Xenomai nanokernel API

2.5.6.1

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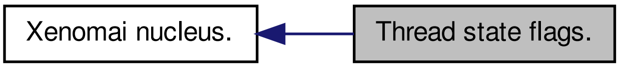
Module Documentation

4.1 Thread state flags.

Bits reporting permanent or transient states of thread.

Collaboration diagram for Thread state flags.:



Defines

- #define XNSUSP 0x00000001

  Suspended.
- #define XNPEND 0x00000002

  Sleep-wait for a resource.
- #define XNDELAY 0x00000004

  Delayed.
- #define XNREADY 0x00000008

  Linked to the ready queue.
- #define XNDORMANT 0x00000010

  Not started yet or killed.
- #define XNZOMBIE 0x00000020

  Zombie thread in deletion process.

- #define XNRESTART 0x00000040

  Restarting thread.
- #define XNSTARTED 0x00000080

  Thread has been started.
- #define XNMAPPED 0x00000100

  Mapped to a regular Linux task (shadow only)
- #define XNRELAX 0x00000200

  Relaxed shadow thread (blocking bit)
- #define XNMIGRATE 0x00000400

  Thread is currently migrating to another CPU.
- #define XNHELD 0x00000800

  Thread is held to process emergency.
- #define XNBOOST 0x00001000

  Undergoes a PIP boost.
- #define XNDEBUG 0x00002000

  Hit a debugger breakpoint (shadow only)
- #define XNLOCK 0x00004000

  Holds the scheduler lock (i.e.
- #define XNRRB 0x00008000

  Undergoes a round-robin scheduling.
- #define XNASDI 0x00010000

  ASR are disabled.
- #define XNDEFCAN 0x00020000

  Deferred cancelability mode (self-set only)
- #define XNTRAPSW 0x00040000

  Trap execution mode switches.
- #define XNRPIOFF 0x00080000

  Stop priority coupling (shadow only)
- #define XNFPU 0x00100000

  Thread uses FPU.
- #define XNSHADOW 0x00200000

  Shadow thread.
- #define XNROOT 0x00400000

  Root thread (that is, Linux/IDLE)
- #define XNSWREP 0x00800000

  Mode switch already reported.

4.1.1 Detailed Description

Bits reporting permanent or transient states of thread.

4.1.2 Define Documentation

4.1.2.1 #define XNHELD 0x00000800

Thread is held to process emergency.

Referenced by xnpod_resume_thread(), and xnpod_suspend_thread().

4.1.2.2 #define XNLOCK 0x00004000

Holds the scheduler lock (i.e.

not preemptible)

Referenced by xnpod_set_thread_mode(), and xnpod_welcome_thread().

4.1.2.3 #define XNMIGRATE 0x00000400

Thread is currently migrating to another CPU.

Referenced by xnpod_delete_thread().

4.1.2.4 #define XNPEND 0x00000002

Sleep-wait for a resource.

Referenced by xnpod_delete_thread(), xnpod_resume_thread(), xnpod_unblock_thread(), xnsynch_acquire(), xnsynch_flush(), xnsynch_forget_sleeper(), xnsynch_release(), xnsynch_sleep_on(), xnsynch_wakeup_one_sleeper(), and xnsynch_wakeup_this_sleeper().

4.1.2.5 #define XNREADY 0x00000008

Linked to the ready queue.

Referenced by xnpod_delete_thread(), xnpod_resume_thread(), xnpod_start_thread(), and xnpod_suspend_thread().

4.1.2.6 #define XNSUSP 0x00000001

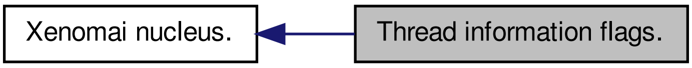
Suspended.

Referenced by xnpod_init_thread(), xnpod_start_thread(), xnpod_suspend_thread(), and xnpod_trap_fault().

4.2 Thread information flags.

Bits reporting events notified to the thread.

Collaboration diagram for Thread information flags.:



Defines

- #define XNTIMEO 0x00000001

  Woken up due to a timeout condition.
- #define XNRMID 0x00000002

  Pending on a removed resource.
- #define XNBREAK 0x00000004

  Forcibly awaken from a wait state.
- #define XNKICKED 0x00000008

  Kicked upon Linux signal (shadow only)
- #define XNWAKEN 0x00000010

  Thread waken up upon resource availability.
- #define XNROBBED 0x00000020

  Robbed from resource ownership.
- #define XNATOMIC 0x00000040

  In atomic switch from secondary to primary mode.
- #define XNAFFSET 0x00000080

  CPU affinity changed from primary mode.
- #define XNPRIOSET 0x00000100

  Priority changed from primary mode.
- #define XNABORT 0x00000200

  Thread is being aborted.
- #define XNCANPND 0x00000400

  Cancellation request is pending.
- #define XNAMOK 0x00000800

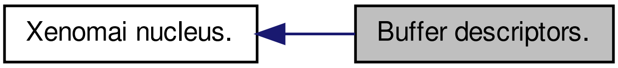
  Runaway, watchdog signal pending (shadow only)

4.2.1 Detailed Description

Bits reporting events notified to the thread.

4.3 Buffer descriptors.

Collaboration diagram for Buffer descriptors.:



Files

- file bufd.h
- file bufd.c

Functions

- static void xnbufd_map_uread (struct xnbufd *bufd, const void __user *ptr, size_t len)

    Initialize a buffer descriptor for reading from user memory.
- static void xnbufd_map_uwrite (struct xnbufd *bufd, void __user *ptr, size_t len)

    Initialize a buffer descriptor for writing to user memory.
- ssize_t xnbufd_unmap_uread (struct xnbufd *bufd)

    Finalize a buffer descriptor obtained from xnbufd_map_uread().
- ssize_t xnbufd_unmap_uwrite (struct xnbufd *bufd)

    Finalize a buffer descriptor obtained from xnbufd_map_uwrite().
- static void xnbufd_map_kread (struct xnbufd *bufd, const void *ptr, size_t len)

    Initialize a buffer descriptor for reading from kernel memory.
- static void xnbufd_map_kwrite (struct xnbufd *bufd, void *ptr, size_t len)

    Initialize a buffer descriptor for writing to kernel memory.
- ssize_t xnbufd_unmap_kread (struct xnbufd *bufd)

    Finalize a buffer descriptor obtained from xnbufd_map_kread().
- ssize_t xnbufd_unmap_kwrite (struct xnbufd *bufd)

    Finalize a buffer descriptor obtained from xnbufd_map_kwrite().
- ssize_t xnbufd_copy_to_kmem (void *ptr, struct xnbufd *bufd, size_t len)

    Copy memory covered by a buffer descriptor to kernel memory.

- ssize_t xnbufd_copy_from_kmem (struct xnbufd ∗bufd, void ∗from, size_t len)

  Copy kernel memory to the area covered by a buffer descriptor.
- void xnbufd_invalidate (struct xnbufd ∗bufd)

  Invalidate a buffer descriptor.
- static void xnbufd_reset (struct xnbufd ∗bufd)

  Reset a buffer descriptor.

4.3.1 Detailed Description

A buffer descriptor is a simple abstraction dealing with copy operations to/from memory buffers which may belong to different address spaces.

To this end, the buffer descriptor library provides a small set of copy routines which are aware of address space restrictions when moving data, and a generic container type which can hold a reference to - or cover - a particular memory area, either present in kernel space, or in any of the existing user memory contexts.

The goal of the buffer descriptor abstraction is to hide address space specifics from Xenomai services dealing with memory areas, allowing them to operate on multiple address spaces seamlessly.

The common usage patterns are as follows:

- Implementing a Xenomai syscall returning a bulk of data to the caller, which may have to be copied back to either kernel or user space:

```
[Syscall implementation]
ssize_t rt_bulk_read_inner(struct xnbufd *bufd)
{
    ssize_t ret;
    size_t len;
    void *bulk;

    bulk = get_next_readable_bulk(&len);
    ret = xnbufd_copy_from_kmem(bufd, bulk, min(bufd->b_len, len));
    free_bulk(bulk);

    ret = this_may_fail();
    if (ret)
            xnbufd_invalidate(bufd);

    return ret;
}

[Kernel wrapper for in-kernel calls]
int rt_bulk_read(void *ptr, size_t len)
{
    struct xnbufd bufd;
    ssize_t ret;

    xnbufd_map_kwrite(&bufd, ptr, len);
    ret = rt_bulk_read_inner(&bufd);
    xnbufd_unmap_kwrite(&bufd);

    return ret;
}

[Userland trampoline for user syscalls]
int __rt_bulk_read(struct pt_regs *regs)
{
    struct xnbufd bufd;
    void __user *ptr;
    ssize_t ret;
    size_t len;

    ptr = (void __user *)__xn_reg_arg1(regs);
    len = __xn_reg_arg2(regs);

    xnbufd_map_uwrite(&bufd, ptr, len);
    ret = rt_bulk_read_inner(&bufd);
    xnbufd_unmap_uwrite(&bufd);

    return ret;
}
```

- Implementing a Xenomai syscall receiving a bulk of data from the caller, which may have to be read from either kernel or user space:

```
[Syscall implementation]
ssize_t rt_bulk_write_inner(struct xnbufd *bufd)
{
    void *bulk = get_free_bulk(bufd->b_len);
    return xnbufd_copy_to_kmem(bulk, bufd, bufd->b_len);
}

[Kernel wrapper for in-kernel calls]
int rt_bulk_write(const void *ptr, size_t len)
{
    struct xnbufd bufd;
    ssize_t ret;

    xnbufd_map_kread(&bufd, ptr, len);
    ret = rt_bulk_write_inner(&bufd);
    xnbufd_unmap_kread(&bufd);

    return ret;
}

[Userland trampoline for user syscalls]
int __rt_bulk_write(struct pt_regs *regs)
{
    struct xnbufd bufd;
    void __user *ptr;
    ssize_t ret;
    size_t len;

    ptr = (void __user *)__xn_reg_arg1(regs);
    len = __xn_reg_arg2(regs);

    xnbufd_map_uread(&bufd, ptr, len);
    ret = rt_bulk_write_inner(&bufd);
    xnbufd_unmap_uread(&bufd);
```

```
        return ret;
}
```

4.3.2 Function Documentation

4.3.2.1 ssize_t xnbufd_copy_from_kmem (struct xnbufd * *bufd*, void * *from*, size_t *len*)

Copy kernel memory to the area covered by a buffer descriptor.

This routine copies *len* bytes from the kernel memory starting at *from* to the area referred to by the buffer descriptor *bufd*. xnbufd_copy_from_kmem() tracks the write offset within the destination memory internally, so that it may be called several times in a loop, until the entire memory area is stored.

The destination address space is dealt with, according to the following rules:

- if *bufd* refers to a writable kernel area (i.e. see xnbufd_map_kwrite()), the copy is immediatly and fully performed with no restriction.
- if *bufd* refers to a writable user area (i.e. see xnbufd_map_uwrite()), the copy is performed only if that area lives in the currently active address space, and only if the caller may sleep Linux-wise to process any potential page fault which may arise while writing to that memory.
- if *bufd* refers to a user area which may not be immediately written to from the current context, the copy is postponed until xnbufd_unmap_uwrite() is invoked for *ubufd*, at which point the copy will take place. In such a case, the source memory is transferred to a carry over buffer allocated internally; this operation may lead to request dynamic memory from the nucleus heap if *len* is greater than 64 bytes.

Parameters

bufd	The address of the buffer descriptor covering the user memory to copy data to.
from	The start address of the kernel memory to copy from.
len	The length of the kernel memory to copy to *bufd*.

Returns

The number of bytes written so far to the memory area covered by *ubufd*. Otherwise,

- -ENOMEM is returned when no memory is available from the nucleus heap to allocate the carry over buffer.

Environments:

This service can be called from:

- Kernel code (including from primary mode) except Xenomai kernel-based task and interrupt service routines.

Rescheduling: may switch the caller to secondary mode if a page fault occurs while writing to the user area. For that reason, xnbufd_copy_from_kmem() may only be called from a preemptible section (Linux-wise).

Note

> Holding the nklock or running real-time interrupts disabled is invalid when calling this routine, and doing so would trigger a debug assertion.

4.3.2.2 ssize_t xnbufd_copy_to_kmem (void * *to*, struct xnbufd * *bufd*, size_t *len*)

Copy memory covered by a buffer descriptor to kernel memory.

This routine copies *len* bytes from the area referred to by the buffer descriptor *bufd* to the kernel memory area *to*. xnbufd_copy_to_kmem() tracks the read offset within the source memory internally, so that it may be called several times in a loop, until the entire memory area is loaded.

The source address space is dealt with, according to the following rules:

- if *bufd* refers to readable kernel area (i.e. see xnbufd_map_kread()), the copy is immediately and fully performed with no restriction.

- if *bufd* refers to a readable user area (i.e. see xnbufd_map_uread()), the copy is performed only if that area lives in the currently active address space, and only if the caller may sleep Linux-wise to process any potential page fault which may arise while reading from that memory.

- any attempt to read from *bufd* from a non-suitable context is considered as a bug, and will raise a panic assertion when the nucleus is compiled in debug mode.

Parameters

to	The start address of the kernel memory to copy to.
bufd	The address of the buffer descriptor covering the user memory to copy data from.
len	The length of the user memory to copy from *bufd*.

Returns

The number of bytes read so far from the memory area covered by *ubufd*. Otherwise:

- -EINVAL is returned upon attempt to read from the user area from an invalid context. This error is only returned when the debug mode is disabled; otherwise a panic assertion is raised.

Environments:

This service can be called from:

- Kernel code (including from primary mode) except Xenomai kernel-based task and interrupt service routines.

Rescheduling: may switch the caller to secondary mode if a page fault occurs while reading from the user area. For that reason, xnbufd_copy_to_kmem() may only be called from a preemptible section (Linux-wise).

Note

Holding the nklock or running real-time interrupts disabled is invalid when calling this routine, and doing so would trigger a debug assertion.

4.3.2.3 void **xnbufd_invalidate** (struct xnbufd * *bufd*)

Invalidate a buffer descriptor.

The buffer descriptor is invalidated, making it unusable for further copy operations. If an outstanding carry over buffer was allocated by a previous call to xnbufd_copy_from_kmem(), it is immediately freed so that no data transfer will happen when the descriptor is finalized.

The only action that may subsequently be performed on an invalidated descriptor is calling the relevant unmapping routine for it. For that reason, xnbufd_invalidate() should be invoked on the error path when data may have been transferred to the carry over buffer.

Parameters

bufd	The address of the buffer descriptor to invalidate.

Environments:

This service can be called from:

- Kernel code (including from primary mode)
- Kernel-based task

- Interrupt service routine

Rescheduling: never.

4.3.2.4 void xnbufd_map_kread (struct xnbufd ∗ *bufd*, const void ∗ *ptr*, size_t *len*) [inline, static]

Initialize a buffer descriptor for reading from kernel memory.

The new buffer descriptor may be used to copy data from kernel memory. This routine should be used in pair with xnbufd_unmap_kread().

Parameters

bufd	The address of the buffer descriptor which will map a *len* bytes kernel memory area, starting from *ptr*.
ptr	The start of the kernel buffer to map.
len	The length of the kernel buffer starting at *ptr*.

Environments:

This service can be called from:

- Kernel code (including from primary mode)
- Kernel-based task
- Interrupt service routine

Rescheduling: never.

4.3.2.5 void xnbufd_map_kwrite (struct xnbufd ∗ *bufd*, void ∗ *ptr*, size_t *len*) [inline, static]

Initialize a buffer descriptor for writing to kernel memory.

The new buffer descriptor may be used to copy data to kernel memory. This routine should be used in pair with xnbufd_unmap_kwrite().

Parameters

bufd	The address of the buffer descriptor which will map a *len* bytes kernel memory area, starting from *ptr*.
ptr	The start of the kernel buffer to map.
len	The length of the kernel buffer starting at *ptr*.

Environments:

This service can be called from:

- Kernel code (including from primary mode)
- Kernel-based task
- Interrupt service routine

Rescheduling: never.

4.3.2.6 void **xnbufd_map_uread** (struct xnbufd * *bufd*, const void __user * *ptr*, size_t *len*) [inline, static]

Initialize a buffer descriptor for reading from user memory.

The new buffer descriptor may be used to copy data from user memory. This routine should be used in pair with xnbufd_unmap_uread().

Parameters

bufd	The address of the buffer descriptor which will map a *len* bytes user memory area, starting from *ptr*. *ptr* is never dereferenced directly, since it may refer to a buffer that lives in another address space.
ptr	The start of the user buffer to map.
len	The length of the user buffer starting at *ptr*.

Environments:

This service can be called from:

- Kernel code (including from primary mode) except Xenomai kernel-based task and interrupt service routines.

Rescheduling: never.

4.3.2.7 void **xnbufd_map_uwrite** (struct xnbufd * *bufd*, void __user * *ptr*, size_t *len*) [inline, static]

Initialize a buffer descriptor for writing to user memory.

The new buffer descriptor may be used to copy data to user memory. This routine should be used in pair with xnbufd_unmap_uwrite().

Parameters

bufd	The address of the buffer descriptor which will map a *len* bytes user memory area, starting from *ptr*. *ptr* is never dereferenced directly, since it may refer to a buffer that lives in another address space.
ptr	The start of the user buffer to map.
len	The length of the user buffer starting at *ptr*.

Environments:

This service can be called from:

- Kernel code (including from primary mode) except Xenomai kernel-based task and interrupt service routines.

Rescheduling: never.

4.3.2.8 void xnbufd_reset (struct xnbufd * *bufd*) [inline, static]

Reset a buffer descriptor.

The buffer descriptor is reset, so that all data already copied is forgotten. Any carry over buffer allocated is kept, though.

Parameters

bufd	The address of the buffer descriptor to reset.

Environments:

This service can be called from:

- Kernel code (including from primary mode)
- Kernel-based task
- Interrupt service routine

Rescheduling: never.

4.3.2.9 ssize_t xnbufd_unmap_kread (struct xnbufd * *bufd*)

Finalize a buffer descriptor obtained from xnbufd_map_kread().

This routine finalizes a buffer descriptor previously initialized by a call to xnbufd_map_kread(), to read data from a kernel area.

Parameters

bufd	The address of the buffer descriptor to finalize.

Returns

The number of bytes read so far from the memory area covered by *ubufd*.

Environments:

This service can be called from:

- Kernel code (including from primary mode)
- Kernel-based task
- Interrupt service routine

Rescheduling: never.

4.3.2.10 ssize_t xnbufd_unmap_kwrite (struct xnbufd * *bufd*)

Finalize a buffer descriptor obtained from xnbufd_map_kwrite().

This routine finalizes a buffer descriptor previously initialized by a call to xnbufd_map_kwrite(), to write data to a kernel area.

