *abs_timeout*)

Attempt, during a bounded time, to send a message to a message queue.

This service is equivalent to mq_send(), except that if the message queue is full and the flag *O_-NONBLOCK* is not set for the descriptor *fd*, the calling thread is only suspended until the timeout specified by *abs_timeout* expires.

Parameters:

fd message queue descriptor;

buffer pointer to the message to be sent;

len length of the message;

prio priority of the message;

abs_timeout the timeout, expressed as an absolute value of the CLOCK_REALTIME clock.

Returns:

0 and send a message on success;
-1 with no message sent and *errno* set if:

- EBADF, *fd* is not a valid message queue descriptor open for writing;
- EMSGSIZE, the message length exceeds the *mq_msgsize* attribute of the message queue;
- EAGAIN, the flag O_NONBLOCK is set for the descriptor *fd* and the message queue is full;
- EPERM, the caller context is invalid;
- ETIMEDOUT, the specified timeout expired;
- EINTR, the service was interrupted by a signal.

Valid contexts:

- Xenomai kernel-space thread,
- Xenomai user-space thread (switches to primary mode).

See also:

Specification.

3.6.2.10 int mq_unlink (const char * *name*)

Unlink a message queue.

This service unlinks the message queue named *name*. The message queue is not destroyed until all queue descriptors obtained with the mq_open() service are closed with the mq_close() service. However, after a call to this service, the unlinked queue may no longer be reached with the mq_open() service.

Parameters:

name name of the message queue to be unlinked.

Return values:

0 on success;

-1 with *errno* set if:

- EPERM, the caller context is invalid;
- ENAMETOOLONG, the length of the *name* argument exceeds 64 characters;
- ENOENT, the message queue does not exist.

Valid contexts:

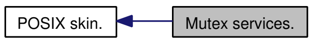
- kernel module initialization or cleanup routine;
- kernel-space cancellation cleanup routine;
- user-space thread (Xenomai threads switch to secondary mode);
- user-space cancellation cleanup routine.

See also:

`Specification.`

3.7 Mutex services.

Collaboration diagram for Mutex services.:



3.7.1 Detailed Description

Mutex services.

A mutex is a MUTual EXclusion device, and is useful for protecting shared data structures from concurrent modifications, and implementing critical sections and monitors.

A mutex has two possible states: unlocked (not owned by any thread), and locked (owned by one thread). A mutex can never be owned by two different threads simultaneously. A thread attempting to lock a mutex that is already locked by another thread is suspended until the owning thread unlocks the mutex first.

Before it can be used, a mutex has to be initialized with pthread_mutex_init(). An attribute object, which reference may be passed to this service, allows to select the features of the created mutex, namely its *type* (see pthread_mutexattr_settype()), the priority *protocol* it uses (see pthread_mutexattr_setprotocol()) and whether it may be shared between several processes (see pthread_mutexattr_setpshared()).

By default, Xenomai POSIX skin mutexes are of the normal type, use no priority protocol and may not be shared between several processes.

Note that only pthread_mutex_init() may be used to initialize a mutex, using the static initializer *PTHREAD_MUTEX_INITIALIZER* is not supported.

Functions

- int pthread_mutex_init (pthread_mutex_t *mx, const pthread_mutexattr_t *attr)

  Initialize a mutex.

- int pthread_mutex_destroy (pthread_mutex_t *mx)

  Destroy a mutex.

- int pthread_mutex_trylock (pthread_mutex_t *mx)

  Attempt to lock a mutex.

- int pthread_mutex_lock (pthread_mutex_t *mx)

  Lock a mutex.

- int pthread_mutex_timedlock (pthread_mutex_t *mx, const struct timespec *to)

  Attempt, during a bounded time, to lock a mutex.

- int pthread_mutex_unlock (pthread_mutex_t *mx)

  Unlock a mutex.

- int pthread_mutexattr_init (pthread_mutexattr_t *attr)

Initialize a mutex attributes object.

- int pthread_mutexattr_destroy (pthread_mutexattr_t *attr)

  Destroy a mutex attributes object.

- int pthread_mutexattr_gettype (const pthread_mutexattr_t *attr, int *type)

  Get the mutex type attribute from a mutex attributes object.

- int pthread_mutexattr_settype (pthread_mutexattr_t *attr, int type)

  Set the mutex type attribute of a mutex attributes object.

- int pthread_mutexattr_getprotocol (const pthread_mutexattr_t *attr, int *proto)

  Get the protocol attribute from a mutex attributes object.

- int pthread_mutexattr_setprotocol (pthread_mutexattr_t *attr, int proto)

  Set the protocol attribute of a mutex attributes object.

- int pthread_mutexattr_getpshared (const pthread_mutexattr_t *attr, int *pshared)

  Get the process-shared attribute of a mutex attributes object.

- int pthread_mutexattr_setpshared (pthread_mutexattr_t *attr, int pshared)

  Set the process-shared attribute of a mutex attributes object.

3.7.2 Function Documentation

3.7.2.1 int pthread_mutex_destroy (pthread_mutex_t * *mx*)

Destroy a mutex.

This service destroys the mutex *mx*, if it is unlocked and not referenced by any condition variable. The mutex becomes invalid for all mutex services (they all return the EINVAL error) except pthread_mutex_init().

Parameters:

mx the mutex to be destroyed.

Returns:

0 on success,
an error number if:

- EINVAL, the mutex *mx* is invalid;
- EPERM, the mutex is not process-shared and does not belong to the current process;
- EBUSY, the mutex is locked, or used by a condition variable.

See also:

`Specification.`

3.7.2.2 int pthread_mutex_init (pthread_mutex_t ∗ *mx*, const pthread_mutexattr_t ∗ *attr*)

Initialize a mutex.

This services initializes the mutex *mx*, using the mutex attributes object *attr*. If *attr* is *NULL*, default attributes are used (see pthread_mutexattr_init()).

Parameters:

mx the mutex to be initialized;

attr the mutex attributes object.

Returns:

0 on success,
an error number if:

- EINVAL, the mutex attributes object *attr* is invalid or uninitialized;
- EBUSY, the mutex *mx* was already initialized;
- ENOMEM, insufficient memory exists in the system heap to initialize the mutex, increase CONFIG_XENO_OPT_SYS_HEAPSZ.

See also:

`Specification.`

3.7.2.3 int pthread_mutex_lock (pthread_mutex_t ∗ *mx*)

Lock a mutex.

This service attempts to lock the mutex *mx*. If the mutex is free, it becomes locked. If it was locked by another thread than the current one, the current thread is suspended until the mutex is unlocked. If it was already locked by the current mutex, the behaviour of this service depends on the mutex type :

- for mutexes of the *PTHREAD_MUTEX_NORMAL* type, this service deadlocks;
- for mutexes of the *PTHREAD_MUTEX_ERRORCHECK* type, this service returns the EDEADLK error number;
- for mutexes of the *PTHREAD_MUTEX_RECURSIVE* type, this service increments the lock recursion count and returns 0.

Parameters:

mx the mutex to be locked.

Returns:

0 on success
an error number if:

- EPERM, the caller context is invalid;
- EINVAL, the mutex *mx* is invalid;
- EPERM, the mutex is not process-shared and does not belong to the current process;

- EDEADLK, the mutex is of the *PTHREAD_MUTEX_ERRORCHECK* type and was already locked by the current thread;
- EAGAIN, the mutex is of the *PTHREAD_MUTEX_RECURSIVE* type and the maximum number of recursive locks has been exceeded.

Valid contexts:

- Xenomai kernel-space thread;
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

3.7.2.4 int pthread_mutex_timedlock (pthread_mutex_t * *mx*, const struct timespec * *to*)

Attempt, during a bounded time, to lock a mutex.

This service is equivalent to pthread_mutex_lock(), except that if the mutex *mx* is locked by another thread than the current one, this service only suspends the current thread until the timeout specified by *to* expires.

Parameters:

mx the mutex to be locked;

to the timeout, expressed as an absolute value of the CLOCK_REALTIME clock.

Returns:

0 on success;
an error number if:

- EPERM, the caller context is invalid;
- EINVAL, the mutex *mx* is invalid;
- EPERM, the mutex is not process-shared and does not belong to the current process;
- ETIMEDOUT, the mutex could not be locked and the specified timeout expired;
- EDEADLK, the mutex is of the *PTHREAD_MUTEX_ERRORCHECK* type and the mutex was already locked by the current thread;
- EAGAIN, the mutex is of the *PTHREAD_MUTEX_RECURSIVE* type and the maximum number of recursive locks has been exceeded.

Valid contexts:

- Xenomai kernel-space thread;
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

3.7.2.5 int pthread_mutex_trylock (pthread_mutex_t * *mx*)

Attempt to lock a mutex.

This service is equivalent to pthread_mutex_lock(), except that if the mutex *mx* is locked by another thread than the current one, this service returns immediately.

Parameters:

mx the mutex to be locked.

Returns:

0 on success;
an error number if:

- EPERM, the caller context is invalid;
- EINVAL, the mutex is invalid;
- EPERM, the mutex is not process-shared and does not belong to the current process;
- EBUSY, the mutex was locked by another thread than the current one;
- EAGAIN, the mutex is recursive, and the maximum number of recursive locks has been exceeded.

Valid contexts:

- Xenomai kernel-space thread,
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

3.7.2.6 int pthread_mutex_unlock (pthread_mutex_t * *mx*)

Unlock a mutex.

This service unlocks the mutex *mx*. If the mutex is of the *PTHREAD_MUTEX_RECURSIVE type* and the locking recursion count is greater than one, the lock recursion count is decremented and the mutex remains locked.

Attempting to unlock a mutex which is not locked or which is locked by another thread than the current one yields the EPERM error, whatever the mutex *type* attribute.

Parameters:

mx the mutex to be released.

Returns:

0 on success;
an error number if:

- EPERM, the caller context is invalid;
- EINVAL, the mutex *mx* is invalid;
- EPERM, the mutex was not locked by the current thread.

Valid contexts:

- Xenomai kernel-space thread,
- kernel-space cancellation cleanup routine,
- Xenomai user-space thread (switches to primary mode),
- user-space cancellation cleanup routine.

See also:

`Specification.`

3.7.2.7 int pthread_mutexattr_destroy (pthread_mutexattr_t * *attr*)

Destroy a mutex attributes object.

