NAME

pthread_cond_init, pthread_cond_destroy, pthread_cond_signal, pthread_cond_broadcast, pthread_cond_wait, pthread_cond_timedwait − operations on conditions

SYNOPSIS

#include <pthread.h>

pthread_cond_t *cond* = **PTHREAD_COND_INITIALIZER;**

int pthread_cond_init(pthread_cond_t *****cond*, **pthread_condattr_t *****cond_attr***);**

int pthread_cond_signal(pthread_cond_t *****cond*);**

int pthread_cond_broadcast(pthread_cond_t *****cond*);**

int pthread_cond_wait(pthread_cond_t *****cond*, **pthread_mutex_t *****mutex***);**

int pthread_cond_timedwait(pthread_cond_t *****cond*, **pthread_mutex_t *****mutex***, **const struct timespec *****abstime***);**

int pthread_cond_destroy(pthread_cond_t *****cond*);**

DESCRIPTION

A condition (short for ‘‘condition variable’’) is a synchronization device that allows threads to suspend execution and relinquish the processors 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.

pthread_cond_init initializes the condition variable *cond*, using the condition attributes specified in *cond_attr*, or default attributes if *cond_attr* is **NULL**. The LinuxThreads implementation supports no attributes for conditions, hence the *cond_attr* parameter is actually ignored.

Variables of type **pthread_cond_t** can also be initialized statically, using the constant **PTHREAD_COND_INITIALIZER**.

pthread_cond_signal restarts one of the threads that are waiting on the condition variable *cond*. If no threads are waiting on *cond*, nothing happens. If several threads are waiting on *cond*, exactly one is restarted, but it is not specified which.

pthread_cond_broadcast restarts all the threads that are waiting on the condition variable *cond*. Nothing happens if no threads are waiting on *cond*.

pthread_cond_wait atomically unlocks the *mutex* (as per **pthread_unlock_mutex**) and waits for the condition variable *cond* to be signaled. The thread execution is suspended and does not consume any CPU time until the condition variable is signaled. The *mutex* must be locked by the calling thread on entrance to **pthread_cond_wait**. Before returning to the calling thread, **pthread_cond_wait** re-acquires *mutex* (as per **pthread_lock_mutex**).

Unlocking the mutex and suspending on the condition variable is done atomically. Thus, if all threads always acquire the mutex before signaling the condition, this guarantees that the condition cannot be

signaled (and thus ignored) between the time a thread locks the mutex and the time it waits on the condition variable.

pthread_cond_timedwait atomically unlocks *mutex* and waits on *cond*, as **pthread_cond_wait** does, but it also bounds the duration of the wait. If *cond* has not been signaled within the amount of time specified by *abstime*, the mutex *mutex* is re-acquired and **pthread_cond_timedwait** returns the error **ETIMEDOUT**. The *abstime* parameter specifies an absolute time, with the same origin as **time**(2) and **gettimeofday**(2): an *abstime* of 0 corresponds to 00:00:00 GMT, January 1, 1970.

pthread_cond_destroy destroys a condition variable, freeing the resources it might hold. No threads must be waiting on the condition variable on entrance to **pthread_cond_destroy**. In the LinuxThreads implementation, no resources are associated with condition variables, thus **pthread_cond_destroy** actually does nothing except checking that the condition has no waiting threads.

CANCELLATION

pthread_cond_wait and **pthread_cond_timedwait** are cancellation points. If a thread is cancelled while suspended in one of these functions, the thread immediately resumes execution, then locks again the *mutex* argument to **pthread_cond_wait** and **pthread_cond_timedwait**, and finally executes the cancellation. Consequently, cleanup handlers are assured that *mutex* is locked when they are called.

ASYNC-SIGNAL SAFETY

The condition functions are not async-signal safe, and should not be called from a signal handler. In particular, calling **pthread_cond_signal** or **pthread_cond_broadcast** from a signal handler may deadlock the calling thread.

RETURN VALUE

All condition variable functions return 0 on success and a non-zero error code on error.

ERRORS

pthread_cond_init, **pthread_cond_signal**, **pthread_cond_broadcast**, and **pthread_cond_wait** never return an error code.

The **pthread_cond_timedwait** function returns the following error codes on error:

ETIMEDOUT
the condition variable was not signaled until the timeout specified by *abstime*

EINTR
pthread_cond_timedwait was interrupted by a signal

The **pthread_cond_destroy** function returns the following error code on error:

EBUSY
some threads are currently waiting on *cond*.

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SEE ALSO

pthread_condattr_init(3), **pthread_mutex_lock**(3), **pthread_mutex_unlock**(3), **gettimeofday**(2), **nanosleep**(2).