Parameters

bufd	The address of the buffer descriptor to finalize.

Returns

The number of bytes written so far to the memory area covered by *ubufd*.

Environments:

This service can be called from:

- Kernel code (including from primary mode)
- Kernel-based task
- Interrupt service routine

Rescheduling: never.

4.3.2.11 ssize_t xnbufd_unmap_uread (struct xnbufd * *bufd*)

Finalize a buffer descriptor obtained from xnbufd_map_uread().

This routine finalizes a buffer descriptor previously initialized by a call to xnbufd_map_uread(), to read data from a user area.

Parameters

bufd	The address of the buffer descriptor to finalize.

Returns

The number of bytes read so far from the memory area covered by *ubufd*.

Environments:

This service can be called from:

- Kernel code (including from primary mode) except Xenomai kernel-based task and interrupt service routines.

Rescheduling: never.

Note

Holding the nklock or running real-time interrupts disabled is invalid when calling this routine, and doing so would trigger a debug assertion.

4.3.2.12 ssize_t xnbufd_unmap_uwrite (struct xnbufd * *bufd*)

Finalize a buffer descriptor obtained from xnbufd_map_uwrite().

This routine finalizes a buffer descriptor previously initialized by a call to xnbufd_map_uwrite(), to write data to a user area.

The main action taken is to write the contents of the kernel memory area passed to xnbufd_copy_from_kmem() whenever the copy operation was postponed at that time; the carry over buffer is eventually released as needed. If xnbufd_copy_from_kmem() was allowed to copy to the destination user memory at once, then xnbufd_unmap_uwrite() leads to a no-op.

Parameters

bufd	The address of the buffer descriptor to finalize.

Returns

The number of bytes written so far to the memory area covered by *ubufd*.

Environments:

This service can be called from:

- Kernel code (including from primary mode) except Xenomai kernel-based task and interrupt service routines.

Rescheduling: never.

Note

Holding the nklock or running real-time interrupts disabled is invalid when calling this routine, and doing so would trigger a debug assertion.

4.4 Dynamic memory allocation services.

Collaboration diagram for Dynamic memory allocation services.:

Xenomai nucleus.
Dynamic memory allocation services.

Files

- file heap.c

  Dynamic memory allocation services.

Functions

- int xnheap_init (xnheap_t *heap, void *heapaddr, u_long heapsize, u_long pagesize)

  Initialize a memory heap.
- void xnheap_set_label (xnheap_t *heap, const char *label,...)

  Set the heap's label string.
- void xnheap_destroy (xnheap_t *heap, void(*flushfn)(xnheap_t *heap, void *extaddr, u_long extsize, void *cookie), void *cookie)

  Destroys a memory heap.
- void * xnheap_alloc (xnheap_t *heap, u_long size)

  Allocate a memory block from a memory heap.
- int xnheap_test_and_free (xnheap_t *heap, void *block, int(*ckfn)(void *block))

  Test and release a memory block to a memory heap.
- int xnheap_free (xnheap_t *heap, void *block)

  Release a memory block to a memory heap.
- int xnheap_extend (xnheap_t *heap, void *extaddr, u_long extsize)

  Extend a memory heap.
- void xnheap_schedule_free (xnheap_t *heap, void *block, xnholder_t *link)

  Schedule a memory block for release.

4.4.1 Detailed Description

Dynamic memory allocation services.

The implementation of the memory allocator follows the algorithm described in a USENIX 1988 paper called "Design of a General Purpose Memory Allocator for the 4.3BSD Unix Kernel" by Marshall K. McKusick and Michael J. Karels. You can find it at various locations on the net, including http://docs.FreeBSD.org/44doc/papers/kernmalloc.pdf. A minor variation allows this implementation to have 'extendable' heaps when needed, with multiple memory extents providing autonomous page address spaces.

The data structures hierarchy is as follows:

```
HEAP {
     block_buckets[]
     extent_queue -------+
}                        |
 V
      EXTENT #1 {
     {static header}
     page_map[npages]
     page_array[npages][pagesize]
      } -+
 |
 |
 V
      EXTENT #n {
     {static header}
     page_map[npages]
     page_array[npages][pagesize]
      }
```

4.4.2 Function Documentation

4.4.2.1 void* xnheap_alloc (xnheap_t * *heap*, u_long *size*)

Allocate a memory block from a memory heap.

Allocates a contiguous region of memory from an active memory heap. Such allocation is guaranteed to be time-bounded.

Parameters

heap	The descriptor address of the heap to get memory from.
size	The size in bytes of the requested block. Sizes lower or equal to the page size are rounded either to the minimum allocation size if lower than this value, or to the minimum alignment size if greater or equal to this value. In the current implementation, with MINALLOC = 8 and MINALIGN = 16, a 7 bytes request will be rounded to 8 bytes, and a 17 bytes request will be rounded to 32.

Returns

The address of the allocated region upon success, or NULL if no memory is available from the specified heap.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

4.4.2.2 void **xnheap_destroy** (xnheap_t * *heap*, void(*)(xnheap_t *heap, void *extaddr, u_long extsize, void *cookie) *flushfn*, void * *cookie*)

Destroys a memory heap.

Destroys a memory heap.

Parameters

heap	The descriptor address of the destroyed heap.
flushfn	If non-NULL, the address of a flush routine which will be called for each extent attached to the heap. This routine can be used by the calling code to further release the heap memory.
cookie	If *flushfn* is non-NULL, *cookie* is an opaque pointer which will be passed unmodified to *flushfn*.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

Referenced by xnpod_init(), and xnpod_shutdown().

4.4.2.3 int **xnheap_extend** (xnheap_t * *heap*, void * *extaddr*, u_long *extsize*)

Extend a memory heap.

Add a new extent to an existing memory heap.

Parameters

heap	The descriptor address of the heap to add an extent to.
extaddr	The address of the extent memory.
extsize	The size of the extent memory (in bytes). In the current implementation, this size must match the one of the initial extent passed to xnheap_init().

Returns

> 0 is returned upon success, or -EINVAL is returned if *extsize* differs from the initial extent's size.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

4.4.2.4 int xnheap_free (xnheap_t ∗ *heap*, void ∗ *block*)

Release a memory block to a memory heap.

Releases a memory region to the memory heap it was previously allocated from.

Parameters

heap	The descriptor address of the heap to release memory to.
block	The address of the region to be returned to the heap.

Returns

> 0 is returned upon success, or one of the following error codes:

- -EFAULT is returned whenever the memory address is outside the heap address space.
- -EINVAL is returned whenever the memory address does not represent a valid block.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

References xnheap_test_and_free().

4.4.2.5 int xnheap_init (xnheap_t * *heap,* void * *heapaddr,* u_long *heapsize,* u_long *pagesize*)

Initialize a memory heap.

Initializes a memory heap suitable for time-bounded allocation requests of dynamic memory.

Parameters

heap	The address of a heap descriptor which will be used to store the allocation data. This descriptor must always be valid while the heap is active therefore it must be allocated in permanent memory.
heapaddr	The address of the heap storage area. All allocations will be made from the given area in time-bounded mode. Since additional extents can be added to a heap, this parameter is also known as the "initial extent".
heapsize	The size in bytes of the initial extent pointed at by *heapaddr*. *heapsize* must be a multiple of pagesize and lower than 16 Mbytes. *heapsize* must be large enough to contain a dynamically-sized internal header. The following formula gives the size of this header:

H = heapsize, P=pagesize, M=sizeof(struct pagemap), E=sizeof(xnextent_t)

hdrsize = ((H - E) * M) / (M + 1)

This value is then aligned on the next 16-byte boundary. The routine xnheap_overhead() computes the corrected heap size according to the previous formula.

Parameters

pagesize	The size in bytes of the fundamental memory page which will be used to subdivide the heap internally. Choosing the right page size is important regarding performance and memory fragmentation issues, so it might be a good idea to take a look at http://docs.FreeBSD.org/44doc/papers/kernmalloc.pdf to pick the best one for your needs. In the current implementation, pagesize must be a power of two in the range [8 .. 32768] inclusive.

Returns

0 is returned upon success, or one of the following error codes:

- -EINVAL is returned whenever a parameter is invalid.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

Referenced by xnpod_init().

4.4.2.6 void **xnheap_schedule_free** (xnheap_t * *heap*, void * *block*, xnholder_t * *link*)

Schedule a memory block for release.

This routine records a block for later release by xnheap_finalize_free(). This service is useful to lazily free blocks of heap memory when immediate release is not an option, e.g. when active references are still pending on the object for a short time after the call. xnheap_finalize_free() is expected to be eventually called by the client code at some point in the future when actually freeing the idle objects is deemed safe.

Parameters

heap	The descriptor address of the heap to release memory to.
block	The address of the region to be returned to the heap.
link	The address of a link member, likely but not necessarily within the released object, which will be used by the heap manager to hold the block in the queue of idle objects.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

4.4.2.7 void **xnheap_set_label** (xnheap_t * *heap*, const char * *label*, ...)

Set the heap's label string.

Set the heap label that will be used in statistic outputs.

Parameters

heap	The address of a heap descriptor.
label	Label string displayed in statistic outputs. This parameter can be a format string, in which case succeeding parameters will be used to resolve the final label.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

Referenced by xnpod_init().

4.4.2.8 int **xnheap_test_and_free** (xnheap_t * *heap*, void * *block*, int(*)(void *block) *ckfn*)

Test and release a memory block to a memory heap.

Releases a memory region to the memory heap it was previously allocated from. Before the actual release is performed, an optional user-defined can be invoked to check for additional criteria with respect to the request consistency.

Parameters

heap	The descriptor address of the heap to release memory to.
block	The address of the region to be returned to the heap.
ckfn	The address of a user-supplied verification routine which is to be called after the memory address specified by *block* has been checked for validity. The routine is expected to proceed to further consistency checks, and either return zero upon success, or non-zero upon error. In the latter case, the release process is aborted, and *ckfn's* return value is passed back to the caller of this service as its error return code. *ckfn* must not trigger the rescheduling procedure either directly or indirectly.

Returns

> 0 is returned upon success, or -EINVAL is returned whenever the block is not a valid region of the specified heap. Additional return codes can also be defined locally by the *ckfn* routine.

Environments:

This service can be called from:

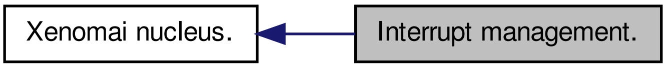
- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

Referenced by xnheap_free().

4.5 Interrupt management.

Collaboration diagram for Interrupt management.:



Files

- file intr.c

  Interrupt management.

Functions

- int xnintr_init (xnintr_t ∗intr, const char ∗name, unsigned irq, xnisr_t isr, xniack_t iack, xnflags_t flags)

  Initialize an interrupt object.
- int xnintr_destroy (xnintr_t ∗intr)

  Destroy an interrupt object.
- int xnintr_attach (xnintr_t ∗intr, void ∗cookie)

  Attach an interrupt object.
- int xnintr_detach (xnintr_t ∗intr)

  Detach an interrupt object.
- int xnintr_enable (xnintr_t ∗intr)

  Enable an interrupt object.
- int xnintr_disable (xnintr_t ∗intr)

  Disable an interrupt object.
- xnarch_cpumask_t xnintr_affinity (xnintr_t ∗intr, xnarch_cpumask_t cpumask)

  Set interrupt's processor affinity.

4.5.1 Detailed Description

Interrupt management.

4.5.2 Function Documentation

4.5.2.1 xnarch_cpumask_t xnintr_affinity (xnintr_t * *intr*, xnarch_cpumask_t *cpumask*)

Set interrupt's processor affinity.

Causes the IRQ associated with the interrupt object *intr* to be received only on processors which bits are set in *cpumask*.

Parameters

intr	The descriptor address of the interrupt object which affinity is to be changed.
cpumask	The new processor affinity of the interrupt object.

Returns

the previous cpumask on success, or an empty mask on failure.

Note

Depending on architectures, setting more than one bit in *cpumask* could be meaningless.

4.5.2.2 int xnintr_attach (xnintr_t * *intr*, void * *cookie*)

Attach an interrupt object.

Attach an interrupt object previously initialized by xnintr_init(). After this operation is completed, all IRQs received from the corresponding interrupt channel are directed to the object's ISR.

Parameters

intr	The descriptor address of the interrupt object to attach.
cookie	A user-defined opaque value which is stored into the interrupt object descriptor for further retrieval by the ISR/ISR handlers.

Returns

0 is returned on success. Otherwise:

- -EINVAL is returned if a low-level error occurred while attaching the interrupt.
- -EBUSY is returned if the interrupt object was already attached.

Note

The caller **must not** hold nklock when invoking this service, this would cause deadlocks.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task

Rescheduling: never.

Note

Attaching an interrupt resets the tracked number of receipts to zero.

4.5.2.3 int **xnintr_destroy** (xnintr_t * *intr*)

Destroy an interrupt object.

Destroys an interrupt object previously initialized by xnintr_init(). The interrupt object is automatically detached by a call to xnintr_detach(). No more IRQs will be dispatched by this object after this service has returned.

Parameters

intr	The descriptor address of the interrupt object to destroy.

Returns

0 is returned on success. Otherwise, -EINVAL is returned if an error occurred while detaching the interrupt (see xnintr_detach()).

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task

Rescheduling: never.

References xnintr_detach().

4.5.2.4 int **xnintr_detach** (xnintr_t * *intr*)

Detach an interrupt object.

Detach an interrupt object previously attached by xnintr_attach(). After this operation is completed, no more IRQs are directed to the object's ISR, but the interrupt object itself remains valid. A detached interrupt object can be attached again by a subsequent call to xnintr_attach().

Parameters

intr	The descriptor address of the interrupt object to detach.

Returns

0 is returned on success. Otherwise:

- -EINVAL is returned if a low-level error occurred while detaching the interrupt, or if the interrupt object was not attached. In both cases, no action is performed.

Note

The caller **must not** hold nklock when invoking this service, this would cause deadlocks.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task

Rescheduling: never.

Referenced by xnintr_destroy().

4.5.2.5 int xnintr_disable (xnintr_t * *intr*)

Disable an interrupt object.

Disables the hardware interrupt line associated with an interrupt object. This operation invalidates further interrupt requests from the given source until the IRQ line is re-enabled anew.

Parameters

intr	The descriptor address of the interrupt object to disable.

Returns

0 is returned on success. Otherwise, -EINVAL is returned if a low-level error occurred while disabling the interrupt.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task

Rescheduling: never.

4.5.2.6 int **xnintr_enable** (xnintr_t * *intr*)

Enable an interrupt object.

Enables the hardware interrupt line associated with an interrupt object. Over real-time control layers which mask and acknowledge IRQs, this operation is necessary to revalidate the interrupt channel so that more interrupts can be notified.

Parameters

intr	The descriptor address of the interrupt object to enable.

Returns

0 is returned on success. Otherwise, -EINVAL is returned if a low-level error occurred while enabling the interrupt.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task

Rescheduling: never.

4.5.2.7 int **xnintr_init** (xnintr_t * *intr,* const char * *name,* unsigned *irq,* xnisr_t *isr,* xniack_t *iack,* xnflags_t *flags*)

Initialize an interrupt object.

Associates an interrupt object with an IRQ line.

When an interrupt occurs on the given *irq* line, the ISR is fired in order to deal with the hardware event. The interrupt service code may call any non-suspensive service from the nucleus.

Upon receipt of an IRQ, the ISR is immediately called on behalf of the interrupted stack context, the rescheduling procedure is locked, and the interrupt source is masked at hardware level. The status value returned by the ISR is then checked for the following values:

- XN_ISR_HANDLED indicates that the interrupt request has been fulfilled by the ISR.
- XN_ISR_NONE indicates the opposite to XN_ISR_HANDLED. The ISR must always return this value when it determines that the interrupt request has not been issued by the dedicated hardware device.

In addition, one of the following bits may be set by the ISR :

NOTE: use these bits with care and only when you do understand their effect on the system. The ISR is not encouraged to use these bits in case it shares the IRQ line with other ISRs in the real-time domain.

- XN_ISR_NOENABLE causes the nucleus to ask the real-time control layer _not_ to re-enable the IRQ line (read the following section). xnarch_end_irq() must be called to re-enable the IRQ line later.
- XN_ISR_PROPAGATE tells the nucleus to require the real-time control layer to forward the IRQ. For instance, this would cause the Adeos control layer to propagate the interrupt down the interrupt pipeline to other Adeos domains, such as Linux. This is the regular way to share interrupts between the nucleus and the host system. In effect, XN_ISR_PROPAGATE implies XN_ISR_NOENABLE since it would make no sense to re-enable the interrupt channel before the next domain down the pipeline has had a chance to process the propagated interrupt.

The nucleus re-enables the IRQ line by default. Over some real-time control layers which mask and acknowledge IRQs, this operation is necessary to revalidate the interrupt channel so that more interrupts can be notified.

A count of interrupt receipts is tracked into the interrupt descriptor, and reset to zero each time the interrupt object is attached. Since this count could wrap around, it should be used as an indication of interrupt activity only.

Parameters

intr	The address of a interrupt object descriptor the nucleus will use to store the object-specific data. This descriptor must always be valid while the object is active therefore it must be allocated in permanent memory.
name	An ASCII string standing for the symbolic name of the interrupt object or NULL ("<unknown>" will be applied then).
irq	The hardware interrupt channel associated with the interrupt object. This value is architecture-dependent. An interrupt object must then be attached to the hardware interrupt vector using the xnintr_attach() service for the associated IRQs to be directed to this object.

isr	The address of a valid low-level interrupt service routine if this parameter is non-zero. This handler will be called each time the corresponding IRQ is delivered on behalf of an interrupt context. When called, the ISR is passed the descriptor address of the interrupt object.
iack	The address of an optional interrupt acknowledge routine, aimed at replacing the default one. Only very specific situations actually require to override the default setting for this parameter, like having to acknowledge non-standard PIC hardware. *iack* should return a non-zero value to indicate that the interrupt has been properly acknowledged. If *iack* is NULL, the default routine will be used instead.
flags	A set of creation flags affecting the operation. The valid flags are:

- XN_ISR_SHARED enables IRQ-sharing with other interrupt objects.

- XN_ISR_EDGE is an additional flag need to be set together with XN_ISR_SHARED to enable IRQ-sharing of edge-triggered interrupts.

Returns

0 is returned on success. Otherwise, -EINVAL is returned if *irq* is not a valid interrupt number.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task

Rescheduling: never.

Referenced by xnpod_enable_timesource().

4.6 Lightweight key-to-object mapping service

Collaboration diagram for Lightweight key-to-object mapping service:

Files

- file map.h
- file map.c

Functions

- xnmap_t * xnmap_create (int nkeys, int reserve, int offset)

  Create a map.
- void xnmap_delete (xnmap_t *map)

  Delete a map.
- int xnmap_enter (xnmap_t *map, int key, void *objaddr)

  Index an object into a map.
- int xnmap_remove (xnmap_t *map, int key)

  Remove an object reference from a map.
- static void * xnmap_fetch_nocheck (xnmap_t *map, int key)

  Search an object into a map - unchecked form.
- static void * xnmap_fetch (xnmap_t *map, int key)

  Search an object into a map.