This service destroys the mutex attributes object *attr*. The object becomes invalid for all mutex services (they all return EINVAL) except pthread_mutexattr_init().

Parameters:

attr the initialized mutex attributes object to be destroyed.

Returns:

0 on success;
an error number if:

- EINVAL, the mutex attributes object *attr* is invalid.

See also:

`Specification.`

3.7.2.8 int pthread_mutexattr_getprotocol (const pthread_mutexattr_t * *attr*, int * *proto*)

Get the protocol attribute from a mutex attributes object.

This service stores, at the address *proto*, the value of the *protocol* attribute in the mutex attributes object *attr*.

The *protcol* attribute may only be one of *PTHREAD_PRIO_NONE* or *PTHREAD_PRIO_INHERIT*. See pthread_mutexattr_setprotocol() for the meaning of these two constants.

Parameters:

attr an initialized mutex attributes object;

proto address where the value of the *protocol* attribute will be stored on success.

Returns:

0 on success,
an error number if:

- EINVAL, the *proto* address is invalid;
- EINVAL, the mutex attributes object *attr* is invalid.

See also:

`Specification.`

3.7.2.9 int pthread_mutexattr_getpshared (const pthread_mutexattr_t * *attr*, int * *pshared*)

Get the process-shared attribute of a mutex attributes object.

This service stores, at the address *pshared*, the value of the *pshared* attribute in the mutex attributes object *attr*.

The *pashared* attribute may only be one of *PTHREAD_PROCESS_PRIVATE* or *PTHREAD_-PROCESS_SHARED*. See pthread_mutexattr_setpshared() for the meaning of these two constants.

Parameters:

attr an initialized mutex attributes object;

pshared address where the value of the *pshared* attribute will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, the *pshared* address is invalid;
- EINVAL, the mutex attributes object *attr* is invalid.

See also:

`Specification.`

3.7.2.10 int pthread_mutexattr_gettype (const pthread_mutexattr_t * *attr*, int * *type*)

Get the mutex type attribute from a mutex attributes object.

This service stores, at the address *type*, the value of the *type* attribute in the mutex attributes object *attr*.

See pthread_mutex_lock() and pthread_mutex_unlock() documentations for a description of the values of the *type* attribute and their effect on a mutex.

Parameters:

attr an initialized mutex attributes object,

type address where the *type* attribute value will be stored on success.

Returns:

0 on sucess,
an error number if:

- EINVAL, the *type* address is invalid;
- EINVAL, the mutex attributes object *attr* is invalid.

See also:

`Specification.`

3.7.2.11 int pthread_mutexattr_init (pthread_mutexattr_t * *attr*)

Initialize a mutex attributes object.

This services initializes the mutex attributes object *attr* with default values for all attributes. Default value are :

- for the *type* attribute, *PTHREAD_MUTEX_NORMAL*;
- for the *protocol* attribute, *PTHREAD_PRIO_NONE*;
- for the *pshared* attribute, *PTHREAD_PROCESS_PRIVATE*.

If this service is called specifying a mutex attributes object that was already initialized, the attributes object is reinitialized.

Parameters:

attr the mutex attributes object to be initialized.

Returns:

0 on success;
an error number if:

- ENOMEM, the mutex attributes object pointer *attr* is *NULL*.

See also:

`Specification.`

3.7.2.12 int pthread_mutexattr_setprotocol (pthread_mutexattr_t * *attr*, int *proto*)

Set the protocol attribute of a mutex attributes object.

This service set the *type* attribute of the mutex attributes object *attr*.

Parameters:

attr an initialized mutex attributes object,

proto value of the *protocol* attribute, may be one of:

- PTHREAD_PRIO_NONE, meaning that a mutex created with the attributes object *attr* will not follow any priority protocol;
- PTHREAD_PRIO_INHERIT, meaning that a mutex created with the attributes object *attr*, will follow the priority inheritance protocol.

The value PTHREAD_PRIO_PROTECT (priority ceiling protocol) is unsupported.

Returns:

0 on success,
an error number if:

- EINVAL, the mutex attributes object *attr* is invalid;
- ENOTSUP, the value of *proto* is unsupported;

- EINVAL, the value of *proto* is invalid.

See also:

`Specification.`

3.7.2.13 int pthread_mutexattr_setpshared (pthread_mutexattr_t * *attr*, int *pshared*)

Set the process-shared attribute of a mutex attributes object.

This service set the *pshared* attribute of the mutex attributes object *attr*.

Parameters:

attr an initialized mutex attributes object.

pshared value of the *pshared* attribute, may be one of:

- PTHREAD_PROCESS_PRIVATE, meaning that a mutex created with the attributes object *attr* will only be accessible by threads within the same process as the thread that initialized the mutex;
- PTHREAD_PROCESS_SHARED, meaning that a mutex created with the attributes object *attr* will be accessible by any thread that has access to the memory where the mutex is allocated.

Returns:

0 on success,
an error status if:

- EINVAL, the mutex attributes object *attr* is invalid;
- EINVAL, the value of *pshared* is invalid.

See also:

`Specification.`

3.7.2.14 int pthread_mutexattr_settype (pthread_mutexattr_t * *attr*, int *type*)

Set the mutex type attribute of a mutex attributes object.

This service set the *type* attribute of the mutex attributes object *attr*.

See pthread_mutex_lock() and pthread_mutex_unlock() documentations for a description of the values of the *type* attribute and their effect on a mutex.

The *PTHREAD_MUTEX_DEFAULT* default *type* is the same as *PTHREAD_MUTEX_NORMAL*. Note that using a Xenomai POSIX skin recursive mutex with a Xenomai POSIX skin condition variable is safe (see pthread_cond_wait() documentation).

Parameters:

attr an initialized mutex attributes object,

type value of the *type* attribute.

Returns:

0 on success,
an error number if:

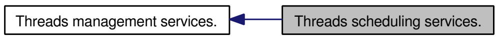
- EINVAL, the mutex attributes object *attr* is invalid;
- EINVAL, the value of *type* is invalid for the *type* attribute.

See also:

`Specification.`

3.8 Threads scheduling services.

Collaboration diagram for Threads scheduling services.:



3.8.1 Detailed Description

Thread scheduling services.

Xenomai POSIX skin supports the scheduling policies SCHED_FIFO, SCHED_RR and SCHED_-OTHER.

The SCHED_OTHER policy is mainly useful for user-space non-realtime activities that need to synchronize with real-time activities.

The SCHED_RR policy is only effective if the time base is periodic (i.e. if configured with the compilation constant *CONFIG_XENO_OPT_POSIX_PERIOD* or the *xeno_nucleus* module parameter *tick_arg* set to a non null value). The SCHED_RR round-robin time slice is configured with the *xeno_posix* module parameter *time_slice*, as a count of system timer clock ticks.

The SCHED_SPORADIC policy is not supported.

The scheduling policy and priority of a thread is set when creating a thread, by using thread creation attributes (see pthread_attr_setinheritsched(), pthread_attr_setschedpolicy() and pthread_-attr_setschedparam()), or when the thread is already running by using the service pthread_-setschedparam().

See also:

`Specification.`

Functions

- int sched_get_priority_min (int policy)

  Get minimum priority of the specified scheduling policy.

- int sched_get_priority_max (int policy)

  Get maximum priority of the specified scheduling policy.

- int sched_rr_get_interval (int pid, struct timespec *interval)

  Get the round-robin scheduling time slice.

- int pthread_getschedparam (pthread_t tid, int *pol, struct sched_param *par)

  Get the scheduling policy and parameters of the specified thread.

- int pthread_setschedparam (pthread_t tid, int pol, const struct sched_param *par)

  Set the scheduling policy and parameters of the specified thread.

- int sched_yield (void)

  Yield the processor.

3.8.2 Function Documentation

3.8.2.1 int pthread_getschedparam (pthread_t *tid*, int ∗ *pol*, struct sched_param ∗ *par*)

Get the scheduling policy and parameters of the specified thread.

This service returns, at the addresses *pol* and *par*, the current scheduling policy and scheduling parameters (i.e. priority) of the Xenomai POSIX skin thread *tid*. If this service is called from user-space and *tid* is not the identifier of a Xenomai POSIX skin thread, this service fallback to Linux regular pthread_getschedparam service.

Parameters:

tid target thread;

pol address where the scheduling policy of *tid* is stored on success;

par address where the scheduling parameters of *tid* is stored on success.

Returns:

0 on success;
an error number if:

- ESRCH, *tid* is invalid.

See also:

`Specification.`

Referenced by pthread_create().

3.8.2.2 int pthread_setschedparam (pthread_t *tid*, int *pol*, const struct sched_param ∗ *par*)

Set the scheduling policy and parameters of the specified thread.

This service set the scheduling policy of the Xenomai POSIX skin thread *tid* to the value *pol*, and its scheduling parameters (i.e. its priority) to the value pointed to by *par*.

When used in user-space, passing the current thread ID as *tid* argument, this service turns the current thread into a Xenomai POSIX skin thread. If *tid* is neither the identifier of the current thread nor the identifier of a Xenomai POSIX skin thread this service falls back to the regular pthread_setschedparam() service, hereby causing the current thread to switch to secondary mode if it is Xenomai thread.

Parameters:

tid target thread;

pol scheduling policy, one of SCHED_FIFO, SCHED_RR or SCHED_OTHER;

par scheduling parameters address.

Returns:

0 on success;
an error number if:

- ESRCH, *tid* is invalid;
- EINVAL, *pol* or *par->sched_priority* is invalid;

- EAGAIN, in user-space, insufficient memory exists in the system heap, increase CONFIG_XENO_OPT_SYS_HEAPSZ;
- EFAULT, in user-space, *par* is an invalid address;
- EPERM, in user-space, the calling process does not have superuser permissions.

See also:

Specification.

3.8.2.3 int sched_get_priority_max (int *policy*)

Get maximum priority of the specified scheduling policy.

This service returns the maximum priority of the scheduling policy *policy*.

Parameters:

policy scheduling policy, one of SCHED_FIFO, SCHED_RR, or SCHED_OTHER.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *policy* is invalid.

See also:

Specification.

3.8.2.4 int sched_get_priority_min (int *policy*)

Get minimum priority of the specified scheduling policy.

This service returns the minimum priority of the scheduling policy *policy*.