NAME

pthread_mutex_init, pthread_mutex_lock, pthread_mutex_trylock, pthread_mutex_unlock, pthread_mutex_destroy − operations on mutexes

SYNOPSIS

#include <pthread.h>

pthread_mutex_t *fastmutex* **= PTHREAD_MUTEX_INITIALIZER;**

pthread_mutex_t *recmutex* **= PTHREAD_RECURSIVE_MUTEX_INITIALIZER_NP;**

pthread_mutex_t *errchkmutex* **= PTHREAD_ERRORCHECK_MUTEX_INITIALIZER_NP;**

int pthread_mutex_init(pthread_mutex_t *****mutex*, **const pthread_mutexattr_t *****mutexattr***);**

int pthread_mutex_lock(pthread_mutex_t *****mutex*);**

int pthread_mutex_trylock(pthread_mutex_t *****mutex*);**

int pthread_mutex_unlock(pthread_mutex_t *****mutex*);**

int pthread_mutex_destroy(pthread_mutex_t *****mutex*);**

DESCRIPTION

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.

pthread_mutex_init initializes the mutex object pointed to by *mutex* according to the mutex attributes specified in *mutexattr*. If *mutexattr* is **NULL**, default attributes are used instead.

The LinuxThreads implementation supports only one mutex attributes, the *mutex kind*, which is either ‘‘fast’’, ‘‘recursive’’, or ‘‘error checking’’. The kind of a mutex determines whether it can be locked again by a thread that already owns it. The default kind is ‘‘fast’’. See **pthread_mutexattr_init**(3) for more information on mutex attributes.

Variables of type **pthread_mutex_t** can also be initialized statically, using the constants **PTHREAD_MUTEX_INITIALIZER** (for fast mutexes), **PTHREAD_RECURSIVE_MUTEX_INITIALIZER_NP** (for recursive mutexes), and **PTHREAD_ERRORCHECK_MUTEX_INITIALIZER_NP** (for error checking mutexes).

pthread_mutex_lock locks the given mutex. If the mutex is currently unlocked, it becomes locked and owned by the calling thread, and **pthread_mutex_lock** returns immediately. If the mutex is already locked by another thread, **pthread_mutex_lock** suspends the calling thread until the mutex is unlocked.

If the mutex is already locked by the calling thread, the behavior of **pthread_mutex_lock** depends on the kind of the mutex. If the mutex is of the ‘‘fast’’ kind, the calling thread is suspended until the mutex is unlocked, thus effectively causing the calling thread to deadlock. If the mutex is of the ‘‘error checking’’ kind, **pthread_mutex_lock** returns immediately with the error code **EDEADLK**. If the mutex is of the ‘‘recursive’’ kind, **pthread_mutex_lock** succeeds and returns immediately, recording the number of times the calling thread has locked the mutex. An equal number of **pthread_mutex_unlock** operations must be performed before the mutex returns to the unlocked state.

pthread_mutex_trylock behaves identically to **pthread_mutex_lock**, except that it does not block the calling thread if the mutex is already locked by another thread (or by the calling thread in the case of a ‘‘fast’’ mutex). Instead, **pthread_mutex_trylock** returns immediately with the error code **EBUSY**.

pthread_mutex_unlock unlocks the given mutex. The mutex is assumed to be locked and owned by the calling thread on entrance to **pthread_mutex_unlock**. If the mutex is of the ‘‘fast’’ kind, **pthread_mutex_unlock** always returns it to the unlocked state. If it is of the ‘‘recursive’’ kind, it decrements the locking count of the mutex (number of **pthread_mutex_lock** operations performed on it by the calling thread), and only when this count reaches zero is the mutex actually unlocked.

On ‘‘error checking’’ mutexes, **pthread_mutex_unlock** actually checks at run-time that the mutex is locked on entrance, and that it was locked by the same thread that is now calling **pthread_mutex_unlock**. If these conditions are not met, an error code is returned and the mutex remains unchanged. ‘‘Fast’’ and ‘‘recursive’’ mutexes perform no such checks, thus allowing a locked mutex to be unlocked by a thread other than its owner. This is non-portable behavior and must not be relied upon.

pthread_mutex_destroy destroys a mutex object, freeing the resources it might hold. The mutex must be unlocked on entrance. In the LinuxThreads implementation, no resources are associated with mutex objects, thus **pthread_mutex_destroy** actually does nothing except checking that the mutex is unlocked.

RETURN VALUE

pthread_mutex_init always returns 0. The other mutex functions return 0 on success and a non-zero error code on error.

ERRORS

The **pthread_mutex_lock** function returns the following error code on error:

EINVAL
the mutex has not been properly initialized.

EDEADLK
the mutex is already locked by the calling thread (‘‘error checking’’ mutexes only).

The **pthread_mutex_unlock** function returns the following error code on error:

EINVAL
the mutex has not been properly initialized.

EPERM
the calling thread does not own the mutex (‘‘error checking’’ mutexes only).

The **pthread_mutex_destroy** function returns the following error code on error:

EBUSY
the mutex is currently locked.

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SEE ALSO

pthread_mutexattr_init(3), **pthread_mutexattr_setkind_np**(3), **pthread_cancel**(3).