4.6.1 Detailed Description

A map is a simple indexing structure which associates unique integer keys with pointers to objects. The current implementation supports reservation, for naming/indexing the real-time objects skins create, either on a fixed, user-provided integer (i.e. a reserved key value), or by drawing the next available key internally if the caller did not specify any fixed key. For instance, in some given map, the key space ranging from 0 to 255 could be reserved for fixed keys, whilst the range from 256 to 511 could be available for drawing free keys dynamically.

A maximum of 1024 unique keys per map is supported on 32bit machines.

(This implementation should not be confused with C++ STL maps, which are dynamically expandable and allow arbitrary key types; Xenomai maps don't).

4.6.2 Function Documentation

4.6.2.1 xnmap_t * xnmap_create (int *nkeys*, int *reserve*, int *offset*)

Create a map.

Allocates a new map with the specified addressing capabilities. The memory is obtained from the Xenomai system heap.

Parameters

nkeys	The maximum number of unique keys the map will be able to hold. This value cannot exceed the static limit represented by XNMAP_MAX_KEYS, and must be a power of two.
reserve	The number of keys which should be kept for reservation within the index space. Reserving a key means to specify a valid key to the xnmap_enter() service, which will then attempt to register this exact key, instead of drawing the next available key from the unreserved index space. When reservation is in effect, the unreserved index space will hold key values greater than *reserve*, keeping the low key values for the reserved space. For instance, passing *reserve* = 32 would cause the index range [0 .. 31] to be kept for reserved keys. When non-zero, *reserve* is rounded to the next multiple of BITS_PER_LONG. If *reserve* is zero no reservation will be available from the map.
offset	The lowest key value xnmap_enter() will return to the caller. Key values will be in the range [0 + offset .. *nkeys* + offset - 1]. Negative offsets are valid.

Returns

the address of the new map is returned on success; otherwise, NULL is returned if *nkeys* is invalid.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

4.6.2.2 void xnmap_delete (xnmap_t * *map*)

Delete a map.

Deletes a map, freeing any associated memory back to the Xenomai system heap.

Parameters

map	The address of the map to delete.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

4.6.2.3 int xnmap_enter (xnmap_t * *map*, int *key*, void * *objaddr*)

Index an object into a map.

Insert a new object into the given map.

Parameters

map	The address of the map to insert into.
key	The key to index the object on. If this key is within the valid index range [0 - offset .. nkeys - offset - 1], then an attempt to reserve this exact key is made. If *key* has an out-of-range value lower or equal to 0 - offset - 1, then an attempt is made to draw a free key from the unreserved index space.
objaddr	The address of the object to index on the key. This value will be returned by a successful call to xnmap_fetch() with the same key.

Returns

a valid key is returned on success, either *key* if reserved, or the next free key. Otherwise:

- -EEXIST is returned upon attempt to reserve a busy key.
- -ENOSPC when no more free key is available.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

4.6.2.4 void **xnmap_fetch** (xnmap_t * *map*, int *key*) [inline, static]

Search an object into a map.

Retrieve an object reference from the given map by its index key.

Parameters

map	The address of the map to retrieve from.
key	The key to be searched for in the map index.

Returns

> The indexed object address is returned on success, otherwise NULL is returned when *key* is invalid or no object is currently indexed on it.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

4.6.2.5 void **xnmap_fetch_nocheck** (xnmap_t * *map*, int *key*) [inline, static]

Search an object into a map - unchecked form.

Retrieve an object reference from the given map by its index key, but does not perform any sanity check on the provided key.

Parameters

map	The address of the map to retrieve from.
key	The key to be searched for in the map index.

Returns

The indexed object address is returned on success, otherwise NULL is returned when no object is currently indexed on *key*.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

4.6.2.6 int **xnmap_remove** (xnmap_t * *map,* int *key*)

Remove an object reference from a map.

Removes an object reference from the given map, releasing the associated key.

Parameters

map	The address of the map to remove from.
key	The key the object reference to be removed is indexed on.

Returns

0 is returned on success. Otherwise:

- -ESRCH is returned if *key* is invalid.

Environments:

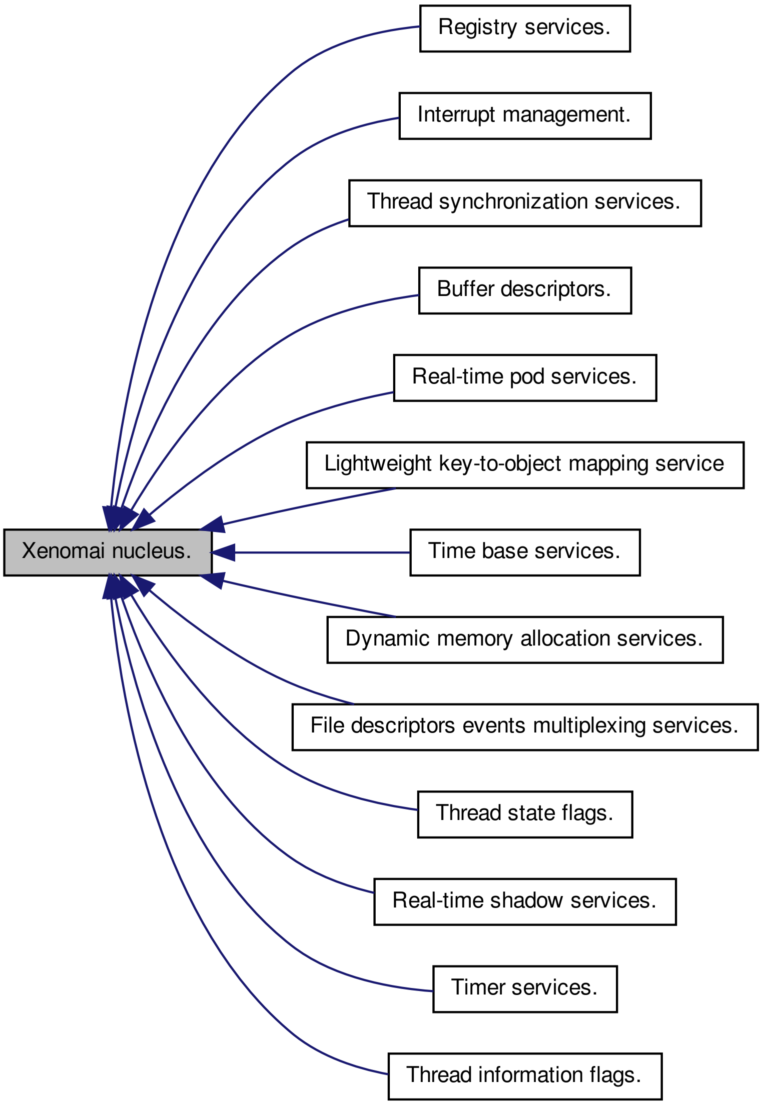
This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

4.7 Xenomai nucleus.

Collaboration diagram for Xenomai nucleus.:


Registry services.
Interrupt management.
Thread synchronization services.
Buffer descriptors.
Real-time pod services.
Lightweight key-to-object mapping service
Xenomai nucleus.
Time base services.
Dynamic memory allocation services.
File descriptors events multiplexing services.
Thread state flags.
Real-time shadow services.
Timer services.
Thread information flags.

Modules

- Thread state flags.

  Bits reporting permanent or transient states of thread.
- Thread information flags.

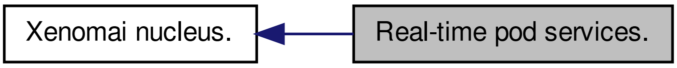
  Bits reporting events notified to the thread.
- Buffer descriptors.
- Dynamic memory allocation services.
- Interrupt management.
- Lightweight key-to-object mapping service
- Real-time pod services.
- Registry services.
- File descriptors events multiplexing services.
- Real-time shadow services.
- Thread synchronization services.
- Time base services.
- Timer services.

4.7.1 Detailed Description

An abstract RTOS core.

4.8 Real-time pod services.

Collaboration diagram for Real-time pod services.:



Data Structures

- struct xnpod

  Real-time pod descriptor.

Files

- file pod.h

  Real-time pod interface header.
- file pod.c

  Real-time pod services.

Functions

- int xnpod_init (void)

  Initialize the core pod.
- int xnpod_enable_timesource (void)

  Activate the core time source.
- void xnpod_disable_timesource (void)

  Stop the core time source.
- void xnpod_shutdown (int xtype)

  Shutdown the current pod.
- int xnpod_init_thread (struct xnthread *thread, const struct xnthread_init_attr *attr, struct xnsched_class *sched_class, const union xnsched_policy_param *sched_param)

  Initialize a new thread.
- int xnpod_start_thread (xnthread_t *thread, const struct xnthread_start_attr *attr)

  Initial start of a newly created thread.

- void xnpod_stop_thread (xnthread_t *thread)

  Stop a thread.
- void xnpod_restart_thread (xnthread_t *thread)

  Restart a thread.
- void xnpod_delete_thread (xnthread_t *thread)

  Delete a thread.
- void xnpod_abort_thread (xnthread_t *thread)

  Abort a thread.
- xnflags_t xnpod_set_thread_mode (xnthread_t *thread, xnflags_t clrmask, xnflags_t setmask)

  Change a thread's control mode.
- void xnpod_suspend_thread (xnthread_t *thread, xnflags_t mask, xnticks_t timeout, xntmode_t timeout_mode, struct xnsynch *wchan)

  Suspend a thread.
- void xnpod_resume_thread (xnthread_t *thread, xnflags_t mask)

  Resume a thread.
- int xnpod_unblock_thread (xnthread_t *thread)

  Unblock a thread.
- int xnpod_set_thread_schedparam (struct xnthread *thread, struct xnsched_class *sched_class, const union xnsched_policy_param *sched_param)

  Change the base scheduling parameters of a thread.
- int xnpod_migrate_thread (int cpu)

  Migrate the current thread.
- void xnpod_dispatch_signals (void)

  Deliver pending asynchronous signals to the running thread.
- static void xnpod_schedule (void)

  Rescheduling procedure entry point.
- int xnpod_set_thread_periodic (xnthread_t *thread, xnticks_t idate, xnticks_t period)

  Make a thread periodic.
- int xnpod_wait_thread_period (unsigned long *overruns_r)

  Wait for the next periodic release point.
- int xnpod_set_thread_tslice (struct xnthread *thread, xnticks_t quantum)

  Set thread time-slicing information.
- int xnpod_add_hook (int type, void(*routine)(xnthread_t *))

  Install a nucleus hook.
- int xnpod_remove_hook (int type, void(*routine)(xnthread_t *))

  Remove a nucleus hook.
- void xnpod_welcome_thread (xnthread_t *thread, int imask)

  Thread prologue.
- int xnpod_trap_fault (xnarch_fltinfo_t *fltinfo)

  Default fault handler.

4.8.1 Detailed Description

Real-time pod services.

4.8.2 Function Documentation

4.8.2.1 void **xnpod_abort_thread** (xnthread_t ∗ *thread*)

Abort a thread.

Unconditionally terminates a thread and releases all the nucleus resources it currently holds, regardless of whether the target thread is currently active in kernel or user-space. xnpod_abort_thread() should be reserved for use by skin cleanup routines; xnpod_delete_thread() should be preferred as the common method for removing threads from a running system.

Parameters

thread	The descriptor address of the terminated thread.

This service forces a call to xnpod_delete_thread() for the target thread.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: possible if the current thread self-deletes.

References XNABORT, XNDORMANT, xnpod_delete_thread(), and xnpod_suspend_thread().

4.8.2.2 int **xnpod_add_hook** (int *type*, void(∗)(xnthread_t ∗) *routine*)

Install a nucleus hook.

The nucleus allows to register user-defined routines which get called whenever a specific scheduling event occurs. Multiple hooks can be chained for a single event type, and get called on a FIFO basis.

The scheduling is locked while a hook is executing.

Parameters

type	Defines the kind of hook to install:

- XNHOOK_THREAD_START: The user-defined routine will be called on behalf of the starter thread whenever a new thread starts. The descriptor address of the started thread is passed to the routine.

- XNHOOK_THREAD_DELETE: The user-defined routine will be called on behalf of the deletor thread whenever a thread is deleted. The descriptor address of the deleted thread is passed to the routine.

- XNHOOK_THREAD_SWITCH: The user-defined routine will be called on behalf of the resuming thread whenever a context switch takes place. The descriptor address of the thread which has been switched out is passed to the routine.

Parameters

routine	The address of the user-supplied routine to call.

Returns

0 is returned on success. Otherwise, one of the following error codes indicates the cause of the failure:

- -EINVAL is returned if type is incorrect.

- -ENOMEM is returned if not enough memory is available from the system heap to add the new hook.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

4.8.2.3 void **xnpod_delete_thread** (xnthread_t ∗ *thread*)

Delete a thread.

Terminates a thread and releases all the nucleus resources it currently holds. A thread exists in the system since xnpod_init_thread() has been called to create it, so this service must be called in order to destroy it afterwards.

Parameters

thread	The descriptor address of the terminated thread.

The target thread's resources may not be immediately removed if this is an active shadow thread running in user-space. In such a case, the mated Linux task is sent a termination signal instead, and the actual deletion is deferred until the task exit event is called.

The DELETE hooks are called on behalf of the calling context (if any). The information stored in the thread control block remains valid until all hooks have been called.

Self-terminating a thread is allowed. In such a case, this service does not return to the caller.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: possible if the current thread self-deletes.

References xnsched::curr, xnsched::status, XNABORT, XNCANPND, XNDEFCAN, XNDORMANT, XNMIGRATE, XNPEND, xnpod_schedule(), xnpod_-unblock_thread(), XNREADY, XNROOT, xnselector_destroy(), xnsynch_forget-_sleeper(), xnsynch_release_all_ownerships(), xntimer_destroy(), and XNZOMBIE.

Referenced by xnpod_abort_thread(), and xnpod_shutdown().

4.8.2.4 void **xnpod_disable_timesource** (void)

Stop the core time source.

Releases the hardware timer, and deactivates the master time base.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task in secondary mode

Rescheduling: never.

References xntimer_freeze().

Referenced by xnpod_shutdown().

4.8.2.5 void xnpod_dispatch_signals (void)

Deliver pending asynchronous signals to the running thread.

This internal routine checks for the presence of asynchronous signals directed to the running thread, and attempts to start the asynchronous service routine (ASR) if any. Called with nklock locked, interrupts off.

References XNASDI.

Referenced by xnpod_welcome_thread(), and xnshadow_harden().

4.8.2.6 int xnpod_enable_timesource (void)

Activate the core time source.

Xenomai implements the notion of time base, by which software timers that belong to different skins may be clocked separately according to distinct frequencies, or aperiodically. In the periodic case, delays and timeouts are given in counts of ticks; the duration of a tick is specified by the time base. In the aperiodic case, timings are directly specified in nanoseconds.

Only a single aperiodic (i.e. tick-less) time base may exist in the system, and the nucleus provides for it through the nktbase object. All skins depending on aperiodic timings should bind to the latter, also known as the master time base. Skins depending on periodic timings may create and bind to their own time base. Such a periodic time base is managed as a slave object of the master one. A cascading software timer, which is fired by the master time base according to the appropriate frequency, triggers in turn the update process of the associated slave time base, which eventually fires the elapsed software timers controlled by the latter.

Xenomai always controls the underlying hardware timer in a tick-less fashion, also known as the oneshot mode. The xnpod_enable_timesource() service configures the timer chip as needed, and activates the master time base.

Returns

0 is returned on success. Otherwise:

- -ENODEV is returned if a failure occurred while configuring the hardware timer.

- -ENOSYS is returned if no active pod exists.

Side-effect: A host timing service is started in order to relay the canonical periodical tick to the underlying architecture, regardless of the frequency used for Xenomai's system tick. This routine does not call the rescheduling procedure.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task in secondary mode

Rescheduling: never.

Note

Built-in support for periodic timing depends on CONFIG_XENO_OPT_TIMING_PERIODIC.

References xnsched::htimer, xnintr_init(), and xntimer_start().

Referenced by xnpod_init().

4.8.2.7 int **xnpod_init** (void)

Initialize the core pod.

Initializes the core interface pod which can subsequently be used to start real-time activities. Once the core pod is active, real-time skins can be stacked over. There can only be a single core pod active in the host environment. - Such environment can be confined to a process (e.g. simulator), or expand machine-wide (e.g. I-pipe).

Returns

0 is returned on success. Otherwise:

- -ENOMEM is returned if the memory manager fails to initialize.

Environments:

This service can be called from:

- Kernel module initialization code

References xnpod::refcnt, xnsched::rootcb, xnpod::sched, xnpod::status, xnpod::tdeleteq, xnpod::threadq, xnpod::timerlck, xnpod::tsliced, xnpod::tslicer, xnpod::tstartq, xnpod::tswitchq, xnheap_destroy(), xnheap_init(), xnheap_set_label(), xnpod_enable_timesource(), xnpod_shutdown(), and xntimer_init().

4.8.2.8 int **xnpod_init_thread** (struct xnthread ∗ *thread*, const struct xnthread_init_attr ∗ *attr*, struct xnsched_class ∗ *sched_class*, const union xnsched_policy_param ∗ *sched_param*)

Initialize a new thread.

Initializes a new thread attached to the active pod. The thread is left in an innocuous state until it is actually started by xnpod_start_thread().

Parameters

thread	The address of a thread descriptor the nucleus will use to store the thread-specific data. This descriptor must always be valid while the thread is active therefore it must be allocated in permanent memory.

Warning

Some architectures may require the descriptor to be properly aligned in memory; this is an additional reason for descriptors not to be laid in the program stack where alignement constraints might not always be satisfied.

Parameters

attr	A pointer to an attribute block describing the initial properties of the new thread. Members of this structure are defined as follows:

- name: An ASCII string standing for the symbolic name of the thread. - This name is copied to a safe place into the thread descriptor. This name might be used in various situations by the nucleus for issuing human-readable diagnostic messages, so it is usually a good idea to provide a sensible value here. The simulator even uses this name intensively to identify threads in the debugging GUI it provides. However, passing NU-LL here is always legal and means "anonymous".

- tbase: The time base descriptor to refer to for all timed operations issued by the new thread. See xntbase_alloc() for detailed explanations about time bases.

- flags: A set of creation flags affecting the operation. The following flags can be part of this bitmask, each of them affecting the nucleus behaviour regarding the created thread:

- XNSUSP creates the thread in a suspended state. In such a case, the thread will have to be explicitly resumed using the xnpod_resume_thread() service for its execution to actually begin, additionally to issuing xnpod_start_thread() for it. This flag can also be specified when invoking xnpod_start_thread() as a starting mode.