Parameters:

policy scheduling policy, one of SCHED_FIFO, SCHED_RR, or SCHED_OTHER.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *policy* is invalid.

See also:

Specification.

3.8.2.5 int sched_rr_get_interval (int *pid*, struct timespec ∗ *interval*)

Get the round-robin scheduling time slice.

This service returns the time quantum used by Xenomai POSIX skin SCHED_RR scheduling policy.

In kernel-space, this service only works if pid is zero, in user-space, round-robin scheduling policy is not supported, and this service not implemented.

Parameters:

pid must be zero;

interval address where the round-robin scheduling time quantum will be returned on success.

Return values:

0 on success;

-1 with *errno* set if:

- ESRCH, *pid* is invalid (not 0).

See also:

Specification.

3.8.2.6 int sched_yield (void)

Yield the processor.

This function move the current thread at the end of its priority group.

Return values:

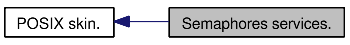
0

See also:

Specification.

3.9 Semaphores services.

Collaboration diagram for Semaphores services.:



3.9.1 Detailed Description

Semaphores services.

Semaphores are counters for resources shared between threads. The basic operations on semaphores are: increment the counter atomically, and wait until the counter is non-null and decrement it atomically.

Semaphores have a maximum value past which they cannot be incremented. The macro *SEM_-VALUE_MAX* is defined to be this maximum value.

Functions

- int sem_init (sem_t *sm, int pshared, unsigned value)

  Initialize an unnamed semaphore.

- int sem_destroy (sem_t *sm)

  Destroy an unnamed semaphore.

- sem_t * sem_open (const char *name, int oflags,...)

  Open a named semaphore.

- int sem_close (sem_t *sm)

  Close a named semaphore.

- int sem_unlink (const char *name)

  Unlink a named semaphore.

- int sem_trywait (sem_t *sm)

  Attempt to lock a semaphore.

- int sem_wait (sem_t *sm)

  Lock a semaphore.

- int sem_timedwait (sem_t *sm, const struct timespec *abs_timeout)

  Attempt, during a bounded time, to lock a semaphore.

- int sem_post (sem_t *sm)

  Unlock a semaphore.

- int sem_getvalue (sem_t *sm, int *value)

  Get the value of a semaphore.

3.9.2 Function Documentation

3.9.2.1 int sem_close (sem_t * *sm*)

Close a named semaphore.

This service closes the semaphore *sm*. The semaphore is destroyed only when unlinked with a call to the sem_unlink() service and when each call to sem_open() matches a call to this service.

When a semaphore is destroyed, the memory it used is returned to the system heap, so that further references to this semaphore are not guaranteed to fail, as is the case for unnamed semaphores.

This service fails if *sm* is an unnamed semaphore.

Parameters:

sm the semaphore to be closed.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, the semaphore *sm* is invalid or is an unnamed semaphore.

See also:

`Specification.`

3.9.2.2 int sem_destroy (sem_t * *sm*)

Destroy an unnamed semaphore.

This service destroys the semaphore *sm*. Threads currently blocked on *sm* are unblocked and the service they called return -1 with *errno* set to EINVAL. The semaphore is then considered invalid by all semaphore services (they all fail with *errno* set to EINVAL) except sem_init().

This service fails if *sm* is a named semaphore.

Parameters:

sm the semaphore to be destroyed.

Return values:

0 on success,

-1 with *errno* set if:

- EINVAL, the semaphore *sm* is invalid or a named semaphore;
- EPERM, the semaphore *sm* is not process-shared and does not belong to the current process.

See also:

`Specification.`

3.9.2.3 int sem_getvalue (sem_t * *sm*, int * *value*)

Get the value of a semaphore.

This service stores at the address *value*, the current count of the semaphore *sm*. The state of the semaphore is unchanged.

If the semaphore is currently locked, the value stored is zero.

Parameters:

sm a semaphore;

value address where the semaphore count will be stored on success.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, the semaphore is invalid or uninitialized;
- EPERM, the semaphore *sm* is not process-shared and does not belong to the current process.

See also:

`Specification.`

3.9.2.4 int sem_init (sem_t * *sm*, int *pshared*, unsigned *value*)

Initialize an unnamed semaphore.

This service initializes the semaphore *sm*, with the value *value*.

This service fails if *sm* is already initialized or is a named semaphore.

Parameters:

sm the semaphore to be initialized;

pshared if zero, means that the new semaphore may only be used by threads in the same process as the thread calling sem_init(); if non zero, means that the new semaphore may be used by any thread that has access to the memory where the semaphore is allocated.

value the semaphore initial value.

Return values:

0 on success,

-1 with *errno* set if:

- EBUSY, the semaphore *sm* was already initialized;
- ENOSPC, insufficient memory exists in the system heap to initialize the semaphore, increase CONFIG_XENO_OPT_SYS_HEAPSZ;
- EINVAL, the *value* argument exceeds *SEM_VALUE_MAX*.

See also:

`Specification.`

3.9.2.5 sem_t* sem_open (const char * *name*, int *oflags*, ...)

Open a named semaphore.

This service establishes a connection between the semaphore named *name* and the calling context (kernel-space as a whole, or user-space process).

If no semaphore named *name* exists and *oflags* has the *O_CREAT* bit set, the semaphore is created by this function, using two more arguments:

- a *mode* argument, of type **mode_t**, currently ignored;
- a *value* argument, of type **unsigned**, specifying the initial value of the created semaphore.

If *oflags* has the two bits *O_CREAT* and *O_EXCL* set and the semaphore already exists, this service fails.

name may be any arbitrary string, in which slashes have no particular meaning. However, for portability, using a name which starts with a slash and contains no other slash is recommended.

If sem_open() is called from the same context (kernel-space as a whole, or user-space process) several times with the same value of *name*, the same address is returned.

Parameters:

name the name of the semaphore to be created;

oflags flags.

Returns:

the address of the named semaphore on success;
SEM_FAILED with *errno* set if:

- ENAMETOOLONG, the length of the *name* argument exceeds 64 characters;
- EEXIST, the bits *O_CREAT* and *O_EXCL* were set in *oflags* and the named semaphore already exists;
- ENOENT, the bit *O_CREAT* is not set in *oflags* and the named semaphore does not exist;
- ENOSPC, insufficient memory exists in the system heap to create the semaphore, increase CONFIG_XENO_OPT_SYS_HEAPSZ;
- EINVAL, the *value* argument exceeds *SEM_VALUE_MAX*.

See also:

Specification.

3.9.2.6 int sem_post (sem_t * *sm*)

Unlock a semaphore.

This service unlocks the semaphore *sm*.

If no thread is currently blocked on this semaphore, its count is incremented, otherwise the highest priority thread is unblocked.

Parameters:

sm the semaphore to be unlocked.

Return values:

0 on success;

-1 with errno set if:

- EINVAL, the specified semaphore is invalid or uninitialized;
- EPERM, the semaphore *sm* is not process-shared and does not belong to the current process;
- EAGAIN, the semaphore count is *SEM_VALUE_MAX*.

See also:

Specification.

3.9.2.7 int sem_timedwait (sem_t * *sm*, const struct timespec * *abs_timeout*)

Attempt, during a bounded time, to lock a semaphore.

This serivce is equivalent to sem_wait(), except that the caller is only blocked until the timeout *abs_timeout* expires.

Parameters:

sm the semaphore to be locked;

abs_timeout the timeout, expressed as an absolute value of the CLOCK_REALTIME clock.

Return values:

0 on success;

-1 with *errno* set if:

- EPERM, the caller context is invalid;
- EINVAL, the semaphore is invalid or uninitialized;
- EINVAL, the specified timeout is invalid;
- EPERM, the semaphore *sm* is not process-shared and does not belong to the current process;
- EINTR, the caller was interrupted by a signal while blocked in this service;
- ETIMEDOUT, the semaphore could not be locked and the specified timeout expired.

Valid contexts:

- Xenomai kernel-space thread,
- Xenomai user-space thread (switches to primary mode).

See also:

Specification.

3.9.2.8 int sem_trywait (sem_t * *sm*)

Attempt to lock a semaphore.

This service is equivalent to sem_wait(), except that it returns immediately if the semaphore *sm* is currently locked, and that it is not a cancellation point.

Parameters:

sm the semaphore to be locked.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, the specified semaphore is invalid or uninitialized;
- EPERM, the semaphore *sm* is not process-shared and does not belong to the current process;
- EAGAIN, the specified semaphore is currently locked.

*

See also:

Specification.

3.9.2.9 int sem_unlink (const char * *name*)

Unlink a named semaphore.

This service unlinks the semaphore named *name*. This semaphore is not destroyed until all references obtained with sem_open() are closed by calling sem_close(). However, the unlinked semaphore may no longer be reached with the sem_open() service.

When a semaphore is destroyed, the memory it used is returned to the system heap, so that further references to this semaphore are not guaranteed to fail, as is the case for unnamed semaphores.

Parameters:

name the name of the semaphore to be unlinked.

Return values:

0 on success;

-1 with *errno* set if:

- ENAMETOOLONG, the length of the *name* argument exceeds 64 characters;
- ENOENT, the named semaphore does not exist.

See also:

Specification.

3.9.2.10 int sem_wait (sem_t * *sm*)

Lock a semaphore.

This service locks the semaphore *sm* if it is currently unlocked (i.e. if its value is greater than 0). If the semaphore is currently locked, the calling thread is suspended until the semaphore is unlocked, or a signal is delivered to the calling thread.

This service is a cancellation point for Xenomai POSIX skin threads (created with the pthread_-create() service). When such a thread is cancelled while blocked in a call to this service, the semaphore state is left unchanged before the cancellation cleanup handlers are called.

Parameters:

sm the semaphore to be locked.

Return values:

0 on success;

-1 with *errno* set if:

- EPERM, the caller context is invalid;
- EINVAL, the semaphore is invalid or uninitialized;
- EPERM, the semaphore *sm* is not process-shared and does not belong to the current process;
- EINTR, the caller was interrupted by a signal while blocked in this service.

Valid contexts:

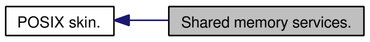
- Xenomai kernel-space thread,
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

3.10 Shared memory services.

Collaboration diagram for Shared memory services.:



3.10.1 Detailed Description

Shared memory services.