- XNFPU (enable FPU) tells the nucleus that the new thread will use the floating-point unit. In such a case, the nucleus will handle the FPU context save/restore ops upon thread switches at the expense of a few additional cycles per context switch. By default, a thread is not expected to use the FPU. This flag is simply ignored when the nucleus runs on behalf of a userspace-based real-time control layer since the FPU management is always active if present.

- stacksize: The size of the stack (in bytes) for the new thread. If zero is passed, the nucleus will use a reasonable pre-defined size depending on the underlying real-time control layer.

- ops: A pointer to a structure defining the class-level operations available for this thread. Fields from this structure must have been set appropriately by the caller.

Parameters

sched_-class	The initial scheduling class the new thread should be assigned to.
sched_-param	The initial scheduling parameters to set for the new thread; *sched_param* must be valid within the context of *sched_class*.

Returns

0 is returned on success. Otherwise, one of the following error codes indicates the cause of the failure:

- -EINVAL is returned if *attr->flags* has invalid bits set.

- -ENOMEM is returned if not enough memory is available from the system heap to create the new thread's stack.

Side-effect: This routine does not call the rescheduling procedure.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

References XNDORMANT, XNFPU, xnpod_suspend_thread(), XNSHADOW, and XNSUSP.

4.8.2.9 int xnpod_migrate_thread (int *cpu*)

Migrate the current thread.

This call makes the current thread migrate to another CPU if its affinity allows it.

Parameters

cpu	The destination CPU.

Return values

0	if the thread could migrate ;
-EPERM	if the calling context is asynchronous, or the current thread affinity forbids this migration ;
-EBUSY	if the scheduler is locked.

References xnpod_schedule().

4.8.2.10 int **xnpod_remove_hook** (int *type,* void(*)(xnthread_t *) *routine*)

Remove a nucleus hook.

This service removes a nucleus hook previously registered using xnpod_add_hook().

Parameters

type	Defines the kind of hook to remove among XNHOOK_THREAD_START, XNHOOK_THREAD_DELETE and XNHOOK_THREAD_SWITCH.
routine	The address of the user-supplied routine to remove.

Returns

> 0 is returned on success. Otherwise, -EINVAL is returned if type is incorrect or if the routine has never been registered before.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

4.8.2.11 void **xnpod_restart_thread** (xnthread_t * *thread*)

Restart a thread.

Restarts a previously started thread. The thread is first terminated then respawned using the same information that prevailed when it was first started, including the mode bits and interrupt mask initially passed to the xnpod_start_thread() service. As a consequence of this call, the thread entry point is rerun.

Parameters

thread	The descriptor address of the affected thread which must have been previously started by the xnpod_start_thread() service.

Self-restarting a thread is allowed. However, restarting the root thread is not. Restarting a thread which was never started once leads to a null-effect.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task

Rescheduling: possible.

References xnpod_schedule(), XNRESTART, XNROOT, XNSHADOW, and XNSTARTED.

4.8.2.12 void **xnpod_resume_thread** (xnthread_t ∗ *thread,* xnflags_t *mask*)

Resume a thread.

Resumes the execution of a thread previously suspended by one or more calls to xnpod_suspend_thread(). This call removes a suspensive condition affecting the target thread. When all suspensive conditions are gone, the thread is left in a READY state at which point it becomes eligible anew for scheduling.

Parameters

thread	The descriptor address of the resumed thread.
mask	The suspension mask specifying the suspensive condition to remove from the thread's wait mask. Possible values usable by the caller are:

- XNSUSP. This flag removes the explicit suspension condition. This condition might be additive to the XNPEND condition.
- XNDELAY. This flag removes the counted delay wait condition.
- XNPEND. This flag removes the resource wait condition. If a watchdog is armed, it is automatically disarmed by this call. Unlike the two previous conditions, only the current thread can set this condition for itself, i.e. no thread can force another one to pend on a resource.

When the thread is eventually resumed by one or more calls to xnpod_resume_thread(), the caller of xnpod_suspend_thread() in the awakened thread that suspended itself should check for the following bits in its own information mask to determine what caused its wake up:

- XNRMID means that the caller must assume that the pended synchronization object has been destroyed (see xnsynch_flush()).
- XNTIMEO means that the delay elapsed, or the watchdog went off before the corresponding synchronization object was signaled.
- XNBREAK means that the wait has been forcibly broken by a call to xnpod_unblock_thread().

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

References xnsched::curr, XNDELAY, XNHELD, XNPEND, XNREADY, xnsynch_forget_sleeper(), and xntimer_stop().

Referenced by xnpod_start_thread(), xnpod_unblock_thread(), xnsynch_flush(), xnsynch_release(), xnsynch_wakeup_one_sleeper(), and xnsynch_wakeup_this_sleeper().

4.8.2.13 void **xnpod_schedule** (void) `[inline, static]`

Rescheduling procedure entry point.

This is the central rescheduling routine which should be called to validate and apply changes which have previously been made to the nucleus scheduling state, such as suspending, resuming or changing the priority of threads. This call first determines if a thread switch should take place, and performs it as needed. xnpod_schedule() schedules out the current thread if:

- the current thread is now blocked or deleted.
- a runnable thread from a higher priority scheduling class is waiting for the CPU.
- the current thread does not lead the runnable threads from its own scheduling class (e.g. round-robin in the RT class).

The nucleus implements a lazy rescheduling scheme so that most of the services affecting the threads state MUST be followed by a call to the rescheduling procedure for the new scheduling state to be applied. In other words, multiple changes on the scheduler state can be done in a row, waking threads up, blocking others, without being immediately translated into the corresponding context switches, like it would be necessary would it appear that a higher priority thread than the current one became runnable for instance. When all changes have been applied, the rescheduling procedure is then called to consider those changes, and possibly replace the current thread by another one.

As a notable exception to the previous principle however, every action which ends up suspending or deleting the current thread begets an immediate call to the rescheduling procedure on behalf of the service causing the state transition. For instance, self-suspension, self-destruction, or sleeping on a synchronization object automatically leads to a call to the rescheduling procedure, therefore the caller does not need to explicitly issue xnpod_schedule() after such operations.

The rescheduling procedure always leads to a null-effect if it is called on behalf of an ISR or callout. Any outstanding scheduler lock held by the outgoing thread will be restored when the thread is scheduled back in.

Calling this procedure with no applicable context switch pending is harmless and simply leads to a null-effect.

Side-effects:

- If an asynchronous service routine exists, the pending asynchronous signals are delivered to a resuming thread or on behalf of the caller before it returns from the procedure if no context switch has taken place. This behaviour can be disabled by setting the XNASDI flag in the thread's status mask by calling xnpod_set_thread_mode().

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine, although this leads to a no-op.
- Kernel-based task
- User-space task

Note

The switch hooks are called on behalf of the resuming thread.

References xnsched::lflags, and xnsched::status.

Referenced by xnpod_delete_thread(), xnpod_migrate_thread(), xnpod_restart_thread(), xnpod_shutdown(), xnpod_start_thread(), xnpod_stop_thread(), xnpod_suspend_thread(), xnregistry_enter(), xnregistry_put(), xnselect_bind(), and xnselect_destroy().

4.8.2.14 xnflags_t xnpod_set_thread_mode (xnthread_t * *thread*, xnflags_t *clrmask*, xnflags_t *setmask*)

Change a thread's control mode.

Change the control mode of a given thread. The control mode affects the behaviour of the nucleus regarding the specified thread.

Parameters

thread	The descriptor address of the affected thread.
clrmask	Clears the corresponding bits from the control field before setmask is applied. The scheduler lock held by the current thread can be forcibly released by passing the XNLOCK bit in this mask. In this case, the lock nesting count is also reset to zero.
setmask	The new thread mode. The following flags can be part of this bitmask, each of them affecting the nucleus behaviour regarding the thread:

- XNLOCK causes the thread to lock the scheduler. The target thread will have to call the xnpod_unlock_sched() service to unlock the scheduler or clear the XNLOCK bit forcibly using this service. A non-preemptible thread may still block, in which case, the lock is reasserted when the thread is scheduled back in.

- XNASDI disables the asynchronous signal handling for this thread. See xnpod_schedule() for more on this.

- XNRPIOFF disables thread priority coupling between Xenomai and Linux schedulers. This bit prevents the root Linux thread from inheriting the priority of the running shadow Xenomai thread. Use CONFIG_XENO_OPT_RPIOFF to globally disable priority coupling.

Environments:

This service can be called from:

- Kernel-based task
- User-space task in primary mode.

Rescheduling: never, therefore, the caller should reschedule if XNLOCK has been passed into *clrmask*.

References XNLOCK.

4.8.2.15 int xnpod_set_thread_periodic (xnthread_t * *thread*, xnticks_t *idate*, xnticks_t *period*)

Make a thread periodic.

Make a thread periodic by programming its first release point and its period in the processor time line. Subsequent calls to xnpod_wait_thread_period() will delay the thread until the next periodic release point in the processor timeline is reached.

Parameters

thread	The descriptor address of the affected thread. This thread is immediately delayed until the first periodic release point is reached.
idate	The initial (absolute) date of the first release point, expressed in clock ticks (see note). The affected thread will be delayed until this point is reached. If *idate* is equal to XN_INFINITE, the current system date is used, and no initial delay takes place.
period	The period of the thread, expressed in clock ticks (see note). As a side-effect, passing XN_INFINITE attempts to stop the thread's periodic timer; in the latter case, the routine always exits succesfully, regardless of the previous state of this timer.

Returns

0 is returned upon success. Otherwise:

- -ETIMEDOUT is returned *idate* is different from XN_INFINITE and represents a date in the past.
- -EWOULDBLOCK is returned if the relevant time base has not been initialized by a call to xnpod_init_timebase().
- -EINVAL is returned if *period* is different from XN_INFINITE but shorter than the scheduling latency value for the target system, as available from /proc/xenomai/latency.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: possible if the operation affects the current thread and *idate* has not elapsed yet.

Note

The *idate* and *period* values will be interpreted as jiffies if *thread* is bound to a periodic time base (see xnpod_init_thread), or nanoseconds otherwise.

References XNDELAY, xnpod_suspend_thread(), xntimer_start(), and xntimer_stop().

4.8.2.16 int xnpod_set_thread_schedparam (struct xnthread * *thread,* struct xnsched_class * *sched_class,* const union xnsched_policy_param * *sched_param*)

Change the base scheduling parameters of a thread.

Changes the base scheduling policy and paramaters of a thread. If the thread is currently blocked, waiting in priority-pending mode (XNSYNCH_PRIO) for a synchronization object to be signaled, the nucleus will attempt to reorder the object's wait queue so that it reflects the new sleeper's priority, unless the XNSYNCH_DREORD flag has been set for the pended object.

Parameters

thread	The descriptor address of the affected thread.
sched_-class	The new scheduling class the thread should be assigned to.
sched_-param	The scheduling parameters to set for the thread; *sched_param* must be valid within the context of *sched_class*.

It is absolutely required to use this service to change a thread priority, in order to have all the needed housekeeping chores correctly performed. i.e. Do *not* call xnsched_set_policy() directly or worse, change the thread.cprio field by hand in any case.

Returns

0 is returned on success. Otherwise, a negative error code indicates the cause of a failure that happened in the scheduling class implementation for *sched_class*. Invalid parameters passed into *sched_param* are common causes of error.

Side-effects:

- This service does not call the rescheduling procedure but may affect the state of the runnable queue for the previous and new scheduling classes.
- Assigning the same scheduling class and parameters to a running or ready thread moves it to the end of the runnable queue, thus causing a manual round-robin.
- If the thread is a user-space shadow, this call propagates the request to the mated Linux task.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine

- Kernel-based task
- User-space task

Rescheduling: never.

4.8.2.17 int xnpod_set_thread_tslice (struct xnthread * *thread,* xnticks_t *quantum*)

Set thread time-slicing information.

Update the time-slicing information for a given thread. This service enables or disables round-robin scheduling for the thread, depending on the value of *quantum*. By default, times-slicing is disabled for a new thread initialized by a call to xnpod_init_thread().

Parameters

thread	The descriptor address of the affected thread.
quantum	The time quantum assigned to the thread expressed in time-slicing ticks (see note). If *quantum* is different from XN_INFINITE, the time-slice for the thread is set to that value and its current time credit is refilled (i.e. the thread is given a full time-slice to run next). Otherwise, if *quantum* equals XN_INFINITE, time-slicing is stopped for that thread.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if the base scheduling class of the target thread does not support time-slicing.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

Note

If *thread* is bound to a periodic timebase, *quantum* represents the number of periodic ticks in that timebase. Otherwise, if *thread* is bound to the master time base, a full time-slice will last: *quantum* * CONFIG_XENO_OPT_TIMING_VIRTICK.

References XNRRB, xntimer_start(), and xntimer_stop().

4.8.2.18 void xnpod_shutdown (int *xtype*)

Shutdown the current pod.

Forcibly shutdowns the active pod. All existing nucleus threads (but the root one) are terminated, and the system heap is freed.

Parameters

xtype	An exit code passed to the host environment who started the nucleus. Zero is always interpreted as a successful return.

The nucleus never calls this routine directly. Skins should provide their own shutdown handlers which end up calling xnpod_shutdown() after their own housekeeping chores have been carried out.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

Rescheduling: never.

References xnheap_destroy(), xnpod_delete_thread(), xnpod_disable_timesource(), xnpod_schedule(), XNROOT, and xntimer_destroy().

Referenced by xnpod_init().

4.8.2.19 int xnpod_start_thread (xnthread_t * *thread,* const struct xnthread_start_attr * *attr*)

Initial start of a newly created thread.

Starts a (newly) created thread, scheduling it for the first time. This call releases the target thread from the XNDORMANT state. This service also sets the initial mode and interrupt mask for the new thread.

Parameters

thread	The descriptor address of the affected thread which must have been previously initialized by the xnpod_init_thread() service.
attr	A pointer to an attribute block describing the execution properties of the new thread. Members of this structure are defined as follows:

- mode: The initial thread mode. The following flags can be part of this bitmask, each of them affecting the nucleus behaviour regarding the started thread:

- XNLOCK causes the thread to lock the scheduler when it starts. The target thread will have to call the xnpod_unlock_sched() service to unlock the scheduler. A non-preemptible thread may still block, in which case, the lock is reasserted when the thread is scheduled back in.

- XNASDI disables the asynchronous signal handling for this thread. See xnpod_schedule() for more on this.

- XNSUSP makes the thread start in a suspended state. In such a case, the thread will have to be explicitly resumed using the xnpod_resume_thread() service for its execution to actually begin.

- imask: The interrupt mask that should be asserted when the thread starts. The processor interrupt state will be set to the given value when the thread starts running. The interpretation of this value might be different across real-time layers, but a non-zero value should always mark an interrupt masking in effect (e.g. local_irq_disable()). Conversely, a zero value should always mark a fully preemptible state regarding interrupts (e.g. local_irq_enable()).

- affinity: The processor affinity of this thread. Passing XNPOD_ALL_CPUS or an empty affinity set means "any cpu".

- entry: The address of the thread's body routine. In other words, it is the thread entry point.

- cookie: A user-defined opaque cookie the nucleus will pass to the emerging thread as the sole argument of its entry point.

The START hooks are called on behalf of the calling context (if any).

Return values

0	if *thread* could be started ;
-EBUSY	if *thread* was not dormant or stopped ;
-EINVAL	if the value of *attr->affinity* is invalid.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: possible.

References XNDORMANT, xnpod_resume_thread(), xnpod_schedule(), XNREADY, XNSHADOW, XNSTARTED, and XNSUSP.

Referenced by xnshadow_map().

4.8.2.20 void xnpod_stop_thread (xnthread_t * *thread*)

Stop a thread.

Stop a previously started thread. The thread is put back into the dormant state; however, it is not deleted from the system.

Parameters

thread	The descriptor address of the affected thread which must have been previously started by the xnpod_start_thread() service.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: possible.

References XNDORMANT, xnpod_schedule(), xnpod_suspend_thread(), and XNROOT.

4.8.2.21 void xnpod_suspend_thread (xnthread_t * *thread,* xnflags_t *mask,* xnticks_t *timeout,* xntmode_t *timeout_mode,* struct xnsynch * *wchan*)

Suspend a thread.

Suspends the execution of a thread according to a given suspensive condition. This thread will not be eligible for scheduling until it all the pending suspensive conditions set by this service are removed by one or more calls to xnpod_resume_thread().

Parameters

thread	The descriptor address of the suspended thread.
mask	The suspension mask specifying the suspensive condition to add to the thread's wait mask. Possible values usable by the caller are:

- XNSUSP. This flag forcibly suspends a thread, regardless of any resource to wait for. A reverse call to xnpod_resume_thread() specifying the XNSUSP bit must be issued to remove this condition, which is cumulative with other suspension bits.*wchan* should be NULL when using this suspending mode.
- XNDELAY. This flags denotes a counted delay wait (in ticks) which dura-

tion is defined by the value of the timeout parameter.

- XNPEND. This flag denotes a wait for a synchronization object to be signaled. The wchan argument must points to this object. A timeout value can be passed to bound the wait. This suspending mode should not be used directly by the client interface, but rather through the xnsynch_sleep_on() call.

Parameters

timeout	The timeout which may be used to limit the time the thread pends on a resource. This value is a wait time given in ticks (see note). It can either be relative, absolute monotonic, or absolute adjustable depending on *timeout_mode*. Passing XN_INFINITE **and** setting *timeout_mode* to XN_RELATIVE specifies an unbounded wait. All other values are used to initialize a watchdog timer. If the current operation mode of the system timer is oneshot and *timeout* elapses before xnpod_suspend_thread() has completed, then the target thread will not be suspended, and this routine leads to a null effect.
timeout_mode	The mode of the *timeout* parameter. It can either be set to XN_RELATIVE, XN_ABSOLUTE, or XN_REALTIME (see also xntimer_start()).
wchan	The address of a pended resource. This parameter is used internally by the synchronization object implementation code to specify on which object the suspended thread pends. NULL is a legitimate value when this parameter does not apply to the current suspending mode (e.g. XNSUSP).

Note

> If the target thread is a shadow which has received a Linux-originated signal, then this service immediately exits without suspending the thread, but raises the XNBREAK condition in its information mask.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: possible if the current thread suspends itself.

Note

> The *timeout* value will be interpreted as jiffies if *thread* is bound to a periodic time base (see xnpod_init_thread), or nanoseconds otherwise.

References xnsched::curr, XNBREAK, XNDELAY, XNDORMANT, XNHELD, -XNKICKED, xnpod_schedule(), XNREADY, XNRELAX, XNRMID, XNROBBED, XNROOT, XNSHADOW, XNSUSP, xnsynch_forget_sleeper(), XNTIMEO, xntimer_start(), and XNWAKEN.

Referenced by xnpod_abort_thread(), xnpod_init_thread(), xnpod_set_thread_periodic(), xnpod_stop_thread(), xnpod_trap_fault(), xnpod_wait_thread_period(), xnshadow_map(), xnshadow_relax(), xnsynch_acquire(), and xnsynch_sleep_on().

4.8.2.22 void **xnpod_trap_fault** (xnarch_fltinfo_t * *fltinfo*)

Default fault handler.

This is the default handler which is called whenever an uncontrolled exception or fault is caught. If the fault is caught on behalf of a real-time thread, the fault is not propagated to the host system. Otherwise, the fault is unhandled by the nucleus and simply propagated.

Parameters

fltinfo	An opaque pointer to the arch-specific buffer describing the fault. The actual layout is defined by the xnarch_fltinfo_t type in each arch-dependent layer file.

References xnpod_suspend_thread(), xnshadow_relax(), and XNSUSP.

4.8.2.23 int **xnpod_unblock_thread** (xnthread_t * *thread*)

Unblock a thread.

Breaks the thread out of any wait it is currently in. This call removes the XNDELAY and XNPEND suspensive conditions previously put by xnpod_suspend_thread() on the target thread. If all suspensive conditions are gone, the thread is left in a READY state at which point it becomes eligible anew for scheduling.

Parameters

thread	The descriptor address of the unblocked thread.

This call neither releases the thread from the XNSUSP, XNRELAX, XNDORMANT or XNHELD suspensive conditions.

When the thread resumes execution, the XNBREAK bit is set in the unblocked thread's information mask. Unblocking a non-blocked thread is perfectly harmless.

Returns

non-zero is returned if the thread was actually unblocked from a pending wait state, 0 otherwise.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

References XNBREAK, XNDELAY, XNPEND, and xnpod_resume_thread().

Referenced by xnpod_delete_thread(), and xnshadow_mark_sig().

4.8.2.24 int xnpod_wait_thread_period (unsigned long * *overruns_r*)

Wait for the next periodic release point.

Make the current thread wait for the next periodic release point in the processor time line.

Parameters

overruns_r	If non-NULL, *overruns_r* must be a pointer to a memory location which will be written with the count of pending overruns. This value is copied only when xnpod_wait_thread_period() returns -ETIMEDOUT or success; the memory location remains unmodified otherwise. If NULL, this count will never be copied back.

Returns

0 is returned upon success; if *overruns_r* is valid, zero is copied to the pointed memory location. Otherwise:

- -EWOULDBLOCK is returned if xnpod_set_thread_periodic() has not previously been called for the calling thread.
- -EINTR is returned if xnpod_unblock_thread() has been called for the waiting thread before the next periodic release point has been reached. In this case, the overrun counter is reset too.
- -ETIMEDOUT is returned if the timer has overrun, which indicates that one or more previous release points have been missed by the calling

thread. If *overruns_r* is valid, the count of pending overruns is copied to the pointed memory location.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: always, unless the current release point has already been reached. In the latter case, the current thread immediately returns from this service without being delayed.

References XNBREAK, XNDELAY, xnpod_suspend_thread(), and xntimer_get_overruns().

4.8.2.25 void **xnpod_welcome_thread** (xnthread_t * *thread,* int *imask*)

Thread prologue.

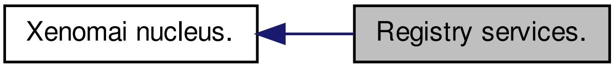
This internal routine is called on behalf of a (re)starting thread's prologue before the user entry point is invoked. This call is reserved for internal housekeeping chores and cannot be inlined.

Entered with nklock locked, irqs off.

References XNLOCK, xnpod_dispatch_signals(), and XNRESTART.

4.9 Registry services.

Collaboration diagram for Registry services.:



Files

- file registry.h

  This file is part of the Xenomai project.
- file registry.c

  This file is part of the Xenomai project.

Functions

- int xnregistry_enter (const char ∗key, void ∗objaddr, xnhandle_t ∗phandle, xnpnode_t ∗pnode)

  Register a real-time object.
- int xnregistry_bind (const char ∗key, xnticks_t timeout, int timeout_mode, xnhandle_t ∗phandle)

  Bind to a real-time object.
- int xnregistry_remove (xnhandle_t handle)

  Forcibly unregister a real-time object.
- int xnregistry_remove_safe (xnhandle_t handle, xnticks_t timeout)

  Unregister an idle real-time object.
- void ∗ xnregistry_get (xnhandle_t handle)

  Find and lock a real-time object into the registry.
- u_long xnregistry_put (xnhandle_t handle)

  Unlock a real-time object from the registry.
- void ∗ xnregistry_fetch (xnhandle_t handle)

  Find a real-time object into the registry.

4.9.1 Detailed Description

The registry provides a mean to index real-time object descriptors created by Xenomai skins on unique alphanumeric keys. When labeled this way, a real-time object is globally exported; it can be searched for, and its descriptor returned to the caller for further use; the latter operation is called a "binding". When no object has been registered under the given name yet, the registry can be asked to set up a rendez-vous, blocking the caller until the object is eventually registered.

4.9.2 Function Documentation

4.9.2.1 int **xnregistry_bind** (const char * *key*, xnticks_t *timeout*, int *timeout_mode*, xnhandle_t * *phandle*)

Bind to a real-time object.

This service retrieves the registry handle of a given object identified by its key. Unless otherwise specified, this service will block the caller if the object is not registered yet, waiting for such registration to occur.

Parameters

key	A valid NULL-terminated string which identifies the object to bind to.
timeout	The timeout which may be used to limit the time the thread wait for the object to be registered. This value is a wait time given in ticks (see note). It can either be relative, absolute monotonic (XN_ABSOLUTE), or absolute adjustable (XN_REALTIME) depending on *timeout_mode*. Passing XN_INFINITE **and** setting *timeout_mode* to XN_RELATIVE specifies an unbounded wait. Passing XN_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry. All other values are used as a wait limit.
timeout_-mode	The mode of the *timeout* parameter. It can either be set to -XN_RELATIVE, XN_ABSOLUTE, or XN_REALTIME (see also xntimer_start()).
phandle	A pointer to a memory location which will be written upon success with the generic handle defined by the registry for the retrieved object. Contents of this memory is undefined upon failure.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if *key* is NULL.
- -EINTR is returned if xnpod_unblock_thread() has been called for the waiting thread before the retrieval has completed.

- -EWOULDBLOCK is returned if *timeout* is equal to XN_NONBLOCK and the searched object is not registered on entry. As a special exception, this error is also returned if this service should block, but was called from a context which cannot sleep (e.g. interrupt, non-realtime or scheduler locked).

- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine only if *timeout* is equal to XN_NONBLOCK.
- Kernel-based thread.

Rescheduling: always unless the request is immediately satisfied or *timeout* specifies a non-blocking operation.

Note

> The *timeout* value will be interpreted as jiffies if *thread* is bound to a periodic time base (see xnpod_init_thread), or nanoseconds otherwise.

References XNBREAK, xnsynch_sleep_on(), xntbase_get_time(), and XNTIMEO.

4.9.2.2 int **xnregistry_enter** (const char * *key,* void * *objaddr,* xnhandle_t * *phandle,* xnpnode_t * *pnode*)

Register a real-time object.

This service allocates a new registry slot for an associated object, and indexes it by an alphanumeric key for later retrieval.

Parameters

key	A valid NULL-terminated string by which the object will be indexed and later retrieved in the registry. Since it is assumed that such key is stored into the registered object, it will *not* be copied but only kept by reference in the registry. Pass an empty string if the object shall only occupy a registry slot for handle-based lookups.
objaddr	An opaque pointer to the object to index by *key*.
phandle	A pointer to a generic handle defined by the registry which will uniquely identify the indexed object, until the latter is unregistered using the xnregistry_remove() service.

pnode	A pointer to an optional /proc node class descriptor. This structure provides the information needed to export all objects from the given class through the /proc filesystem, under the /proc/xenomai/registry entry. Passing NULL indicates that no /proc support is available for the newly registered object.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if *objaddr* are NULL, or if *key* constains an invalid '/' character.
- -ENOMEM is returned if the system fails to get enough dynamic memory from the global real-time heap in order to register the object.
- -EEXIST is returned if the *key* is already in use.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based thread

Rescheduling: possible.

References xnpod_schedule(), and xnsynch_init().

4.9.2.3 void* xnregistry_fetch (xnhandle_t *handle*)

Find a real-time object into the registry.

This service retrieves an object from its handle into the registry and returns the memory address of its descriptor.

Parameters

handle	The generic handle of the object to fetch. If XNOBJECT_SELF is passed, the object is the calling Xenomai thread.

Returns

The memory address of the object's descriptor is returned on success. - Otherwise, NULL is returned if *handle* does not reference a registered object, or if *handle* is equal to XNOBJECT_SELF but the current context is not a real-time thread.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine only if *handle* is different from XNOBJECT_SELF.
- Kernel-based thread

Rescheduling: never.

4.9.2.4 void* xnregistry_get (xnhandle_t *handle*)

Find and lock a real-time object into the registry.

This service retrieves an object from its handle into the registry and prevents it removal atomically. A locking count is tracked, so that xnregistry_get() and xnregistry_put() must be used in pair.

Parameters

handle	The generic handle of the object to find and lock. If XNOBJECT_SELF is passed, the object is the calling Xenomai thread.

Returns

The memory address of the object's descriptor is returned on success. - Otherwise, NULL is returned if *handle* does not reference a registered object, or if *handle* is equal to XNOBJECT_SELF but the current context is not a real-time thread.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine only if *handle* is different from XNOBJECT_SELF.
- Kernel-based thread.

Rescheduling: never.

4.9.2.5 u_long xnregistry_put (xnhandle_t *handle*)

Unlock a real-time object from the registry.

This service decrements the lock count of a registered object previously locked by a call to xnregistry_get(). The object is actually unlocked from the registry when the locking count falls down to zero, thus waking up any thread currently blocked on xnregistry_remove() for unregistering it.

Parameters

handle	The generic handle of the object to unlock. If XNOBJECT_SELF is passed, the object is the calling Xenomai thread.

Returns

The decremented lock count is returned upon success. Zero is also returned if *handle* does not reference a registered object, or if *handle* is equal to XNOBJECT_SELF but the current context is not a real-time thread.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine only if *handle* is different from XNOBJECT_SELF.
- Kernel-based thread

Rescheduling: possible if the lock count falls down to zero and some thread is currently waiting for the object to be unlocked.

References xnpod_schedule(), and xnsynch_flush().

4.9.2.6 int **xnregistry_remove** (xnhandle_t *handle*)

Forcibly unregister a real-time object.

This service forcibly removes an object from the registry. The removal is performed regardless of the current object's locking status.

Parameters

handle	The generic handle of the object to remove.

Returns

0 is returned upon success. Otherwise:

- -ESRCH is returned if *handle* does not reference a registered object.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based thread

Rescheduling: never.

Referenced by xnregistry_remove_safe().

4.9.2.7 int **xnregistry_remove_safe** (xnhandle_t *handle*, xnticks_t *timeout*)

Unregister an idle real-time object.

This service removes an object from the registry. The caller might sleep as a result of waiting for the target object to be unlocked prior to the removal (see xnregistry_put()).

Parameters

handle	The generic handle of the object to remove.
timeout	If the object is locked on entry, *param* gives the number of clock ticks to wait for the unlocking to occur (see note). Passing XN-_INFINITE causes the caller to block indefinitely until the object is unlocked. Passing XN_NONBLOCK causes the service to return immediately without waiting if the object is locked on entry.

Returns

0 is returned upon success. Otherwise:

- -ESRCH is returned if *handle* does not reference a registered object.
- -EWOULDBLOCK is returned if *timeout* is equal to XN_NONBLOCK and the object is locked on entry.
- -EBUSY is returned if *handle* refers to a locked object and the caller could not sleep until it is unlocked.
- -ETIMEDOUT is returned if the object cannot be removed within the specified amount of time.
- -EINTR is returned if xnpod_unblock_thread() has been called for the calling thread waiting for the object to be unlocked.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine only if *timeout* is equal to XN_NONBLOCK.
- Kernel-based thread.

Rescheduling: possible if the object to remove is currently locked and the calling context can sleep.

Note

> The *timeout* value will be interpreted as jiffies if the current thread is bound to a periodic time base (see xnpod_init_thread), or nanoseconds otherwise.

References XNBREAK, xnregistry_remove(), xnsynch_sleep_on(), and XNTIMEO.

4.10 File descriptors events multiplexing services.

Collaboration diagram for File descriptors events multiplexing services.:

Xenomai nucleus.
File descriptors events multiplexing services.

Files

- file select.h

  file descriptors events multiplexing header.
- file select.c

  file descriptors events multiplexing.

Functions

- void xnselect_init (struct xnselect *select_block)

  Initialize a struct xnselect structure.
- int xnselect_bind (struct xnselect *select_block, struct xnselect_binding *binding, struct xnselector *selector, unsigned type, unsigned index, unsigned state)

  Bind a file descriptor (represented by its xnselect structure) to a selector block.
- void xnselect_destroy (struct xnselect *select_block)

  Destroy the xnselect structure associated with a file descriptor.
- int xnselector_init (struct xnselector *selector)

  Initialize a selector structure.
- int xnselect (struct xnselector *selector, fd_set *out_fds[XNSELECT_MAX_TYPES], fd_set *in_fds[XNSELECT_MAX_TYPES], int nfds, xnticks_t timeout, xntmode_t timeout_mode)

  Check the state of a number of file descriptors, wait for a state change if no descriptor is ready.
- void xnselector_destroy (struct xnselector *selector)

  Destroy a selector block.

4.10.1 Detailed Description

File descriptors events multiplexing services.

This module implements the services needed for implementing the posix "select" service, or any other events multiplexing services.

Following the implementation of the posix select service, this module defines three types of events:

- *XNSELECT_READ* meaning that a file descriptor is ready for reading;
- *XNSELECT_WRITE* meaning that a file descriptor is ready for writing;
- *XNSELECT_EXCEPT* meaning that a file descriptor received an exceptional event.

It works by defining two structures:

- a *struct xnselect* structure, which should be added to every file descriptor for every event type (read, write, or except);
- a *struct xnselector* structure, the selection structure, passed by the thread calling the xnselect service, where this service does all its housekeeping.

4.10.2 Function Documentation

4.10.2.1 int **xnselect** (struct xnselector * *selector*, fd_set * *out_fds[XNSELECT_MAX_TYPES]*, fd_set * *in_fds[XNSELECT_MAX_TYPES]*, int *nfds*, xnticks_t *timeout*, xntmode_t *timeout_mode*)

Check the state of a number of file descriptors, wait for a state change if no descriptor is ready.

Parameters

selector	structure to check for pending events
out_fds	The set of descriptors with pending events if a strictly positive number is returned, or the set of descriptors not yet bound if -ECHRNG is returned;
in_fds	the set of descriptors which events should be checked
nfds	the highest-numbered descriptor in any of the *in_fds* sets, plus 1;
timeout	the timeout, whose meaning depends on *timeout_mode*, note that xnselect() pass *timeout* and *timeout_mode* unchanged to xnsynch_sleep_on, so passing a relative value different from -XN_INFINITE as a timeout with *timeout_mode* set to XN_RELATIVE, will cause a longer sleep than expected if the sleep is interrupted.
timeout_mode	the mode of *timeout*.

Return values

-EINVAL	if *nfds* is negative;
-ECHRNG	if some of the descriptors passed in *in_fds* have not yet been registered with xnselect_bind(), *out_fds* contains the set of such descriptors;
-EINTR	if *xnselect* was interrupted while waiting;
0	in case of timeout.
the	number of file descriptors having received an event.

References XNBREAK, xnsynch_sleep_on(), and XNTIMEO.

4.10.2.2 int xnselect_bind (struct xnselect * *select_block,* struct xnselect_binding * *binding,* struct xnselector * *selector,* unsigned *type,* unsigned *index,* unsigned *state*)

Bind a file descriptor (represented by its *xnselect* structure) to a selector block.

Parameters

select_-block	pointer to the *struct xnselect* to be bound;
binding	pointer to a newly allocated (using xnmalloc) *struct xnselect_-binding*;
selector	pointer to the selector structure;
type	type of events (*XNSELECT_READ*, *XNSELECT_WRITE*, or *X-NSELECT_EXCEPT*);
index	index of the file descriptor (represented by *select_block*) in the bit fields used by the *selector* structure;
state	current state of the file descriptor>.

select_block must have been initialized with xnselect_init(), the *xnselector* structure must have been initialized with xnselector_init(), *binding* may be uninitialized.

This service must be called with nklock locked, irqs off. For this reason, the *binding* parameter must have been allocated by the caller outside the locking section.

Return values

-EINVAL	if *type* or *index* is invalid;
0	otherwise.

References xnpod_schedule().

4.10.2.3 void xnselect_destroy (struct xnselect * *select_block*)

Destroy the *xnselect* structure associated with a file descriptor.

Any binding with a *xnselector* block is destroyed.

Parameters

select_-block	pointer to the *xnselect* structure associated with a file descriptor

References xnpod_schedule().

4.10.2.4 void **xnselect_init** (struct **xnselect** * *select_block*)

Initialize a *struct xnselect* structure.

This service must be called to initialize a *struct xnselect* structure before it is bound to a selector by the means of xnselect_bind().

Parameters

select_-block	pointer to the xnselect structure to be initialized

4.10.2.5 void **xnselector_destroy** (struct xnselector * *selector*)

Destroy a selector block.

All bindings with file descriptor are destroyed.

Parameters

selector	the selector block to be destroyed

Referenced by xnpod_delete_thread().

4.10.2.6 int **xnselector_init** (struct xnselector * *selector*)

Initialize a selector structure.

Parameters

selector	The selector structure to be initialized.

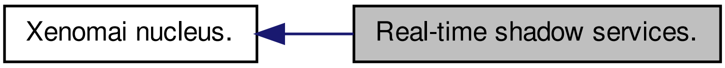
Return values

0	

References xnsynch_init().

4.11 Real-time shadow services.

Collaboration diagram for Real-time shadow services.:



Files

- file shadow.c

  Real-time shadow services.

Functions

- int xnshadow_mark_sig (xnthread_t *thread, unsigned muxid)

  Mark the per-thread per-skin signal condition for the skin whose muxid is muxid.

- void xnshadow_clear_sig (xnthread_t *thread, unsigned muxid)

  Clear the per-thrad per-skin signal condition.

- int xnshadow_harden (void)

  Migrate a Linux task to the Xenomai domain.

- void xnshadow_relax (int notify, int reason)

  Switch a shadow thread back to the Linux domain.