Shared memory objects are memory regions that can be mapped into processes address space, allowing them to share these regions as well as to share them with kernel-space modules.

Shared memory are also the only mean by which anonymous POSIX skin synchronization objects (mutexes, condition variables or semaphores) may be shared between kernel-space modules and user-space processes, or between several processes.

Functions

- int shm_open (const char *name, int oflags, mode_t mode)

  Open a shared memory object.

- int close (int fd)

  Close a file descriptor.

- int shm_unlink (const char *name)

  Unlink a shared memory object.

- int ftruncate (int fd, off_t len)

  Truncate a file or shared memory object to a specified length.

- void * mmap (void *addr, size_t len, int prot, int flags, int fd, off_t off)

  Map pages of memory.

- int munmap (void *addr, size_t len)

  Unmap pages of memory.

3.10.2 Function Documentation

3.10.2.1 int close (int *fd*)

Close a file descriptor.

This service closes the file descriptor *fd*. In kernel-space, this service only works for file descriptors opened with shm_open(), i.e. shared memory objects. A shared memory object is only destroyed once all file descriptors are closed with this service, it is unlinked with the shm_unlink() service, and all mappings are unmapped with the munmap() service.

Parameters:

fd file descriptor.

Return values:

0 on success;

-1 with *errno* set if:

- EBADF, *fd* is not a valid file descriptor (in kernel-space, it was not obtained with shm_open());
- EPERM, the caller context is invalid.

Valid contexts:

- kernel module initialization or cleanup routine;
- kernel-space cancellation cleanup routine;
- user-space thread (Xenomai threads switch to secondary mode);
- user-space cancellation cleanup routine.

See also:

`Specification.`

Referenced by shm_open().

3.10.2.2 int ftruncate (int *fd*, off_t *len*)

Truncate a file or shared memory object to a specified length.

When used in kernel-space, this service set to *len* the size of a shared memory object opened with the shm_open() service. In user-space this service falls back to Linux regular ftruncate service for file descriptors not obtained with shm_open(). When this service is used to increase the size of a shared memory object, the added space is zero-filled.

Shared memory are suitable for direct memory access (allocated in physically contiguous memory) if their size is less than or equal to 128 K.

Shared memory objects may only be resized if they are not currently mapped.

Parameters:

fd file descriptor;

len new length of the underlying file or shared memory object.

Return values:

0 on success;

-1 with *errno* set if:

- EBADF, *fd* is not a valid file descriptor;
- EPERM, the caller context is invalid;
- EINVAL, the specified length is invalid;
- EINTR, this service was interrupted by a signal;
- EBUSY, *fd* is a shared memory object descriptor and the underlying shared memory is currently mapped;

- EFBIG, allocation of system memory failed.

Valid contexts:

- kernel module initialization or cleanup routine;
- user-space thread (Xenomai threads switch to secondary mode).

See also:

`Specification.`

Referenced by shm_open().

3.10.2.3 void* mmap (void * *addr*, size_t *len*, int *prot*, int *flags*, int *fd*, off_t *off*)

Map pages of memory.

This service allow shared memory regions to be accessed by the caller.

When used in kernel-space, this service returns the address of the offset *off* of the shared memory object underlying *fd*. The protection flags *prot*, are only checked for consistency with *fd* open flags, but memory protection is unsupported. An existing shared memory region exists before it is mapped, this service only increments a reference counter.

The only supported value for *flags* is *MAP_SHARED*.

When used in user-space, this service maps the specified shared memory region into the caller address-space. If *fd* is not a shared memory object descriptor (i.e. not obtained with shm_open()), this service falls back to the regular Linux mmap service.

Parameters:

addr ignored.

len size of the shared memory region to be mapped.

prot protection bits, checked in kernel-space, but only useful in user-space, are a bitwise or of the following values:

- PROT_NONE, meaning that the mapped region can not be accessed;
- PROT_READ, meaning that the mapped region can be read;
- PROT_WRITE, meaning that the mapped region can be written;
- PROT_EXEC, meaning that the mapped region can be executed.

flags only MAP_SHARED is accepted, meaning that the mapped memory region is shared.

fd file descriptor, obtained with shm_open().

off offset in the shared memory region.

Return values:

0 on success;

MAP_FAILED with *errno* set if:

- EINVAL, *len* is null or *addr* is not a multiple of *PAGE_SIZE*;
- EBADF, *fd* is not a shared memory object descriptor (obtained with shm_open());
- EPERM, the caller context is invalid;
- ENOTSUP, *flags* is not *MAP_SHARED*;

- EACCES, *fd* is not opened for reading or is not opend for writing and PROT_WRITE is set in *prot*;
- EINTR, this service was interrupted by a signal;
- ENXIO, the range [off;off+len) is invalid for the shared memory region specified by *fd*;
- EAGAIN, insufficient memory exists in the system heap to create the mapping, increase CONFIG_XENO_OPT_SYS_HEAPSZ.

Valid contexts:

- kernel module initialization or cleanup routine;
- user-space thread (Xenomai threads switch to secondary mode).

See also:

`Specification.`

3.10.2.4 int munmap (void ∗ *addr*, size_t *len*)

Unmap pages of memory.

This service unmaps the shared memory region [addr;addr+len) from the caller address-space.

When called from kernel-space the memory region remain accessible as long as it exists, and this service only decrements a reference counter.

When called from user-space, if the region is not a shared memory region, this service falls back to the regular Linux munmap() service.

Parameters:

addr start address of shared memory area;

len length of the shared memory area.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *len* is null, *addr* is not a multiple of the page size or the range [addr;addr+len) is not a mapped region;
- ENXIO, *addr* is not the address of a shared memory area;
- EPERM, the caller context is invalid;
- EINTR, this service was interrupted by a signal.

Valid contexts:

- kernel module initialization or cleanup routine;
- kernel-space cancellation cleanup routine;
- user-space thread (Xenomai threads switch to secondary mode);
- user-space cancellation cleanup routine.

See also:

`Specification.`

3.10.2.5 int shm_open (const char ∗ *name*, int *oflags*, mode_t *mode*)

Open a shared memory object.

This service establishes a connection between a shared memory object and a file descriptor. Further use of this descriptor will allow to dimension and map the shared memory into the calling context address space.

One of the following access mode should be set in *oflags:*

- O_RDONLY, meaning that the shared memory object may only be mapped with the PROT_-READ flag;
- O_WRONLY, meaning that the shared memory object may only be mapped with the PROT_-WRITE flag;
- O_RDWR, meaning that the shared memory object may be mapped with the PROT_READ | PROT_WRITE flag.

If no shared memory object named *name* exists, and *oflags* has the *O_CREAT* bit set, the shared memory object is created by this function.

If *oflags* has the two bits *O_CREAT* and *O_EXCL* set and the shared memory object alread exists, this service fails.

If *oflags* has the bit *O_TRUNC* set, the shared memory exists and is not currently mapped, its size is truncated to 0.

name may be any arbitrary string, in which slashes have no particular meaning. However, for portability, using a name which starts with a slash and contains no other slash is recommended.

Parameters:

name name of the shared memory object to open;

oflags flags.

mode ignored.

Returns:

a file descriptor on success;
-1 with *errno* set if:

- ENAMETOOLONG, the length of the *name* argument exceeds 64 characters;
- EEXIST, the bits *O_CREAT* and *O_EXCL* were set in *oflags* and the shared memory object already exists;
- ENOENT, the bit *O_CREAT* is not set in *oflags* and the shared memory object does not exist;
- ENOSPC, insufficient memory exists in the system heap to create the shared memory object, increase CONFIG_XENO_OPT_SYS_HEAPSZ;
- EPERM, the caller context is invalid;
- EINVAL, the O_TRUNC flag was specified and the shared memory object is currently mapped;
- EMFILE, too many descriptors are currently open.

Valid contexts:

- kernel module initialization or cleanup routine;

- user-space thread (Xenomai threads switch to secondary mode).

See also:

`Specification.`

References close(), and ftruncate().

3.10.2.6 int shm_unlink (const char * *name*)

Unlink a shared memory object.

This service unlinks the shared memory object named *name*. The shared memory object is not destroyed until every file descriptor obtained with the shm_open() service is closed with the close() service and all mappings done with mmap() are unmapped with munmap(). However, after a call to this service, the unlinked shared memory object may no longer be reached with the shm_open() service.

Parameters:

name name of the shared memory obect to be unlinked.

Return values:

0 on success;

-1 with *errno* set if:

- EPERM, the caller context is invalid;
- ENAMETOOLONG, the length of the *name* argument exceeds 64 characters;
- ENOENT, the shared memory object does not exist.

Valid contexts:

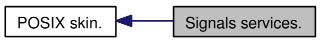
- kernel module initialization or cleanup routine;
- kernel-space cancellation cleanup routine;
- user-space thread (Xenomai threads switch to secondary mode);
- user-space cancellation cleanup routine.

See also:

`Specification.`

3.11 Signals services.

Collaboration diagram for Signals services.:



3.11.1 Detailed Description

Signals management services.

Signals are asynchronous notifications delivered to a process or thread. Such notifications occur as the result of an exceptional event or at the request of another process.

The services documented here are reserved to Xenomai kernel-space threads, user-space threads switch to secondary mode when handling signals, and use Linux regular signals services.

Xenomai POSIX skin signals are implemented as real-time signals, meaning that they are queued when posted several times to a thread before the first notification is handled, and that each signal carry additional data in a **siginfo_t** object. In order to ensure consistence with user-space signals, valid signals number range from 1 to SIGRTMAX, signals from SIGRTMIN to SIGRTMAX being higher priority than signals from 1 to SIGRTMIN-1. As a special case, signal 0 may be used with services pthread_kill() and pthread_sigqueue_np() to check if a thread exists, but entails no other action.

The action to be taken upon reception of a signal depends on the thread signal mask, (see pthread_sigmask()), and on the settings described by a **sigaction** structure (see sigaction()).

Functions

- int sigemptyset (sigset_t ∗set)

  Initialize and empty a signal set.

- int sigfillset (sigset_t ∗set)

  Initialize and fill a signal set.

- int sigaddset (sigset_t ∗set, int sig)

  Add a signal to a signal set.

- int sigdelset (sigset_t ∗set, int sig)

  Delete a signal from a signal set.

- int sigismember (const sigset_t ∗set, int sig)

  Test for a signal in a signal set.