- int xnshadow_map (xnthread_t *thread, xncompletion_t __user *u_completion, unsigned long __user *u_mode)

  Create a shadow thread context.

- xnshadow_ppd_t * xnshadow_ppd_get (unsigned muxid)

  Return the per-process data attached to the calling process.

4.11.1 Detailed Description

Real-time shadow services.

4.11.2 Function Documentation

4.11.2.1 void xnshadow_clear_sig (xnthread_t * *thread*, unsigned *muxid*)

Clear the per-thrad per-skin signal condition.

Called with nklock locked irqs off.

Parameters

thread	the target thrad
muxid	

4.11.2.2 int xnshadow_harden (void)

Migrate a Linux task to the Xenomai domain.

This service causes the transition of "current" from the Linux domain to -Xenomai. This is obtained by asking the gatekeeper to resume the shadow mated with "current" then triggering the rescheduling procedure in the Xenomai domain. The shadow will resume in the Xenomai domain as returning from schedule().

Environments:

This service can be called from:

- User-space thread operating in secondary (i.e. relaxed) mode.

Rescheduling: always.

References XNATOMIC, and xnpod_dispatch_signals().

Referenced by xnshadow_map().

4.11.2.3 int xnshadow_map (xnthread_t * *thread*, xncompletion_t __user * *u_completion*, unsigned long __user * *u_mode*)

Create a shadow thread context.

This call maps a nucleus thread to the "current" Linux task. The priority and scheduling class of the underlying Linux task are not affected; it is assumed that the interface library did set them appropriately before issuing the shadow mapping request.

Parameters

thread	The descriptor address of the new shadow thread to be mapped to "current". This descriptor must have been previously initialized by a call to xnpod_init_thread().

u_-completion	is the address of an optional completion descriptor aimed at synchronizing our parent thread with us. If non-NULL, the information xnshadow_map() will store into the completion block will be later used to wake up the parent thread when the current shadow has been initialized. In the latter case, the new shadow thread is left in a dormant state (XNDORMANT) after its creation, leading to the suspension of "current" in the Linux domain, only processing signals. Otherwise, the shadow thread is immediately started and "current" immediately resumes in the Xenomai domain from this service.
	u_mode is the address of a mode variable in user space that will reflect the current thread mode (primary or secondary). - The nucleus will try to update the variable before switching to secondary or after switching from primary mode.

Returns

0 is returned on success. Otherwise:

- -ERESTARTSYS is returned if the current Linux task has received a signal, thus preventing the final migration to the Xenomai domain (i.e. in order to process the signal in the Linux domain). This error should not be considered as fatal.

- -EPERM is returned if the shadow thread has been killed before the current task had a chance to return to the caller. In such a case, the real-time mapping operation has failed globally, and no Xenomai resource remains attached to it.

- -EINVAL is returned if the thread control block does not bear the XNSHADOW bit.

- -EBUSY is returned if either the current Linux task or the associated shadow thread is already involved in a shadow mapping.

Environments:

This service can be called from:

- Regular user-space process.

Rescheduling: always.

References XNMAPPED, xnpod_start_thread(), xnpod_suspend_thread(), XNPRIOSET, XNRELAX, XNSHADOW, and xnshadow_harden().

4.11.2.4 int xnshadow_mark_sig (xnthread_t * *thread,* unsigned *muxid*)

Mark the per-thread per-skin signal condition for the skin whose muxid is *muxid*.

Parameters

thread	the target thread;
muxid	the muxid of the skin for which the signal is marked pending.

Returns

whether rescheduling is needed.

References XNMAPPED, and xnpod_unblock_thread().

4.11.2.5 xnshadow_ppd_t* xnshadow_ppd_get (unsigned *muxid*)

Return the per-process data attached to the calling process.

This service returns the per-process data attached to the calling process for the skin whose muxid is *muxid*. It must be called with nklock locked, irqs off.

See xnshadow_register_interface() documentation for information on the way to attach a per-process data to a process.

Parameters

muxid	the skin muxid.

Returns

the per-process data if the current context is a user-space process;
NULL otherwise.

4.11.2.6 void xnshadow_relax (int *notify,* int *reason*)

Switch a shadow thread back to the Linux domain.

This service yields the control of the running shadow back to Linux. This is obtained by suspending the shadow and scheduling a wake up call for the mated user task inside the Linux domain. The Linux task will resume on return from xnpod_suspend_thread() on behalf of the root thread.

Parameters

notify	A boolean flag indicating whether threads monitored from secondary mode switches should be sent a SIGDEBUG signal. For instance, some internal operations like task exit should not trigger such signal.
reason	The reason to report along with the SIGDEBUG signal.

Environments:

This service can be called from:

- User-space thread operating in primary (i.e. harden) mode.

Rescheduling: always.

Note

> "current" is valid here since the shadow runs with the properties of the Linux task.

References XNAFFSET, xnpod_suspend_thread(), XNPRIOSET, XNRELAX, XNROOT, and XNTRAPSW.

Referenced by xnpod_trap_fault().

4.12 Thread synchronization services.

Collaboration diagram for Thread synchronization services.:

Xenomai nucleus.
Thread synchronization services.

Files

- file synch.c

  Thread synchronization services.

Functions

- void xnsynch_init (struct xnsynch *synch, xnflags_t flags, xnarch_atomic_t *fastlock)

  Initialize a synchronization object.
- xnflags_t xnsynch_sleep_on (struct xnsynch *synch, xnticks_t timeout, xntmode_t timeout_mode)

  Sleep on an ownerless synchronization object.
- struct xnthread * xnsynch_wakeup_one_sleeper (struct xnsynch *synch)

  Give the resource ownership to the next waiting thread.
- struct xnpholder * xnsynch_wakeup_this_sleeper (struct xnsynch *synch, struct xnpholder *holder)

  Give the resource ownership to a given waiting thread.
- xnflags_t xnsynch_acquire (struct xnsynch *synch, xnticks_t timeout, xntmode_t timeout_mode)

  Acquire the ownership of a synchronization object.
- static void xnsynch_clear_boost (struct xnsynch *synch, struct xnthread *owner)

  Clear the priority boost.
- void xnsynch_requeue_sleeper (struct xnthread *thread)

  Change a sleeper's priority.
- struct xnthread * xnsynch_release (struct xnsynch *synch)

  Give the resource ownership to the next waiting thread.
- struct xnthread * xnsynch_peek_pendq (struct xnsynch *synch)

Access the thread leading a synch object wait queue.

- int xnsynch_flush (struct xnsynch ∗synch, xnflags_t reason)

  Unblock all waiters pending on a resource.
- void xnsynch_forget_sleeper (struct xnthread ∗thread)

  Abort a wait for a resource.
- void xnsynch_release_all_ownerships (struct xnthread ∗thread)

  Release all ownerships.

4.12.1 Detailed Description

Thread synchronization services.

4.12.2 Function Documentation

4.12.2.1 xnflags_t **xnsynch_acquire** (struct xnsynch ∗ *synch*, xnticks_t *timeout*, xntmode_t *timeout_mode*)

Acquire the ownership of a synchronization object.

This service should be called by upper interfaces wanting the current thread to acquire the ownership of the given resource. If the resource is already assigned to a thread, the caller is suspended.

This service must be used only with synchronization objects that track ownership (XNSYNCH_OWNER set.

Parameters

synch	The descriptor address of the synchronization object to acquire.
timeout	The timeout which may be used to limit the time the thread pends on the resource. This value is a wait time given in ticks (see note). It can either be relative, absolute monotonic, or absolute adjustable depending on *timeout_mode*. Passing XN_INFINITE **and** setting *mode* to XN_RELATIVE specifies an unbounded wait. All other values are used to initialize a watchdog timer.
timeout_-mode	The mode of the *timeout* parameter. It can either be set to -XN_RELATIVE, XN_ABSOLUTE, or XN_REALTIME (see also xntimer_start()).

Returns

A bitmask which may include zero or one information bit among XNRMID, XNTIMEO and XNBREAK, which should be tested by the caller, for detecting respectively: object deletion, timeout or signal/unblock conditions which might have happened while waiting.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: possible.

Note

> The *timeout* value will be interpreted as jiffies if the current thread is bound to a periodic time base (see xnpod_init_thread), or nanoseconds otherwise.

References XNBOOST, XNBREAK, XNPEND, xnpod_suspend_thread(), XNRMID, XNROBBED, XNTIMEO, and XNWAKEN.

4.12.2.2 void **xnsynch_clear_boost** (struct xnsynch * *synch,* struct xnthread * *owner*) `[static]`

Clear the priority boost.

This service is called internally whenever a synchronization object is not claimed anymore by sleepers to reset the object owner's priority to its initial level.

Parameters

synch	The descriptor address of the synchronization object.
owner	The descriptor address of the thread which currently owns the synchronization object.

Note

> This routine must be entered nklock locked, interrupts off.

References XNBOOST.

Referenced by xnsynch_flush(), xnsynch_forget_sleeper(), and xnsynch_-release().

4.12.2.3 int **xnsynch_flush** (struct xnsynch * *synch,* xnflags_t *reason*)

Unblock all waiters pending on a resource.

This service atomically releases all threads which currently sleep on a given resource.

This service should be called by upper interfaces under circumstances requiring that the pending queue of a given resource is cleared, such as before the resource is deleted.

Parameters

synch	The descriptor address of the synchronization object to be flushed.
reason	Some flags to set in the information mask of every unblocked thread. Zero is an acceptable value. The following bits are pre-defined by the nucleus:

- XNRMID should be set to indicate that the synchronization object is about to be destroyed (see xnpod_resume_thread()).

- XNBREAK should be set to indicate that the wait has been forcibly interrupted (see xnpod_unblock_thread()).

Returns

> XNSYNCH_RESCHED is returned if at least one thread is unblocked, which means the caller should invoke xnpod_schedule() for applying the new scheduling state. Otherwise, XNSYNCH_DONE is returned.

Side-effects:

- The effective priority of the previous resource owner might be lowered to its base priority value as a consequence of the priority inheritance boost being cleared.

- The synchronization object is no more owned by any thread.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

References XNPEND, xnpod_resume_thread(), and xnsynch_clear_boost().

Referenced by xnregistry_put().

4.12.2.4 void **xnsynch_forget_sleeper** (struct xnthread * *thread*)

Abort a wait for a resource.

Performs all the necessary housekeeping chores to stop a thread from waiting on a given synchronization object.

Parameters

thread	The descriptor address of the affected thread.

When the trace support is enabled (i.e. MVM), the idle state is posted to the synchronization object's state diagram (if any) whenever no thread remains blocked on it. The real-time interfaces must ensure that such condition (i.e. EMPTY/IDLE) is mapped to state #0.

Note

> This routine must be entered nklock locked, interrupts off.

References XNPEND, and xnsynch_clear_boost().

Referenced by xnpod_delete_thread(), xnpod_resume_thread(), and xnpod_-suspend_thread().

4.12.2.5 void **xnsynch_init** (struct xnsynch * *synch*, xnflags_t *flags*, xnarch_atomic_t * *fastlock*)

Initialize a synchronization object.

Initializes a new specialized object which can subsequently be used to synchronize real-time activities. The Xenomai nucleus provides a basic synchronization object which can be used to build higher resource objects. Nucleus threads can wait for and signal such objects in order to synchronize their activities.

This object has built-in support for priority inheritance.

Parameters

synch	The address of a synchronization object descriptor the nucleus will use to store the object-specific data. This descriptor must always be valid while the object is active therefore it must be allocated in permanent memory.
flags	A set of creation flags affecting the operation. The valid flags are:

- XNSYNCH_PRIO causes the threads waiting for the resource to pend in priority order. Otherwise, FIFO ordering is used (XNSYNCH_FIFO).

- XNSYNCH_OWNER indicates that the synchronization object shall track its owning thread (required if XNSYNCH_PIP is selected). Note that setting this flag implies the use xnsynch_acquire and xnsynch_release instead of xnsynch_sleep_on and xnsynch_wakeup_one_sleeper/xnsynch_wakeup_this_sleeper.

- XNSYNCH_PIP causes the priority inheritance mechanism to be automatically activated when a priority inversion is detected among threads using this object. Otherwise, no priority inheritance takes place upon priority inversion (XNSYNCH_NOPIP).
- XNSYNCH_DREORD (Disable REORDering) tells the nucleus that the wait queue should not be reordered whenever the priority of a blocked thread it holds is changed. If this flag is not specified, changing the priority of a blocked thread using xnpod_set_thread_schedparam() will cause this object's wait queue to be reordered according to the new priority level, provided the synchronization object makes the waiters wait by priority order on the awaited resource (XNSYNCH_PRIO).

Parameters

fastlock	Address of the fast lock word to be associated with the synchronization object. If NULL is passed or XNSYNCH_OWNER is not set, fast-lock support is disabled.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: never.

Referenced by xnregistry_enter(), and xnselector_init().

4.12.2.6 struct xnthread* **xnsynch_peek_pendq** (struct xnsynch * *synch*) [read]

Access the thread leading a synch object wait queue.

This services returns the descriptor address of to the thread leading a synchronization object wait queue.

Parameters

synch	The descriptor address of the target synchronization object.

Returns

The descriptor address of the unblocked thread.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

4.12.2.7 struct xnthread* xnsynch_release (struct xnsynch * *synch*) [read]

Give the resource ownership to the next waiting thread.

This service releases the ownership of the given synchronization object. The thread which is currently leading the object's pending list, if any, is unblocked from its pending state. However, no reschedule is performed.

This service must be used only with synchronization objects that track ownership (XNSYNCH_OWNER set).

Parameters

synch	The descriptor address of the synchronization object whose ownership is changed.

Returns

The descriptor address of the unblocked thread.

Side-effects:

- The effective priority of the previous resource owner might be lowered to its base priority value as a consequence of the priority inheritance boost being cleared.
- The synchronization object ownership is transfered to the unblocked thread.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

References XNPEND, xnpod_resume_thread(), xnsynch_clear_boost(), and -XNWAKEN.

Referenced by xnsynch_release_all_ownerships().

4.12.2.8 void **xnsynch_release_all_ownerships** (struct xnthread * *thread*)

Release all ownerships.

This call is used internally to release all the ownerships obtained by a thread on synchronization objects. This routine must be entered interrupts off.

Parameters

thread	The descriptor address of the affected thread.

Note

This routine must be entered nklock locked, interrupts off.

References xnsynch_release().

Referenced by xnpod_delete_thread().

4.12.2.9 void **xnsynch_requeue_sleeper** (struct xnthread * *thread*)

Change a sleeper's priority.

This service is used by the PIP code to update the pending priority of a sleeping thread.

Parameters

thread	The descriptor address of the affected thread.

Note

This routine must be entered nklock locked, interrupts off.

References XNBOOST.

4.12.2.10 xnflags_t xnsynch_sleep_on (struct xnsynch * *synch*, xnticks_t *timeout*, xntmode_t *timeout_mode*)

Sleep on an ownerless synchronization object.

Makes the calling thread sleep on the specified synchronization object, waiting for it to be signaled.

This service should be called by upper interfaces wanting the current thread to pend on the given resource. It must not be used with synchronization objects that are supposed to track ownership (XNSYNCH_OWNER).

Parameters

synch	The descriptor address of the synchronization object to sleep on.
timeout	The timeout which may be used to limit the time the thread pends on the resource. This value is a wait time given in ticks (see note). It can either be relative, absolute monotonic, or absolute adjustable depending on *timeout_mode*. Passing XN_INFINITE **and** setting *mode* to XN_RELATIVE specifies an unbounded wait. All other values are used to initialize a watchdog timer.
timeout_mode	The mode of the *timeout* parameter. It can either be set to XN_RELATIVE, XN_ABSOLUTE, or XN_REALTIME (see also xntimer_start()).

Returns

A bitmask which may include zero or one information bit among XNRMID, XNTIMEO and XNBREAK, which should be tested by the caller, for detecting respectively: object deletion, timeout or signal/unblock conditions which might have happened while waiting.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task

Rescheduling: always.

Note

The *timeout* value will be interpreted as jiffies if the current thread is bound to a periodic time base (see xnpod_init_thread), or nanoseconds otherwise.

References XNBREAK, XNPEND, xnpod_suspend_thread(), XNRMID, and XNTIMEO.

Referenced by xnregistry_bind(), xnregistry_remove_safe(), and xnselect().

4.12.2.11 struct xnthread* xnsynch_wakeup_one_sleeper (struct xnsynch * *synch*) [read]

Give the resource ownership to the next waiting thread.

This service wakes up the thread which is currently leading the synchronization object's pending list. The sleeping thread is unblocked from its pending state, but no reschedule is performed.

This service should be called by upper interfaces wanting to signal the given resource so that a single waiter is resumed. It must not be used with synchronization objects that are supposed to track ownership (XNSYNCH_OWNER not set).

Parameters

synch	The descriptor address of the synchronization object whose ownership is changed.

Returns

The descriptor address of the unblocked thread.

Side-effects:

- The effective priority of the previous resource owner might be lowered to its base priority value as a consequence of the priority inheritance boost being cleared.

- The synchronization object ownership is transfered to the unblocked thread.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

References XNPEND, and xnpod_resume_thread().

4.12.2.12 struct xnpholder* xnsynch_wakeup_this_sleeper (struct xnsynch * *synch*, struct xnpholder * *holder*) [read]

Give the resource ownership to a given waiting thread.

This service wakes up a specific thread which is currently pending on the given synchronization object. The sleeping thread is unblocked from its pending state, but no reschedule is performed.

This service should be called by upper interfaces wanting to signal the given resource so that a specific waiter is resumed. It must not be used with synchronization objects that are supposed to track ownership (XNSYNCH_OWNER not set).

Parameters

synch	The descriptor address of the synchronization object whose ownership is changed.
holder	The link holder address of the thread to unblock (&thread->plink) which MUST be currently linked to the synchronization object's pending queue (i.e. synch->pendq).

Returns

The link address of the unblocked thread in the synchronization object's pending queue.

Side-effects:

- The effective priority of the previous resource owner might be lowered to its base priority value as a consequence of the priority inheritance boost being cleared.
- The synchronization object ownership is transfered to the unblocked thread.

Environments:

This service can be called from:

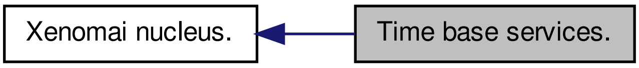
- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

References XNPEND, and xnpod_resume_thread().