- int sigaction (int sig, const struct sigaction ∗act, struct sigaction ∗oact)

  Examine and change a signal action.

- int pthread_kill (pthread_t thread, int sig)

  Send a signal to a thread.

- int pthread_sigqueue_np (pthread_t thread, int sig, union sigval value)

Queue a signal to a thread.

- int sigpending (sigset_t *set)

  Examine pending signals.

- int pthread_sigmask (int how, const sigset_t *set, sigset_t *oset)

  Examine and change the set of signals blocked by a thread.

- int sigwait (const sigset_t *set, int *sig)

  Wait for signals.

- int sigwaitinfo (const sigset_t *__restrict__ set, siginfo_t *__restrict__ info)

  Wait for signals.

- int sigtimedwait (const sigset_t *__restrict__ set, siginfo_t *__restrict__ info, const struct timespec *__restrict__ timeout)

  Wait during a bounded time for signals.

3.11.2 Function Documentation

3.11.2.1 int pthread_kill (pthread_t *thread*, int *sig*)

Send a signal to a thread.

This service send the signal *sig* to the Xenomai POSIX skin thread *thread* (created with pthread_-create()). If *sig* is zero, this service check for existence of the thread *thread*, but no signal is sent.

Parameters:

thread thread identifier;

sig signal number.

Returns:

0 on success;
an error number if:

- EINVAL, *sig* is an invalid signal number;
- EAGAIN, the maximum number of pending signals has been exceeded;
- ESRCH, *thread* is an invalid thread identifier.

See also:

`Specification.`

3.11.2.2 int pthread_sigmask (int *how*, const sigset_t * *set*, sigset_t * *oset*)

Examine and change the set of signals blocked by a thread.

The signal mask of a thread is the set of signals that are blocked by this thread.

If *oset* is not NULL, this service stores, at the address *oset* the current signal mask of the calling thread.

If *set* is not NULL, this service sets the signal mask of the calling thread according to the value of *how*, as follow:

- if *how* is SIG_BLOCK, the signals in *set* are added to the calling thread signal mask;
- if *how* is SIG_SETMASK, the calling thread signal mask is set to *set*;
- if *how* is SIG_UNBLOCK, the signals in *set* are removed from the calling thread signal mask.

If some signals are unblocked by this service, they are handled before this service returns.

Parameters:

how if *set* is not null, a value indicating how to interpret *set*;

set if not null, a signal set that will be used to modify the calling thread signal mask;

oset if not null, address where the previous value of the calling thread signal mask will be stored on success.

Returns:

0 on success;
an error number if:

- EPERM, the calling context is invalid;
- EINVAL, *how* is not SIG_BLOCK, SIG_UNBLOCK or SIG_SETMASK.

Valid contexts:

- Xenomai POSIX skin kernel-space thread.

See also:

`Specification.`

3.11.2.3 int pthread_sigqueue_np (pthread_t *thread*, int *sig*, union sigval *value*)

Queue a signal to a thread.

This service send the signal *sig* to the Xenomai POSIX skin thread *thread* (created with pthread_-create()), with the value *value*. If *sig* is zero, this service check for existence of the thread *thread*, but no signal is sent.

This service is equivalent to the POSIX service sigqueue(), except that the signal is directed to a thread instead of being directed to a process.

Parameters:

thread thread identifier,

sig signal number,

value additional datum passed to *thread* with the signal *sig*.

Returns:

0 on success;
an error number if:

- EINVAL, *sig* is an invalid signal number;
- EAGAIN, the maximum number of pending signals has been exceeded;
- ESRCH, *thread* is an invalid thread identifier.

See also:

`sigqueue() specification.`

3.11.2.4 int sigaction (int *sig*, const struct sigaction ∗ *act*, struct sigaction ∗ *oact*)

Examine and change a signal action.

The **sigaction** structure descibes the actions to be taken upon signal delivery. A **sigaction** structure is associated with every signal, for the kernel-space as a whole.

If *oact* is not *NULL*, this service returns at the address *oact*, the current value of the **sigaction** structure associated with the signal *sig*.

If *act* is not *NULL*, this service set to the value pointed to by *act*, the **sigaction** structure associated with the signal *sig*.

The structure **sigaction** has the following members:

- *sa_flags*, is a bitwise OR of the flags;
  - SA_RESETHAND, meaning that the signal handler will be reset to SIG_GFL and SA_-SIGINFO cleared upon reception of a signal,
  - SA_NODEFER, meaning that the signal handler will be called with the signal *sig* not masked when handling the signal *sig*,
  - SA_SIGINFO, meaning that the member *sa_sigaction* of the **sigaction** structure will be used as a signal handler instead of *sa_handler*
- *sa_mask*, of type **sigset_t**, is the value to which the thread signals mask will be set during execution of the signal handler (*sig* is automatically added to this set if SA_NODEFER is not set in *sa_flags*);
- *sa_handler*, of type **void (∗)(int)** is the signal handler which will be called upon signal delivery if SA_SIGINFO is not set in *sa_flags*, or one of SIG_IGN or SIG_DFL, meaning that the signal will be respectively ignored or handled with the default handler;
- *sa_sigaction*, of type **void (∗)(int, siginfo_t ∗, void ∗)** is the signal handler which will be called upon signal delivery if SA_SIGINFO is set in *sa_flags*.

When using *sa_handler* as a signal handler, it is passed the number of the received signal, when using *sa_sigaction*, two additional arguments are passed:

- a pointer to a **siginfo_t** object, containing additional information about the received signal;
- a void pointer, always null in this implementation.

The following members of the **siginfo_t** structure are filled by this implementation:

- *si_signo*, the signal number;
- *si_code*, the provenance of the signal, one of:
  - SI_QUEUE, the signal was queued with pthread_sigqueue_np(),
  - SI_USER, the signal was queued with pthread_kill(),
  - SI_TIMER, the signal was queued by a timer (see timer_settime()),
  - SI_MESQ, the signal was queued by a message queue (see mq_notify());
- *si_value*, an additional datum, of type **union sigval**.

Parameters:

sig a signal number;

act if not null, description of the action to be taken upon notification of the signal *sig*;

oact if not null, address where the previous description of the signal action is stored on success.

Return values:

0 on sucess;

-1 with *errno* set if:

- EINVAL, *sig* is an invalid signal number;
- ENOTSUP, the *sa_flags* member of *act* contains other flags than SA_RESETHAND, SA_NODEFER and SA_SIGINFO;

See also:

`Specification.`

3.11.2.5 int sigaddset (sigset_t * *set*, int *sig*)

Add a signal to a signal set.

This service adds the signal number *sig* to the signal set pointed to by *set*.

Parameters:

set address of a signal set;

sig signal to be added to *set*.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *sig* is not a valid signal number.

See also:

`Specification.`

3.11.2.6 int sigdelset (sigset_t * *set*, int *sig*)

Delete a signal from a signal set.

This service remove the signal number *sig* from the signal set pointed to by *set*.

Parameters:

set address of a signal set;

sig signal to be removed from *set*.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *sig* is not a valid signal number.

See also:

Specification.

3.11.2.7 int sigemptyset (sigset_t * *set*)

Initialize and empty a signal set.

This service initializes ane empties the signal set pointed to by *set*.

Parameters:

set address of a the signal set to be initialized.

Return values:

0

See also:

Specification.

3.11.2.8 int sigfillset (sigset_t * *set*)

Initialize and fill a signal set.

This service initializes ane fills the signal set pointed to by *set*.

Parameters:

set address of a the signal set to be filled.

Return values:

0

See also:

Specification.

3.11.2.9 int sigismember (const sigset_t * *set*, int *sig*)

Test for a signal in a signal set.

This service tests whether the signal number *sig* is member of the signal set pointed to by *set*.

Parameters:

set address of a signal set;

sig tested signal number.

Return values:

0 on success;

-1 with *errno* set if:

- EINVAL, *sig* is not a valid signal number.

See also:

`Specification.`

3.11.2.10 int sigpending (sigset_t * *set*)

Examine pending signals.

This service stores, at the address *set*, the set of signals that are currently blocked and have been received by the calling thread.

Parameters:

set address where the set of blocked and received signals are stored on success.

Return values:

0 on success;

-1 with *errno* set if:

- EPERM, the calling context is invalid.

Valid contexts:

- Xenomai POSIX skin kernel-space thread.

See also:

`Specification.`

3.11.2.11 int sigtimedwait (const sigset_t *__restrict__ *set*, siginfo_t *__restrict__ *info*, const struct timespec *__restrict__ *timeout*)

Wait during a bounded time for signals.

This service is equivalent to the sigwaitinfo() service, except that the calling thread is only blocked until the timeout specified by *timeout* expires.

Parameters:

> ***set*** set of signals to wait for;
>
> ***info*** address where the received **siginfo_t** object will be stored on success;
>
> ***timeout*** the timeout, expressed as a time interval.

Return values:

> ***0*** on success;
>
> ***-1*** with *errno* set if:
>
> - EINVAL, the specified timeout is invalid;
> - EPERM, the caller context is invalid;
> - EINVAL, a signal in *set* is not currently blocked;
> - EAGAIN, no signal was received and the specified timeout expired.

Valid contexts:

- Xenomai POSIX skin kernel-space thread.

See also:

> `Specification.`

3.11.2.12 int sigwait (const sigset_t * *set*, int * *sig*)

Wait for signals.

This service blocks a Xenomai kernel-space POSIX skin thread until a signal of the set *set* is received. If a signal in *set* is not currently blocked by the calling thread, this service returns immediately with an error. The signal received is stored at the address *sig*.

If a signal of the set *set* was already pending, it is cleared and this service returns immediately.

Signals are received in priority order, i.e. from SIGRTMIN to SIGRTMAX, then from 1 to SIGRTMIN-1.

Parameters:

> ***set*** set of signals to wait for;
>
> ***sig*** address where the received signal will be stored on success.

Returns:

> 0 on success;
> an error number if:
>
> - EPERM, the caller context is invalid;
> - EINVAL, a signal in *set* is not currently blocked.

Valid contexts:

- Xenomai POSIX skin kernel-space thread.

See also:

> `Specification.`

3.11.2.13 int sigwaitinfo (const sigset_t *__restrict__ *set*, siginfo_t *__restrict__ *info*)

Wait for signals.

This service is equivalent to the sigwait() service, except that it returns, at the address *info*, the **siginfo_t** object associated with the received signal instead of only returning the signal number.

Parameters:

set set of signals to wait for;

info address where the received **siginfo_t** object will be stored on success.

Return values:

0 on success;

-1 with *errno* set if:

- EPERM, the caller context is invalid;
- EINVAL, a signal in *set* is not currently blocked.

Valid contexts:

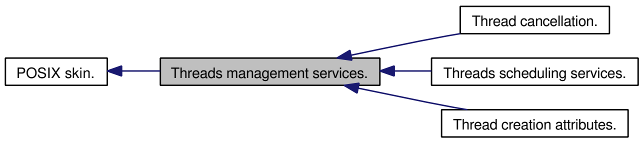
- Xenomai POSIX skin kernel-space thread.

See also:

Specification.

3.12 Threads management services.

Collaboration diagram for Threads management services.:


Thread cancellation.
POSIX skin.
Threads management services.
Threads scheduling services.
Thread creation attributes.

3.12.1 Detailed Description

Threads management services.

See also:

Specification.

Modules

- Thread cancellation.

  Thread cancellation.

- Threads scheduling services.

  Thread scheduling services.

- Thread creation attributes.

  Thread creation attributes.

Functions

- int pthread_once (pthread_once_t *once, void(*init_routine)(void))

  Execute an initialization routine.

- int pthread_create (pthread_t *tid, const pthread_attr_t *attr, void *(*start)(void *), void *arg)

  Create a thread.

- int pthread_detach (pthread_t thread)

  Detach a running thread.

- int pthread_equal (pthread_t t1, pthread_t t2)

  Compare thread identifiers.

- void pthread_exit (void *value_ptr)

  Terminate the current thread.

- int pthread_join (pthread_t thread, void **value_ptr)

Wait for termination of a specified thread.

- pthread_t pthread_self (void)

  Get the identifier of the calling thread.

- int pthread_make_periodic_np (pthread_t thread, struct timespec *starttp, struct timespec *periodtp)

  Make a thread periodic.

- int pthread_wait_np (unsigned long *overruns_r)

  Wait for current thread next period.

- int pthread_set_mode_np (int clrmask, int setmask)

  Set the mode of the current thread.

- int pthread_set_name_np (pthread_t thread, const char *name)

  Set a thread name.

3.12.2 Function Documentation

3.12.2.1 int pthread_create (pthread_t * *tid*, const pthread_attr_t * *attr*, void *(*)(void *) *start*, void * *arg*)

Create a thread.

This service create a thread. The created thread may be used with all POSIX skin services.

The new thread run the *start* routine, with the *arg* argument.

The new thread signal mask is inherited from the current thread, if it was also created with pthread_create(), otherwise the new thread signal mask is empty.

Other attributes of the new thread depend on the *attr* argument. If *attr* is null, default values for these attributes are used. See Thread creation attributes. for a definition of thread creation attributes and their default values.

Returning from the *start* routine has the same effect as calling pthread_exit() with the return value.

Parameters:

tid address where the identifier of the new thread will be stored on success;

attr thread attributes;

start thread routine;

arg thread routine argument.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid;
- EAGAIN, insufficient memory exists in the system heap to create a new thread, increase CONFIG_XENO_OPT_SYS_HEAPSZ;

- EINVAL, thread attribute *inheritsched* is set to PTHREAD_INHERIT_SCHED and the calling thread does not belong to the POSIX skin;

See also:

Specification.

References pthread_getschedparam().

3.12.2.2 int pthread_detach (pthread_t *thread*)

Detach a running thread.

This service detaches a joinable thread. A detached thread is a thread which control block is automatically reclaimed when it terminates. The control block of a joinable thread, on the other hand, is only reclaimed when joined with the service pthread_join().

If some threads are currently blocked in the pthread_join() service with *thread* as a target, they are unblocked and pthread_join() returns EINVAL.

Parameters:

thread target thread.

Returns:

0 on success;
an error number if:

- ESRCH, *thread* is an invalid thread identifier;
- EINVAL, *thread* is not joinable.

See also:

Specification.

3.12.2.3 int pthread_equal (pthread_t *t1*, pthread_t *t2*)

Compare thread identifiers.

This service compare the thread identifiers *t1* and *t2*. No attempt is made to check the threads for existence. In order to check if a thread exists, the pthread_kill() service should be used with the signal number 0.

Parameters:

t1 thread identifier;

t2 other thread identifier.

Returns:

a non zero value if the thread identifiers are equal;
0 otherwise.

See also:

Specification.

3.12.2.4 void pthread_exit (void * *value_ptr*)

Terminate the current thread.

This service terminate the current thread with the return value *value_ptr*. If the current thread is joinable, the return value is returned to any thread joining the current thread with the pthread_-join() service.

When a thread terminates, cancellation cleanup handlers are executed in the reverse order that they were pushed. Then, thread-specific data destructors are executed.

Parameters:

value_ptr thread return value.

See also:

`Specification.`

3.12.2.5 int pthread_join (pthread_t *thread*, void ** *value_ptr*)

Wait for termination of a specified thread.

If the thread *thread* is running and joinable, this service blocks the calling thread until the thread *thread* terminates or detaches. In this case, the calling context must be a blockable context (i.e. a Xenomai thread without the scheduler locked) or the root thread (i.e. a module initilization or cleanup routine). When *thread* terminates, the calling thread is unblocked and its return value is stored at* the address *value_ptr*.

If, on the other hand, the thread *thread* has already finished execution, its return value is stored at the address *value_ptr* and this service returns immediately. In this case, this service may be called from any context.

This service is a cancelation point for POSIX skin threads: if the calling thread is canceled while blocked in a call to this service, the cancelation request is honored and *thread* remains joinable.

Multiple simultaneous calls to pthread_join() specifying the same running target thread block all the callers until the target thread terminates.

Parameters:

thread identifier of the thread to wait for;

value_ptr address where the target thread return value will be stored on success.

Returns:

0 on success;
an error number if:

- ESRCH, *thread* is invalid;
- EDEADLK, attempting to join the calling thread;
- EINVAL, *thread* is detached;
- EPERM, the caller context is invalid.

Valid contexts, if this service has to block its caller:

- Xenomai kernel-space thread;

- kernel module initilization or cleanup routine;
- Xenomai user-space thread (switches to primary mode).

See also:

`Specification.`

3.12.2.6 int pthread_make_periodic_np (pthread_t *thread*, struct timespec * *starttp*, struct timespec * *periodtp*)

Make a thread periodic.

This service make the POSIX skin thread *thread* periodic.

This service is a non-portable extension of the POSIX interface.

Parameters:

thread thread identifier. This thread is immediately delayed until the first periodic release point is reached.

starttp start time, expressed as an absolute value of the CLOCK_REALTIME clock. The affected thread will be delayed until this point is reached.

periodtp period, expressed as a time interval.

Returns:

0 on success;
an error number if:

- ESRCH, *thread* is invalid;
- ETIMEDOUT, the start time has already passed.

Rescheduling: always, until the *starttp* start time has been reached.

3.12.2.7 int pthread_once (pthread_once_t * *once*, void(*)(void) *init_routine*)

Execute an initialization routine.

This service may be used by libraries which need an initialization function to be called only once.

The function *init_routine* will only be called, with no argument, the first time this service is called specifying the address *once*.

Returns:

0 on success;
an error number if:

- EINVAL, the object pointed to by *once* is invalid (it must have been initialized with PTHREAD_ONCE_INIT).

See also:

`Specification.`

3.12.2.8 pthread_t pthread_self (void)

Get the identifier of the calling thread.

This service returns the identifier of the calling thread.

Returns:

identifier of the calling thread;
NULL if the calling thread is not a POSIX skin thread.

See also:

`Specification.`

3.12.2.9 int pthread_set_mode_np (int *clrmask*, int *setmask*)

Set the mode of the current thread.

This service sets the mode of the calling thread. *clrmask* and *setmask* are two bit masks which are respectively cleared and set in the calling thread status. They are a bitwise OR of the following values:

- PTHREAD_LOCK_SCHED, when set, locks the scheduler, which prevents the current thread from being switched out by the scheduler until the scheduler is unlocked;
- PTHREAD_SHIELD, when set, activates the interrupt shield, which improve the execution determinism of the current thread by blocking Linux interrupts when it runs in secondary mode;
- PTHREAD_RPIOFF, when set, prevents the root Linux thread from inheriting the priority of the calling thread, when this thread is running in secondary mode;
- PTHREAD_WARNSW, when set, cause the signal SIGXCPU to be sent to the current thread, whenever it involontary switches to secondary mode;
- PTHREAD_PRIMARY, cause the migration of the current thread to primary mode.

PTHREAD_LOCK_SCHED is valid for any Xenomai thread, the other bits are only valid for Xenomai user-space threads.

This service is a non-portable extension of the POSIX interface.

Parameters:

clrmask set of bits to be cleared;

setmask set of bits to be set.

Returns:

0 on success;
an error number if:

- EINVAL, some bit in *clrmask* or *setmask* is invalid.

3.12.2.10 int pthread_set_name_np (pthread_t *thread*, const char ∗ *name*)

Set a thread name.

This service set to *name*, the name of *thread*. This name is used for displaying information in /proc/xenomai/sched.

This service is a non-portable extension of the POSIX interface.

Parameters:

thread target thread;

name name of the thread.

Returns:

0 on success;
an error number if:

- ESRCH, *thread* is invalid.

3.12.2.11 int pthread_wait_np (unsigned long ∗ *overruns_r*)

Wait for current thread next period.

If it is periodic, this service blocks the calling thread until the next period elapses.

This service is a cancelation point for POSIX skin threads.

This service is a non-portable extension of the POSIX interface.

Parameters:

overruns_r address where the overruns count is returned in case of overrun.

Returns:

0 on success;
an error number if:

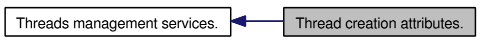
- EPERM, the calling context is invalid;
- EWOULDBLOCK, the calling thread is not periodic;
- EINTR, this service was interrupted by a signal;
- ETIMEDOUT, at least one overrun occurred.

Valid contexts:

- Xenomai kernel-space thread;
- Xenomai user-space thread (switches to primary mode).