4.13 Time base services.

Collaboration diagram for Time base services.:



Files

- file timebase.h
- file timebase.c

Functions

- int xntbase_alloc (const char *name, u_long period, u_long flags, xntbase_t **basep)

  Allocate a time base.
- void xntbase_free (xntbase_t *base)

  Free a time base.
- int xntbase_update (xntbase_t *base, u_long period)

  Change the period of a time base.
- int xntbase_switch (const char *name, u_long period, xntbase_t **basep)

  Replace a time base.
- void xntbase_start (xntbase_t *base)

  Start a time base.
- void xntbase_stop (xntbase_t *base)

  Stop a time base.
- void xntbase_tick (xntbase_t *base)

  Announce a clock tick to a time base.
- xnticks_t xntbase_convert (xntbase_t *srcbase, xnticks_t ticks, xntbase_t *dstbase)

  Convert a clock value into another time base.
- static xnticks_t xntbase_get_time (xntbase_t *base)

  Get the clock time for a given time base.
- void xntbase_adjust_time (xntbase_t *base, xnsticks_t delta)

  Adjust the clock time for the system.

4.13.1 Detailed Description

Xenomai implements the notion of time base, by which software timers that belong to different skins may be clocked separately according to distinct frequencies, or aperiodically. In the periodic case, delays and timeouts are given in counts of ticks; the duration of a tick is specified by the time base. In the aperiodic case, timings are directly specified in nanoseconds.

Only a single aperiodic (i.e. tick-less) time base may exist in the system, and the nucleus provides for it through the nktbase object. All skins depending on aperiodic timings should bind to the latter (see xntbase_alloc()), also known as the master time base.

Skins depending on periodic timings may create and bind to their own time base. Such a periodic time base is managed as a timed slave object of the master time base. A cascading software timer fired by the master time base according to the appropriate frequency, triggers in turn the update process of the associated timed slave, which eventually fires the elapsed software timers controlled by the periodic time base. In other words, Xenomai emulates periodic timing over an aperiodic policy.

Xenomai always controls the underlying timer hardware in a tick-less fashion, also known as the oneshot mode.

4.13.2 Function Documentation

4.13.2.1 void **xntbase_adjust_time** (xntbase_t * *base*, xnsticks_t *delta*)

Adjust the clock time for the system.

Xenomai tracks the current time as a monotonously increasing count of ticks since the epoch. The epoch is initially the same as the underlying machine time, and it is always synchronised across all active time bases.

This service changes the epoch for the system by applying the specified tick delta on the master's wallclock offset and resynchronizing all other time bases.

Parameters

base	The address of the initiating time base.
delta	The adjustment of the system time expressed in ticks of the specified time base.

Note

> This routine must be entered nklock locked, interrupts off.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

4.13.2.2 int xntbase_alloc (const char * *name*, u_long *period*, u_long *flags*, xntbase_t ** *basep*)

Allocate a time base.

A time base is an abstraction used to provide private clocking information to real-time skins, by which they may operate either in aperiodic or periodic mode, possibly according to distinct clock frequencies in the latter case. This abstraction is required in order to support several RTOS emulators running concurrently, which may exhibit different clocking policies and/or period.

Once allocated, a time base may be attached to all software timers created directly or indirectly by a given skin, and influences all timed services accordingly.

The xntbase_alloc() service allocates a new time base to the caller, and returns the address of its descriptor. The new time base is left in a disabled state (unless *period* equals XN_APERIODIC_TICK), calling xntbase_start() is needed to enable it.

Parameters

name	The symbolic name of the new time base. This information is used to report status information when reading from /proc/xenomai/timebases; it has currently no other usage.
period	The duration of the clock tick for the new time base, given as a count of nanoseconds. The special *XN_APERIODIC_TICK* value may be used to retrieve the master - aperiodic - time base, which is always up and running when a real-time skin has called the xnpod_init() service. All other values are meant to define the clock rate of a periodic time base. For instance, passing 1000000 (ns) in the *period* parameter will create a periodic time base clocked at a frequency of 1Khz.
flags	A bitmask composed as follows:

- XNTBISO causes the target timebase to be isolated from global wallclock offset updates as performed by xntbase_adjust_time().

Parameters

basep	A pointer to a memory location which will be written upon success with the address of the allocated time base. If *period* equals XN_APERIODIC_TICK, the address of the built-in master time base descriptor will be copied back to this location.

Returns

0 is returned on success. Otherwise:

- -ENOMEM is returned if no system memory is available to allocate a new time base descriptor.

Environments:

This service can be called from:

- Kernel module initialization code
- User-space task in secondary mode

Rescheduling: never.

Note

Any periodic time base allocated by a real-time skin must be released by a call to xntbase_free() before the kernel module implementing the skin may be unloaded.

Referenced by xntbase_switch().

4.13.2.3 xnticks_t **xntbase_convert** (xntbase_t * *srcbase*, xnticks_t *ticks*, xntbase_t * *dstbase*)

Convert a clock value into another time base.

Parameters

srcbase	The descriptor address of the source time base.
ticks	The clock value expressed in the source time base to convert to the destination time base.
dstbase	The descriptor address of the destination time base.

Returns

The converted count of ticks in the destination time base is returned.

Environments:

This service can be called from:

- Kernel module initialization code
- Kernel-based task
- User-space task

Rescheduling: never.

4.13.2.4 void xntbase_free (xntbase_t * *base*)

Free a time base.

This service disarms all outstanding timers from the affected periodic time base, destroys the aperiodic cascading timer, then releases the time base descriptor.

Parameters

base	The address of the time base descriptor to release.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task in secondary mode

Rescheduling: never.

Note

> Requests to free the master time base are silently caught and discarded; in such a case, outstanding aperiodic timers are left untouched.

Referenced by xntbase_switch().

4.13.2.5 xnticks_t xntbase_get_time (xntbase_t * *base*) [inline, static]

Get the clock time for a given time base.

This service returns the (external) clock time as maintained by the specified time base. This value is adjusted with the wallclock offset as defined by xntbase_adjust_time().

Parameters

base	The address of the time base to query.

Returns

> The current time (in jiffies) if the specified time base runs in periodic mode, or the machine time (converted to nanoseconds) as maintained by the hardware if *base* refers to the master time base.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

Referenced by xnregistry_bind().

4.13.2.6 void **xntbase_start** (xntbase_t * *base*)

Start a time base.

This service enables a time base, using a cascading timer running in the master time base as the source of periodic clock ticks. The time base is synchronised on the Xenomai system clock. Timers attached to the started time base are immediated armed.

Parameters

base	The address of the time base descriptor to start.

Environments:

This service can be called from:

- Kernel module initialization code
- Kernel-based task
- User-space task

Rescheduling: never.

Note

> Requests to enable the master time base are silently caught and discarded; only the internal service xnpod_enable_timesource() is allowed to start the latter. The master time base remains enabled until no real-time skin remains attached to the nucleus.

Referenced by xntbase_switch().

4.13.2.7 void **xntbase_stop** (xntbase_t * *base*)

Stop a time base.

This service disables a time base, stopping the cascading timer running in the master time base which is used to clock it. Outstanding timers attached to the stopped time base are immediated disarmed.

Stopping a time base also invalidates its clock setting.

Parameters

base	The address of the time base descriptor to stop.

Environments:

This service can be called from:

- Kernel module initialization code
- Kernel-based task
- User-space task

Note

Requests to disable the master time base are silently caught and discarded; only the internal service xnpod_disable_timesource() is allowed to stop the latter. The master time base remains enabled until no real-time skin remains attached to the nucleus.

4.13.2.8 int **xntbase_switch** (const char * *name*, u_long *period*, xntbase_t ** *basep*)

Replace a time base.

This service is useful for switching the current time base of a real-time skin between aperiodic and periodic modes, by providing a new time base descriptor as needed. The original time base descriptor is freed as a result of this operation (unless it refers to the master time base). The new time base is automatically started by a call to xntbase_start() if the original time base was enabled at the time of the call, or left in a disabled state otherwise.

This call handles all mode transitions and configuration changes carefully, i.e. periodic <-> periodic, aperiodic <-> aperiodic, periodic <-> aperiodic.

Parameters

name	The symbolic name of the new time base. This information is used to report status information when reading from /proc/xenomai/timebases; it has currently no other usage.
period	The duration of the clock tick for the time base, given as a count of nanoseconds. This value is meant to define the new clock rate of the new periodic time base (i.e. 1e9 / period).

basep	A pointer to a memory location which will be first read to pick the address of the original time base to be replaced, then written back upon success with the address of the new time base. A null pointer is allowed on input in *basep*, in which case the new time base will be created as if xntbase_alloc() had been called directly.

Returns

0 is returned on success. Otherwise:

- -ENOMEM is returned if no system memory is available to allocate a new time base descriptor.

Environments:

This service can be called from:

- Kernel module initialization code
- User-space task in secondary mode

Rescheduling: never.

References xntbase_alloc(), xntbase_free(), xntbase_start(), and xntbase_update().

4.13.2.9 void **xntbase_tick** (xntbase_t * *base*)

Announce a clock tick to a time base.

This service announces a new clock tick to a time base. Normally, only specialized nucleus code would announce clock ticks. However, under certain circumstances, it may be useful to allow client code to send such notifications on their own.

Notifying a clock tick to a time base causes the timer management code to check for outstanding timers, which may in turn fire off elapsed timeout handlers. Additionally, periodic time bases (i.e. all but the master time base) would also update their count of elapsed jiffies, in case the current processor has been defined as the internal time keeper (i.e. CPU# == XNTIMER_KEEPER_ID).

Parameters

base	The address of the time base descriptor to announce a tick to.

Environments:

This service can be called from:

- Interrupt context only.

Rescheduling: never.

References xntimer_tick_aperiodic().

4.13.2.10 int **xntbase_update** (xntbase_t * *base*, u_long *period*)

Change the period of a time base.

Parameters

base	The address of the time base descriptor to update.
period	The duration of the clock tick for the time base, given as a count of nanoseconds. This value is meant to define the new clock rate of the affected periodic time base (i.e. 1e9 / period).

Returns

0 is returned on success. Otherwise:

- -EINVAL is returned if an attempt is made to set a null period.

Environments:

This service can be called from:

- Kernel module initialization code
- Kernel-based task
- User-space task

Rescheduling: never.

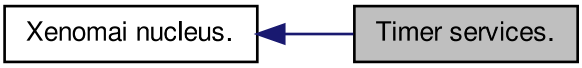
Note

Requests to update the master time base are silently caught and discarded. The master time base has a fixed aperiodic policy which may not be changed.

Referenced by xntbase_switch().

4.14 Timer services.

Collaboration diagram for Timer services.:



Files

- file timer.h
- file timer.c

Functions

- static int xntimer_start (xntimer_t ∗timer, xnticks_t value, xnticks_t interval, xntmode_t mode)

    Arm a timer.
- static void xntimer_stop (xntimer_t ∗timer)

    Disarm a timer.
- static xnticks_t xntimer_get_date (xntimer_t ∗timer)

    Return the absolute expiration date.
- static xnticks_t xntimer_get_timeout (xntimer_t ∗timer)

    Return the relative expiration date.
- static xnticks_t xntimer_get_interval (xntimer_t ∗timer)

    Return the timer interval value.
- void xntimer_tick_aperiodic (void)

    Process a timer tick for the aperiodic master time base.
- void xntimer_tick_periodic (xntimer_t ∗mtimer)

    Process a timer tick for a slave periodic time base.
- void xntimer_init (xntimer_t ∗timer, xntbase_t ∗base, void(∗handler)(xntimer_t ∗timer))

    Initialize a timer object.
- void xntimer_destroy (xntimer_t ∗timer)

    Release a timer object.
- unsigned long xntimer_get_overruns (xntimer_t ∗timer, xnticks_t now)

    Get the count of overruns for the last tick.
- void xntimer_freeze (void)

    Freeze all timers (from every time bases).

4.14.1 Detailed Description

The Xenomai timer facility always operate the timer hardware in oneshot mode, regardless of the time base in effect. Periodic timing is obtained through a software emulation, using cascading timers.

Depending on the time base used, the timer object stores time values either as count of jiffies (periodic), or as count of CPU ticks (aperiodic).

4.14.2 Function Documentation

4.14.2.1 void xntimer_destroy (xntimer_t * *timer*)

Release a timer object.

Destroys a timer. After it has been destroyed, all resources associated with the timer have been released. The timer is automatically deactivated before deletion if active on entry.

Parameters

timer	The address of a valid timer descriptor.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

References xntimer_stop().

Referenced by xnpod_delete_thread(), and xnpod_shutdown().

4.14.2.2 void xntimer_freeze (void)

Freeze all timers (from every time bases).

This routine deactivates all active timers atomically.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

- Kernel-based task
- User-space task

Rescheduling: never.

Referenced by xnpod_disable_timesource().

4.14.2.3 xnticks_t xntimer_get_date (xntimer_t * *timer*) [inline, static]

Return the absolute expiration date.

Return the next expiration date of a timer in absolute clock ticks (see note).

Parameters

timer	The address of a valid timer descriptor.

Returns

> The expiration date converted to the current time unit. The special value XN_INFINITE is returned if *timer* is currently inactive.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

Note

> This service is sensitive to the current operation mode of the associated time base, as defined by the xnpod_init_timebase() service. In periodic mode, clock ticks are interpreted as periodic jiffies. In oneshot mode, clock ticks are interpreted as nanoseconds.

4.14.2.4 xnticks_t xntimer_get_interval (xntimer_t * *timer*) [inline, static]

Return the timer interval value.

Return the timer interval value in clock ticks (see note).

Parameters

timer	The address of a valid timer descriptor.

Returns

The expiration date converted to the current time unit. The special value XN_INFINITE is returned if *timer* is currently inactive or aperiodic.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

Note

This service is sensitive to the current operation mode of the associated time base, as defined by the xnpod_init_timebase() service. In periodic mode, clock ticks are interpreted as periodic jiffies. In oneshot mode, clock ticks are interpreted as nanoseconds.

4.14.2.5 unsigned long xntimer_get_overruns (xntimer_t ∗ *timer,* xnticks_t *now*)

Get the count of overruns for the last tick.

This service returns the count of pending overruns for the last tick of a given timer, as measured by the difference between the expected expiry date of the timer and the date *now* passed as argument.

Parameters

timer	The address of a valid timer descriptor.
now	current date (in the monotonic time base)

Returns

the number of overruns of *timer* at date *now*

Referenced by xnpod_wait_thread_period().

4.14.2.6 xnticks_t xntimer_get_timeout (xntimer_t * *timer*) [inline, static]

Return the relative expiration date.

Return the next expiration date of a timer in relative clock ticks (see note).

Parameters

timer	The address of a valid timer descriptor.

Returns

> The expiration date converted to the current time unit. The special value XN_INFINITE is returned if *timer* is currently inactive. In oneshot mode, it might happen that the timer has already expired when this service is run (even if the associated handler has not been fired yet); in such a case, 1 is returned.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

Note

> This service is sensitive to the current operation mode of the associated time base, as defined by the xnpod_init_timebase() service. In periodic mode, clock ticks are interpreted as periodic jiffies. In oneshot mode, clock ticks are interpreted as nanoseconds.

4.14.2.7 void xntimer_init (xntimer_t * *timer*, xntbase_t * *base*, void(*)(xntimer_t *timer) *handler*)

Initialize a timer object.

Creates a timer. When created, a timer is left disarmed; it must be started using xntimer_start() in order to be activated.

Parameters

timer	The address of a timer descriptor the nucleus will use to store the object-specific data. This descriptor must always be valid while the object is active therefore it must be allocated in permanent memory.
base	The descriptor address of the time base the new timer depends on. See xntbase_alloc() for detailed explanations about time bases.
handler	The routine to call upon expiration of the timer.

There is no limitation on the number of timers which can be created/active concurrently.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

Referenced by xnpod_init().

4.14.2.8 void xntimer_start (xntimer_t * *timer*, xnticks_t *value*, xnticks_t *interval*, xntmode_t *mode*) [inline, static]

Arm a timer.

Activates a timer so that the associated timeout handler will be fired after each expiration time. A timer can be either periodic or single-shot, depending on the reload value passed to this routine. The given timer must have been previously initialized, and will be clocked according to the policy defined by the time base specified in xntimer_init().

Parameters

timer	The address of a valid timer descriptor.
value	The date of the initial timer shot, expressed in clock ticks (see note).
interval	The reload value of the timer. It is a periodic interval value to be used for reprogramming the next timer shot, expressed in clock ticks (see note). If *interval* is equal to XN_INFINITE, the timer will not be reloaded after it has expired.

mode	The timer mode. It can be XN_RELATIVE if *value* shall be interpreted as a relative date, XN_ABSOLUTE for an absolute date based on the monotonic clock of the related time base (as returned my xntbase_get_jiffies()), or XN_REALTIME if the absolute date is based on the adjustable real-time clock of the time base (as returned by xntbase_get_time().

Returns

0 is returned upon success, or -ETIMEDOUT if an absolute date in the past has been given.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

Note

This service is sensitive to the current operation mode of the associated time base, as defined by the xnpod_init_timebase() service. In periodic mode, clock ticks are interpreted as periodic jiffies. In oneshot mode, clock ticks are interpreted as nanoseconds.
Must be called with nklock held, IRQs off.

Referenced by xnpod_enable_timesource(), xnpod_set_thread_periodic(), xnpod_set_thread_tslice(), and xnpod_suspend_thread().

4.14.2.9 int xntimer_stop (xntimer_t * *timer*) [inline, static]

Disarm a timer.

This service deactivates a timer previously armed using xntimer_start(). Once disarmed, the timer can be subsequently re-armed using the latter service.

Parameters

timer	The address of a valid timer descriptor.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task

Rescheduling: never.

Note

Must be called with nklock held, IRQs off.

Referenced by xnpod_resume_thread(), xnpod_set_thread_periodic(), xnpod_set_thread_tslice(), and xntimer_destroy().

4.14.2.10 void xntimer_tick_aperiodic (void)

Process a timer tick for the aperiodic master time base.

This routine informs all active timers that the clock has been updated by processing the outstanding timer list. Elapsed timer actions will be fired.

Environments:

This service can be called from:

- Interrupt service routine, nklock locked, interrupts off

Rescheduling: never.

References xnsched::htimer, xnsched::lflags, and xnsched::status.

Referenced by xntbase_tick().

4.14.2.11 void xntimer_tick_periodic (xntimer_t * *mtimer*)

Process a timer tick for a slave periodic time base.

The periodic timer tick is cascaded from a software timer managed from the master aperiodic time base; in other words, periodic timing is emulated by software timers running in aperiodic timing mode. There may be several concurrent periodic time bases (albeit a single aperiodic time base - i.e. the master one called "nktbase" - may exist at any point in time).

This routine informs all active timers that the clock has been updated by processing the timer wheel. Elapsed timer actions will be fired.

Parameters

mtimer	The address of the cascading timer running in the master time base which announced the tick.

Environments:

This service can be called from:

- Interrupt service routine, nklock locked, interrupts off

Rescheduling: never.

Note

Only active timers are inserted into the timer wheel.

4.15 HAL.

Generic Adeos-based hardware abstraction layer.