3.13 Thread creation attributes.

Collaboration diagram for Thread creation attributes.:



3.13.1 Detailed Description

Thread creation attributes.

The services described in this section allow to set the attributes of a **pthread_attr_t** object, passed to the pthread_create() service in order to set the attributes of a created thread.

A **pthread_attr_t** object has to be initialized with pthread_attr_init() first, which sets attributes to their default values, i.e. in kernel-space:

- *detachstate* to PTHREAD_CREATE_JOINABLE,
- *stacksize* to PTHREAD_STACK_MIN,
- *inheritsched* to PTHREAD_EXPLICIT_SCHED,
- *schedpolicy* to SCHED_OTHER,
- *name* to NULL (only available in kernel-space),
- scheduling priority to the minimum,
- floating-point hardware enabled (only available in kernel-space),
- processor affinity set to all available processors (only available as a thread attribute in kernel-space).

In user-space, the attributes and their defaults values are those documented by the underlying threading library (LinuxThreads or NPTL).

Functions

- int pthread_attr_init (pthread_attr_t *attr)

  Initialize a thread attributes object.

- int pthread_attr_destroy (pthread_attr_t *attr)

  Destroy a thread attributes object.

- int pthread_attr_getdetachstate (const pthread_attr_t *attr, int *detachstate)

  Get detachstate attribute.

- int pthread_attr_setdetachstate (pthread_attr_t *attr, int detachstate)

  Set detachstate attribute.

- int pthread_attr_getstacksize (const pthread_attr_t *attr, size_t *stacksize)

  Get stacksize attribute.

- int pthread_attr_setstacksize (pthread_attr_t *attr, size_t stacksize)

  Set stacksize attribute.

- int pthread_attr_getinheritsched (const pthread_attr_t *attr, int *inheritsched)

  Get inheritsched attribute.

- int pthread_attr_setinheritsched (pthread_attr_t *attr, int inheritsched)

  Set inheritsched attribute.

- int pthread_attr_getschedpolicy (const pthread_attr_t *attr, int *policy)

  Get schedpolicy attribute.

- int pthread_attr_setschedpolicy (pthread_attr_t *attr, int policy)

  Set schedpolicy attribute.

- int pthread_attr_getschedparam (const pthread_attr_t *attr, struct sched_param *par)

  Get schedparam attribute.

- int pthread_attr_setschedparam (pthread_attr_t *attr, const struct sched_param *par)

  Set schedparam attribute.

- int pthread_attr_getscope (const pthread_attr_t *attr, int *scope)

  Get contention scope attribute.

- int pthread_attr_setscope (pthread_attr_t *attr, int scope)

  Set contention scope attribute.

- int pthread_attr_getname_np (const pthread_attr_t *attr, const char **name)

  Get name attribute.

- int pthread_attr_setname_np (pthread_attr_t *attr, const char *name)

  Set name attribute.

- int pthread_attr_getfp_np (const pthread_attr_t *attr, int *fp)

  Get the floating point attribute.

- int pthread_attr_setfp_np (pthread_attr_t *attr, int fp)

  Set the floating point attribute.

- int pthread_attr_getaffinity_np (const pthread_attr_t *attr, xnarch_cpumask_t *mask)

  Get the processor affinity attribute.

- int pthread_attr_setaffinity_np (pthread_attr_t *attr, xnarch_cpumask_t mask)

  Set the processor affinity attribute.

3.13.2 Function Documentation

3.13.2.1 int pthread_attr_destroy (pthread_attr_t * *attr*)

Destroy a thread attributes object.

This service invalidates the attribute object pointed to by *attr*. The object becomes invalid for all services (they all return EINVAL) except pthread_attr_init().

See also:

`Specification.`

3.13.2.2 int pthread_attr_getaffinity_np (const pthread_attr_t * *attr*, xnarch_cpumask_t * *mask*)

Get the processor affinity attribute.

This service stores, at the address *mask*, the value of the *affinity* attribute in the attribute object *attr*.

The *affinity* attributes is a bitmask where bits set indicate processor where a thread created with the attribute *attr* may run. The least significant bit corresponds to the first logical processor.

This service is a non-portable extension of the POSIX interface.

Parameters:

attr attribute object;

mask address where the value of the *affinity* attribute will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

Valid contexts:

- kernel module initialization or cleanup routine;
- Xenomai kernel-space thread.

3.13.2.3 int pthread_attr_getdetachstate (const pthread_attr_t * *attr*, int * *detachstate*)

Get detachstate attribute.

This service returns, at the address *detachstate*, the value of the *detachstate* attribute in the thread attribute object *attr*.

Valid values of this attribute are PTHREAD_CREATE_JOINABLE and PTHREAD_CREATE_-DETACHED. A detached thread is a thread which control block is automatically reclaimed when it terminates. The control block of a joinable thread, on the other hand, is only reclaimed when joined with the service pthread_join().

A thread that was created joinable may be detached after creation by using the pthread_detach() service.

Parameters:

attr attribute object

detachstate address where the value of the detachstate attribute will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid;

See also:

`Specification.`

3.13.2.4 int pthread_attr_getfp_np (const pthread_attr_t * *attr*, int * *fp*)

Get the floating point attribute.

This service returns, at the address *fp*, the value of the *fp* attribute in the attribute object *attr*.

The *fp* attribute is a boolean attribute indicating whether a thread created with the attribute *attr* may use floating-point hardware.

This service is a non-portable extension of the POSIX interface.

Parameters:

attr attribute object;

fp address where the value of the *fp* attribute will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

Valid contexts:

- kernel module initialization or cleanup routine;
- Xenomai kernel-space thread.

3.13.2.5 int pthread_attr_getinheritsched (const pthread_attr_t * *attr*, int * *inheritsched*)

Get inheritsched attribute.

This service returns at the address *inheritsched* the value of the *inheritsched* attribute in the attribute object *attr*.

Threads created with this attribute set to PTHREAD_INHERIT_SCHED will use the same scheduling policy and priority as the thread calling pthread_create(). Threads created with this attribute set to PTHREAD_EXPLICIT_SCHED will use the value of the *schedpolicy* attribute as scheduling policy, and the value of the *schedparam* attribute as scheduling priority.

Parameters:

attr attribute object;

inheritsched address where the value of the *inheritsched* attribute will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

See also:

`Specification.`

3.13.2.6 int pthread_attr_getname_np (const pthread_attr_t * *attr*, const char ** *name*)

Get name attribute.

This service stores, at the address *name*, the value of the *name* attribute in the attribute object *attr*.

The *name* attribute is the name under which a thread created with the attribute object *attr* will appear under /proc/xenomai/sched.

The name returned by this function is only valid until the name is changed with pthread_attr_-setname_np() or the *attr* object is destroyed with pthread_attr_destroy().

If *name* is *NULL*, a unique default name will be used.

This service is a non-portable extension of the POSIX interface.

Parameters:

attr attribute object;

name address where the value of the *name* attribute will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

Valid contexts:

- kernel module initialization or cleanup routine;
- Xenomai kernel-space thread.

3.13.2.7 int pthread_attr_getschedparam (const pthread_attr_t * *attr*, struct sched_param * *par*)

Get schedparam attribute.

This service stores, at the address *par*, the value of the *schedparam* attribute in the attribute object *attr*.

The only member of the **sched_param** structure used by this implementation is *sched_priority*. Threads created with *attr* will use the value of this attribute as a scheduling priority if the attribute *inheritsched* is set to PTHREAD_EXPLICIT_SCHED. Valid priorities range from 1 to 99.

Parameters:

attr attribute object;

par address where the value of the *schedparam* attribute will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

See also:

Specification.

3.13.2.8 int pthread_attr_getschedpolicy (const pthread_attr_t * *attr*, int * *policy*)

Get schedpolicy attribute.

This service stores, at the address *policy*, the value of the *policy* attribute in the attribute object *attr*.

Threads created with the attribute object *attr* use the value of this attribute as scheduling policy if the *inheritsched* attribute is set to PTHREAD_EXPLICIT_SCHED. The value of this attribute is one of SCHED_FIFO, SCHED_RR or SCHED_OTHER.

Parameters:

attr attribute object;

policy address where the value of the *policy* attribute in the attribute object *attr* will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

See also:

Specification.

3.13.2.9 int pthread_attr_getscope (const pthread_attr_t * *attr*, int * *scope*)

Get contention scope attribute.

This service stores, at the address *scope*, the value of the *scope* attribute in the attribute object *attr*.

The *scope* attribute represents the scheduling contention scope of threads created with the attribute object *attr*. This implementation only supports the value PTHREAD_SCOPE_SYSTEM.

Parameters:

attr attribute object;

scope address where the value of the *scope* attribute will be stored on sucess.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

See also:

`Specification.`

3.13.2.10 int pthread_attr_getstacksize (const pthread_attr_t * *attr*, size_t * *stacksize*)

Get stacksize attribute.

This service stores, at the address *stacksize*, the value of the *stacksize* attribute in the attribute object *attr*.

The *stacksize* attribute is used as the stack size of the threads created using the attribute object *attr*.

Parameters:

attr attribute object;

stacksize address where the value of the *stacksize* attribute will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

See also:

`Specification.`

3.13.2.11 int pthread_attr_init (pthread_attr_t * *attr*)

Initialize a thread attributes object.

This service initializes the thread creation attributes structure pointed to by *attr*. Attributes are set to their default values (see Thread creation attributes.).

If this service is called specifying a thread attributes object that was already initialized, the attributes object is reinitialized.

Parameters:

attr address of the thread attributes object to initialize.

Returns:

0.

See also:

`Specification.`

3.13.2.12 int pthread_attr_setaffinity_np (pthread_attr_t * *attr*, xnarch_cpumask_t *mask*)

Set the processor affinity attribute.

This service sets to *mask*, the value of the *affinity* attribute in the attribute object *attr*.

The *affinity* attributes is a bitmask where bits set indicate processor where a thread created with the attribute *attr* may run. The least significant bit corresponds to the first logical processor.

This service is a non-portable extension of the POSIX interface.

Parameters:

attr attribute object;

mask address where the value of the *affinity* attribute will be stored on success.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

Valid contexts:

- kernel module initialization or cleanup routine;
- Xenomai kernel-space thread.

3.13.2.13 int pthread_attr_setdetachstate (pthread_attr_t * *attr*, int *detachstate*)

Set detachstate attribute.

This service sets to *detachstate* the value of the *detachstate* attribute in the attribute object *attr*.

Valid values of this attribute are PTHREAD_CREATE_JOINABLE and PTHREAD_CREATE_-DETACHED. A detached thread is a thread which control block is automatically reclaimed when it terminates. The control block of a joinable thread, on the other hand, is only reclaimed when joined with the service pthread_join().

A thread that was created joinable may be detached after creation by using the pthread_detach() service.

Parameters:

attr attribute object;

detachstate value of the detachstate attribute.

Returns:

0 on success;
an error number if:

- EINVAL, the attribute object *attr* is invalid

See also:

`Specification.`

3.13.2.14 int pthread_attr_setfp_np (pthread_attr_t * *attr*, int *fp*)

Set the floating point attribute.

This service set to *fp*, the value of the *fp* attribute in the attribute object *attr*.

The *fp* attribute is a boolean attribute indicating whether a thread created with the attribute *attr* may use floating-point hardware.

This service is a non-portable extension of the POSIX interface.

Parameters:

attr attribute object;

fp value of the *fp* attribute.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid.

Valid contexts:

- kernel module initialization or cleanup routine;
- Xenomai kernel-space thread.

3.13.2.15 int pthread_attr_setinheritsched (pthread_attr_t * *attr*, int *inheritsched*)

Set inheritsched attribute.

This service set to *inheritsched* the value of the *inheritsched* attribute in the attribute object *attr*.

Threads created with this attribute set to PTHREAD_INHERIT_SCHED will use the same scheduling policy and priority as the thread calling pthread_create(). Threads created with this attribute set to PTHREAD_EXPLICIT_SCHED will use the value of the *schedpolicy* attribute as scheduling policy, and the value of the *schedparam* attribute as scheduling priority.

Parameters:

attr attribute object;

inheritsched value of the *inheritsched* attribute, PTHREAD_INHERIT_SCHED or PTHREAD_EXPLICIT_SCHED.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* or *inheritsched* is invalid.

See also:

`Specification.`

3.13.2.16 int pthread_attr_setname_np (pthread_attr_t * *attr*, const char * *name*)

Set name attribute.

This service set to *name*, the value of the *name* attribute in the attribute object *attr*.

The *name* attribute is the name under which a thread created with the attribute object *attr* will appear under /proc/xenomai/sched.

If *name* is *NULL*, a unique default name will be used.

This service is a non-portable extension of the POSIX interface.

Parameters:

attr attribute object;

name value of the *name* attribute.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* is invalid;
- ENOMEM, insufficient memory exists in the system heap to duplicate the name string, increase CONFIG_XENO_OPT_SYS_HEAPSZ.

Valid contexts:

- kernel module initialization or cleanup routine;
- Xenomai kernel-space thread.

3.13.2.17 int pthread_attr_setschedparam (pthread_attr_t * *attr*, const struct sched_param * *par*)

Set schedparam attribute.

This service set to *par*, the value of the *schedparam* attribute in the attribute object *attr*.

The only member of the **sched_param** structure used by this implementation is *sched_priority*. Threads created with *attr* will use the value of this attribute as a scheduling priority if the attribute *inheritsched* is set to PTHREAD_EXPLICIT_SCHED. Valid priorities range from 1 to 99.

Parameters:

attr attribute object;

par value of the *schedparam* attribute.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* or *par* is invalid.

See also:

`Specification.`

3.13.2.18 int pthread_attr_setschedpolicy (pthread_attr_t * *attr*, int *policy*)

Set schedpolicy attribute.

This service set to *policy* the value of the *policy* attribute in the attribute object *attr*.

Threads created with the attribute object *attr* use the value of this attribute as scheduling policy if the *inheritsched* attribute is set to PTHREAD_EXPLICIT_SCHED. The value of this attribute is one of SCHED_FIFO, SCHED_RR or SCHED_OTHER.

Parameters:

attr attribute object;

policy value of the *policy* attribute.

Returns:

0 on success;
an error number if:

- EINVAL, *attr* or *policy* is invalid.

See also:

`Specification.`

3.13.2.19 int pthread_attr_setscope (pthread_attr_t * *attr*, int *scope*)

Set contention scope attribute.

This service set to *scope* the value of the *scope* attribute in the attribute object *attr*.

The *scope* attribute represents the scheduling contention scope of threads created with the attribute object *attr*. This implementation only supports the value PTHREAD_SCOPE_SYSTEM.

Parameters:

attr attribute object;

scope value of the *scope* attribute.

Returns:

0 on success;
an error number if:

- ENOTSUP, *scope* is an unsupported value of the scope attribute.
- EINVAL, *attr* is invalid.

See also:

`Specification.`

3.13.2.20 int pthread_attr_setstacksize (pthread_attr_t * *attr*, size_t *stacksize*)

Set stacksize attribute.

This service set to *stacksize*, the value of the *stacksize* attribute in the attribute object *attr*.

The *stacksize* attribute is used as the stack size of the threads created using the attribute object *attr*.

The minimum value for this attribute is PTHREAD_STACK_MIN.

Parameters:

attr attribute object;

stacksize value of the *stacksize* attribute.

Returns:

0 on success;
an error number if:

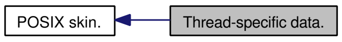
- EINVAL, *attr* or *stacksize* is invalid.

See also:

`Specification.`

3.14 Thread-specific data.

Collaboration diagram for Thread-specific data.:



3.14.1 Detailed Description

Thread-specific data.

Programs often need global or static variables that have different values in different threads. Since threads share one memory space, this cannot be achieved with regular variables. Thread-specific data is the POSIX threads answer to this need.

Each thread possesses a private memory block, the thread-specific data area, or TSD area for short. This area is indexed by TSD keys. The TSD area associates values of type 'void *' to TSD keys. TSD keys are common to all threads, but the value associated with a given TSD key can be different in each thread.

When a thread is created, its TSD area initially associates *NULL* with all keys.

The services documented here are valid in kernel-space context; when called in user-space, the underlying Linux threading library (LinuxThreads or NPTL) services are used.

Functions

- int pthread_key_create (pthread_key_t *key, void(*destructor)(void *))

  Create a thread-specific data key.

- int pthread_setspecific (pthread_key_t key, const void *value)

  Associate a thread-specific value with the specified key.

- void * pthread_getspecific (pthread_key_t key)

  Get the thread-specific value bound to the specified key.

- int pthread_key_delete (pthread_key_t key)

  Delete a thread-specific data key.

3.14.2 Function Documentation

3.14.2.1 void* pthread_getspecific (pthread_key_t *key*)

Get the thread-specific value bound to the specified key.

This service returns the value associated, for the calling thread, with the key *key*.

Parameters:

key TSD key, obtained with pthread_key_create().

Returns:

the value associated with *key*;
NULL if the context is invalid.

Valid contexts:

- Xenomai POSIX skin kernel-space thread.

See also:

Specification.

3.14.2.2 int pthread_key_create (pthread_key_t * *key*, void(*)(void *) *destructor*)

Create a thread-specific data key.

This service create a TSD key. The NULL value is associated for all threads with the new key and the new key is returned at the address *key*. If *destructor* is not null, it is executed when a thread is terminated as long as the datum associated with the key is not NULL, up to PTHREAD_-DESTRUCTOR_ITERATIONS times.

Parameters:

key address where the new key will be stored on success;

destructor function to be invoked when a thread terminates and has a non NULL value associated with the new key.

Returns:

0 on success;
an error number if:

- EAGAIN, the total number of keys PTHREAD_KEYS_MAX TSD has been exceeded;
- ENOMEM, insufficient memory exists in the system heap to create a new key, increase CONFIG_XENO_OPT_SYS_HEAPSZ.

See also:

Specification.

3.14.2.3 int pthread_key_delete (pthread_key_t *key*)

Delete a thread-specific data key.

This service deletes the TSD key *key*. Note that the key destructor function is not called, so, if any thread has a value associated with *key* that is a pointer to dynamically allocated memory, the application has to manage to free that memory by other means.

Parameters:

key the TSD key to be destroyed.

Returns:

0 on success;
an error number if:

- EINVAL, *key* is invalid.

See also:

`Specification.`

3.14.2.4 int pthread_setspecific (pthread_key_t *key*, const void * *value*)

Associate a thread-specific value with the specified key.

This service associates, for the calling thread, the value *value* to the key *key*.

Parameters:

key TSD key, obtained with pthread_key_create();

value value.

Returns:

0 on success;
an error number if:

- EPERM, the caller context is invalid;
- EINVAL, *key* is invalid.

Valid contexts:

- Xenomai POSIX skin kernel-space thread.

See also:

`Specification.`

Chapter 4

File Documentation

4.1 ksrc/skins/posix/syscall.c File Reference

4.1.1 Detailed Description

This file is part of the Xenomai project.

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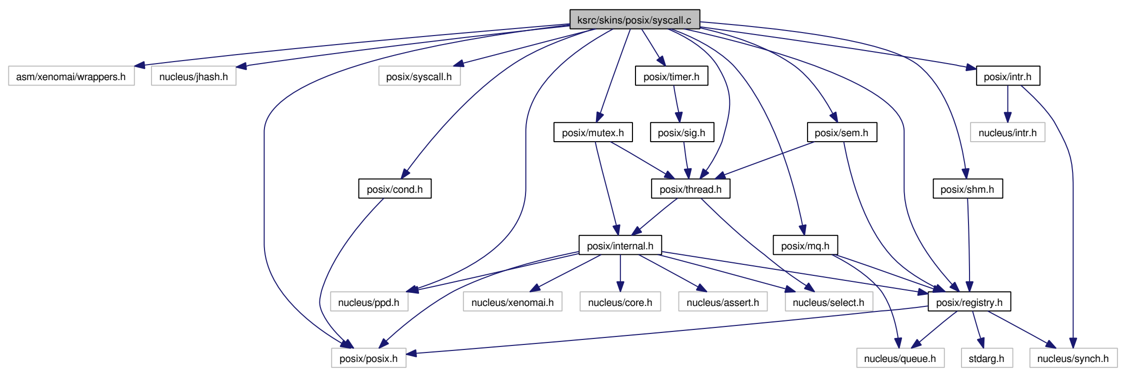
Include dependency graph for syscall.c:



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