Files

- file hal.c

  Adeos-based Real-Time Abstraction Layer for ARM.
- file hal.c

  Adeos-based Real-Time Abstraction Layer for the Blackfin architecture.
- file nmi.c

  NMI watchdog support.
- file hal.c

  Generic Real-Time HAL.
- file nmi.c

  Adeos-based Real-Time Abstraction Layer for x86.
- file hal.c

  Adeos-based Real-Time Abstraction Layer for the NIOS2 architecture.
- file hal.c

  Adeos-based Real-Time Abstraction Layer for PowerPC.
- file hal-common.c

  Adeos-based Real-Time Abstraction Layer for x86.
- file hal_32.c

  Adeos-based Real-Time Abstraction Layer for x86.
- file hal_64.c

  Adeos-based Real-Time Abstraction Layer for x86_64.
- file nmi.c

  NMI watchdog for x86, from linux/arch/i386/kernel/nmi.c.
- file smi.c

  SMI workaround for x86.

Functions

- int rthal_timer_request (void(*tick_handler)(void), void(*mode_emul)(enum clock_event_mode mode, struct clock_event_device *cdev), int(*tick_emul)(unsigned long delay, struct clock_event_device *cdev), int cpu)

  Grab the hardware timer.
- void rthal_timer_release (int cpu)

  Release the hardware timer.
- int rthal_irq_host_request (unsigned irq, rthal_irq_host_handler_t handler, char *name, void *dev_id)

  Install a shared Linux interrupt handler.

- int rthal_irq_host_release (unsigned irq, void *dev_id)

  Uninstall a shared Linux interrupt handler.
- int rthal_irq_enable (unsigned irq)

  Enable an interrupt source.
- int rthal_irq_disable (unsigned irq)

  Disable an interrupt source.
- int rthal_irq_request (unsigned irq, rthal_irq_handler_t handler, rthal_irq_ackfn_t ackfn, void *cookie)

  Install a real-time interrupt handler.
- int rthal_irq_release (unsigned irq)

  Uninstall a real-time interrupt handler.
- int rthal_irq_affinity (unsigned irq, cpumask_t cpumask, cpumask_t *oldmask)

  Set/Get processor affinity for external interrupt.
- rthal_trap_handler_t rthal_trap_catch (rthal_trap_handler_t handler)

  Installs a fault handler.
- int rthal_apc_alloc (const char *name, void(*handler)(void *cookie), void *cookie)

  Allocate an APC slot.
- void rthal_apc_free (int apc)

  Releases an APC slot.

4.15.1 Detailed Description

Generic Adeos-based hardware abstraction layer. x86_64-specific HAL services.

i386-specific HAL services.

PowerPC-specific HAL services.

NIOS2-specific HAL services.

Generic NMI watchdog services.

Blackfin-specific HAL services.

ARM-specific HAL services.

4.15.2 Function Documentation

4.15.2.1 int **rthal_apc_alloc** (const char * *name*, void(*)(void *cookie) *handler*, void * *cookie*)

Allocate an APC slot.

APC is the acronym for Asynchronous Procedure Call, a mean by which activities from the Xenomai domain can schedule deferred invocations of handlers to be run into the Linux domain, as soon as possible when the Linux kernel gets back in control. Up to BITS_PER_LONG APC slots can be active at any point in time. APC support is built upon Adeos's virtual interrupt support.

The HAL guarantees that any Linux kernel service which would be callable from a regular Linux interrupt handler is also available to APC handlers, including over PREEMPT_RT kernels exhibiting a threaded IRQ model.

Parameters

name	is a symbolic name identifying the APC which will get reported through the /proc/xenomai/apc interface. Passing NULL to create an anonymous APC is allowed.
handler	The address of the fault handler to call upon exception condition. The handle will be passed the *cookie* value unmodified.
cookie	A user-defined opaque cookie the HAL will pass to the APC handler as its sole argument.

Returns

an valid APC id. is returned upon success, or a negative error code otherwise:

- -EINVAL is returned if *handler* is invalid.
- -EBUSY is returned if no more APC slots are available.

Environments:

This service can be called from:

- Linux domain context.

4.15.2.2 int rthal_apc_free (int *apc*)

Releases an APC slot.

This service deallocates an APC slot obtained by rthal_apc_alloc().

Parameters

apc	The APC id. to release, as returned by a successful call to the rthal_apc_alloc() service.

Environments:

This service can be called from:

- Any domain context.

4.15.2.3 int rthal_irq_affinity (unsigned *irq*, cpumask_t *cpumask*, cpumask_t * *oldmask*)

Set/Get processor affinity for external interrupt.

On SMP systems, this service ensures that the given interrupt is preferably dispatched to the specified set of processors. The previous affinity mask is returned by this service.

Parameters

irq	The interrupt source whose processor affinity is affected by the operation. Only external interrupts can have their affinity changed/queried, thus virtual interrupt numbers allocated by rthal_alloc_virq() are invalid values for this parameter.
cpumask	A list of CPU identifiers passed as a bitmask representing the new affinity for this interrupt. A zero value cause this service to return the current affinity mask without changing it.
oldmask	If non-NULL, a pointer to a memory area which will bve overwritten by the previous affinity mask used for this interrupt source, or a zeroed mask if an error occurred. This service always returns a zeroed mask on uniprocessor systems.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if *irq* is invalid.

Environments:

This service can be called from:

- Linux domain context.

4.15.2.4 int rthal_irq_disable (unsigned *irq*)

Disable an interrupt source.

Disables an interrupt source at PIC level. After this call has returned, no more IRQs from the given source will be allowed, until the latter is enabled again using rthal_irq_enable().

Parameters

irq	The interrupt source to disable. This value is architecture-dependent.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if *irq* is invalid.
- Other error codes might be returned in case some internal error happens at the Adeos level. Such error might caused by conflicting Adeos requests made by third-party code.

Environments:

This service can be called from:

- Any domain context.

4.15.2.5 int rthal_irq_enable (unsigned *irq*)

Enable an interrupt source.

Enables an interrupt source at PIC level. Since Adeos masks and acknowledges the associated interrupt source upon IRQ receipt, this action is usually needed whenever the HAL handler does not propagate the IRQ event to the Linux domain, thus preventing the regular Linux interrupt handling code from re-enabling said source. After this call has returned, IRQs from the given source will be enabled again.

Parameters

irq	The interrupt source to enable. This value is architecture-dependent.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if *irq* is invalid.
- Other error codes might be returned in case some internal error happens at the Adeos level. Such error might caused by conflicting Adeos requests made by third-party code.

Environments:

This service can be called from:

- Any domain context.

4.15.2.6 int rthal_irq_host_release (unsigned *irq,* void ∗ *dev_id*)

Uninstall a shared Linux interrupt handler.

Uninstalls a shared interrupt handler from the Linux domain for the given interrupt source. The handler is removed from the existing list of Linux handlers for this interrupt source.

Parameters

irq	The interrupt source to detach the shared handler from. This value is architecture-dependent.
dev_id	is a valid device id, identical in essence to the one requested by the free_irq() service provided by the Linux kernel. This value will be used to locate the handler to remove from the chain of existing Linux handlers for the given interrupt source. This parameter must match the device id. passed to rthal_irq_host_request() for the same handler instance.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if *irq* is invalid.

Environments:

This service can be called from:

- Linux domain context.

4.15.2.7 int rthal_irq_host_request (unsigned *irq,* rthal_irq_host_handler_t *handler,* char ∗ *name,* void ∗ *dev_id*)

Install a shared Linux interrupt handler.

Installs a shared interrupt handler in the Linux domain for the given interrupt source. The handler is appended to the existing list of Linux handlers for this interrupt source.

Parameters

irq	The interrupt source to attach the shared handler to. This value is architecture-dependent.
handler	The address of a valid interrupt service routine. This handler will be called each time the corresponding IRQ is delivered, as part of the chain of existing regular Linux handlers for this interrupt source. The handler prototype is the same as the one required by the request_irq() service provided by the Linux kernel.

name	is a symbolic name identifying the handler which will get reported through the /proc/interrupts interface.
dev_id	is a unique device id, identical in essence to the one requested by the request_irq() service.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if *irq* is invalid or *handler* is NULL.

Environments:

This service can be called from:

- Linux domain context.

4.15.2.8 int rthal_irq_release (unsigned *irq*)

Uninstall a real-time interrupt handler.

Uninstalls an interrupt handler previously attached using the rthal_irq_request() service.

Parameters

irq	The hardware interrupt channel to uninstall a handler from. This value is architecture-dependent.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if *irq* is invalid.
- Other error codes might be returned in case some internal error happens at the Adeos level. Such error might caused by conflicting Adeos requests made by third-party code.

Environments:

This service can be called from:

- Any domain context.

Referenced by rthal_timer_release().

4.15.2.9 int rthal_irq_request (unsigned *irq,* rthal_irq_handler_t *handler,* rthal_irq_ackfn_t *ackfn,* void * *cookie*)

Install a real-time interrupt handler.

Installs an interrupt handler for the specified IRQ line by requesting the appropriate Adeos virtualization service. The handler is invoked by Adeos on behalf of the Xenomai domain context. Once installed, the HAL interrupt handler will be called prior to the regular Linux handler for the same interrupt source.

Parameters

irq	The hardware interrupt channel to install a handler on. This value is architecture-dependent.
handler	The address of a valid interrupt service routine. This handler will be called each time the corresponding IRQ is delivered, and will be passed the *cookie* value unmodified.
ackfn	The address of an optional interrupt acknowledge routine, aimed at replacing the one provided by Adeos. Only very specific situations actually require to override the default Adeos setting for this parameter, like having to acknowledge non-standard PIC hardware. If *ackfn* is NULL, the default Adeos routine will be used instead.
cookie	A user-defined opaque cookie the HAL will pass to the interrupt handler as its sole argument.

Returns

0 is returned upon success. Otherwise:

- -EBUSY is returned if an interrupt handler is already installed. rthal_irq_release() must be issued first before a handler is installed anew.
- -EINVAL is returned if *irq* is invalid or *handler* is NULL.
- Other error codes might be returned in case some internal error happens at the Adeos level. Such error might caused by conflicting Adeos requests made by third-party code.

Environments:

This service can be called from:

- Any domain context.

Referenced by rthal_timer_request().

4.15.2.10 void rthal_timer_release (int *cpu*)

Release the hardware timer.

Releases the hardware timer, thus reverting the effect of a previous call to rthal_timer_request(). In case the timer hardware is shared with Linux, a periodic setup suitable for the Linux kernel will be reset.

Parameters

cpu	The CPU number the timer was grabbed from.

Environments:

This service can be called from:

- Linux domain context.

References rthal_irq_release().

4.15.2.11 int **rthal_timer_request** (void(*)(void) *tick_handler*, void(*)(enum clock_event_mode mode, struct clock_event_device *cdev) *mode_emul*, int(*)(unsigned long delay, struct clock_event_device *cdev) *tick_emul*, int *cpu*)

Grab the hardware timer.

rthal_timer_request() grabs and tunes the hardware timer in oneshot mode in order to clock the master time base.

A user-defined routine is registered as the clock tick handler. This handler will always be invoked on behalf of the Xenomai domain for each incoming tick.

Hooks for emulating oneshot mode for the tick device are accepted when CONFIG_GENERIC_CLOCKEVENTS is defined for the host kernel. Host tick emulation is a way to share the clockchip hardware between Linux and Xenomai, when the former provides support for oneshot timing (i.e. high resolution timers and no-HZ scheduler ticking).

Parameters

tick_handler	The address of the Xenomai tick handler which will process each incoming tick.
mode_emul	The optional address of a callback to be invoked upon mode switch of the host tick device, notified by the Linux kernel. This parameter is only considered whenever CONFIG_GENERIC_CLOCKEVENTS is defined.
tick_emul	The optional address of a callback to be invoked upon setup of the next shot date for the host tick device, notified by the Linux kernel. This parameter is only considered whenever CONFIG_GENERIC_CLOCKEVENTS is defined.
cpu	The CPU number to grab the timer from.

Returns

a positive value is returned on success, representing the duration of a - Linux periodic tick expressed as a count of nanoseconds; zero should be returned when the Linux kernel does not undergo periodic timing on the given CPU (e.g. oneshot mode). Otherwise:

- -EBUSY is returned if the hardware timer has already been grabbed. rthal_timer_request() must be issued before rthal_timer_request() is called again.
- -ENODEV is returned if the hardware timer cannot be used. This situation may occur after the kernel disabled the timer due to invalid calibration results; in such a case, such hardware is unusable for any timing duties.

Environments:

This service can be called from:

- Linux domain context.

References rthal_irq_request().

4.15.2.12 int rthal_trap_catch (rthal_trap_handler_t *handler*)

Installs a fault handler.

The HAL attempts to invoke a fault handler whenever an uncontrolled exception or fault is caught at machine level. This service allows to install a user-defined handler for such events.

Parameters

handler	The address of the fault handler to call upon exception condition. The handler is passed the address of the low-level information block describing the fault as passed by Adeos. Its layout is implementation-dependent.

Returns

The address of the fault handler previously installed.

Environments:

This service can be called from:

- Any domain context.

4.16 Sched

Data Structures

- struct xnsched

  Scheduling information structure.

Files

- file sched.h

  Scheduler interface header.
- file sched-idle.c

  Idle scheduling class implementation (i.e. Linux placeholder).
- file sched-rt.c

  Common real-time scheduling class implementation (FIFO + RR)
- file sched-sporadic.c

  POSIX SCHED_SPORADIC scheduling class.
- file sched-tp.c

  Temporal partitioning (typical of IMA systems).
- file sched.c

Typedefs

- typedef struct xnsched xnsched_t

  Scheduling information structure.

Functions

- static void xnsched_rotate (struct xnsched *sched, struct xnsched_class *sched_class, const union xnsched_policy_param *sched_param)

  Rotate a scheduler runqueue.

4.16.1 Function Documentation

4.16.1.1 void **xnsched_rotate** (struct **xnsched** * *sched,* struct xnsched_class * *sched_class,* const union xnsched_policy_param * *param*) `[inline, static]`

Rotate a scheduler runqueue.

The specified scheduling class is requested to rotate its runqueue for the given scheduler. Rotation is performed according to the scheduling parameter specified by *sched_param*.

Note

The nucleus supports round-robin scheduling for the members of the RT class.

Parameters

sched	The per-CPU scheduler hosting the target scheduling class.
sched_class	The scheduling class which should rotate its runqueue.
sched_param	The scheduling parameter providing rotation information to the specified scheduling class.

Environments:

This service should be called from:

- Kernel-based task
- Interrupt service routine
- User-space task (primary mode only)

Rescheduling: never.

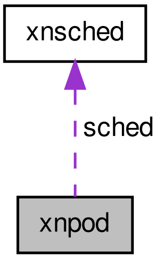
Chapter 5

Data Structure Documentation

5.1 xnpod Struct Reference

Real-time pod descriptor.

Collaboration diagram for xnpod:



Data Fields

- xnflags_t status
- xnsched_t sched [XNARCH_NR_CPUS]
- xnqueue_t threadq
- int threadq_rev
- xnqueue_t tstartq
- xnqueue_t tswitchq
- xnqueue_t tdeleteq

- atomic_counter_t timerlck
- xntimer_t tslicer
- int tsliced
- int refcnt

5.1.1 Detailed Description

Real-time pod descriptor.

The source of all Xenomai magic.

5.1.2 Field Documentation

5.1.2.1 int xnpod::refcnt

Reference count.

Referenced by xnpod_init().

5.1.2.2 xnsched_t xnpod::sched[XNARCH_NR_CPUS]

Per-cpu scheduler slots.

Referenced by xnpod_init().

5.1.2.3 xnflags_t xnpod::status

Status bitmask.

Referenced by xnpod_init().

5.1.2.4 xnqueue_t xnpod::tdeleteq

Thread delete hook queue.

Referenced by xnpod_init().

5.1.2.5 xnqueue_t xnpod::threadq

All existing threads.

Referenced by xnpod_init().

5.1.2.6 int xnpod::threadq_rev

Modification counter of threadq.

5.1.2.7 atomic_counter_t xnpod::timerlck

Timer lock depth.

Referenced by xnpod_init().

5.1.2.8 int xnpod::tsliced

Number of threads using the slicer

Referenced by xnpod_init().

5.1.2.9 xntimer_t xnpod::tslicer

Time-slicing timer for aperiodic mode

Referenced by xnpod_init().

5.1.2.10 xnqueue_t xnpod::tstartq

Thread start hook queue.

Referenced by xnpod_init().

5.1.2.11 xnqueue_t xnpod::tswitchq

Thread switch hook queue.

Referenced by xnpod_init().

The documentation for this struct was generated from the following file:

- include/nucleus/pod.h

5.2 xnsched Struct Reference

Scheduling information structure.

Data Fields

- xnflags_t status
- xnflags_t lflags
- struct xnthread * curr
- struct xnsched_rt rt
- volatile unsigned inesting

- struct xntimer htimer
- struct xnthread rootcb

5.2.1 Detailed Description

Scheduling information structure.

5.2.2 Field Documentation

5.2.2.1 struct xnthread* xnsched::curr

Current thread.

Referenced by xnpod_delete_thread(), xnpod_resume_thread(), and xnpod_suspend_thread().

5.2.2.2 struct xntimer xnsched::htimer

Host timer.

Referenced by xnpod_enable_timesource(), and xntimer_tick_aperiodic().

5.2.2.3 volatile unsigned xnsched::inesting

Interrupt nesting level.

5.2.2.4 xnflags_t xnsched::lflags

Scheduler specific local flags bitmask.

Referenced by xnpod_schedule(), and xntimer_tick_aperiodic().

5.2.2.5 struct xnthread xnsched::rootcb

Root thread control block.

Referenced by xnpod_init().

5.2.2.6 struct xnsched_rt xnsched::rt

Context of built-in real-time class.

5.2.2.7 xnflags_t xnsched::status

Scheduler specific status bitmask.

Referenced by xnpod_delete_thread(), xnpod_schedule(), and xntimer_tick_aperiodic().

The documentation for this struct was generated from the following file:

- include/nucleus/sched.h

5.3 xnthread_info Struct Reference

Structure containing thread information.

Data Fields

- unsigned long state

  Thread state,.
- int bprio

  Base priority.
- int cprio

  Current priority.
- int cpu

  CPU the thread currently runs on.
- unsigned long affinity

  Thread's CPU affinity.
- unsigned long long relpoint

  Time of next release.
- unsigned long long exectime

  Execution time in primary mode in nanoseconds.
- unsigned long modeswitches

  Number of primary->secondary mode switches.
- unsigned long ctxswitches

  Number of context switches.
- unsigned long pagefaults

  Number of triggered page faults.
- char name [XNOBJECT_NAME_LEN]

  Symbolic name assigned at creation.

5.3.1 Detailed Description

Structure containing thread information.

5.3.2 Field Documentation

5.3.2.1 unsigned long xnthread_info::affinity

Thread's CPU affinity.

5.3.2.2 int xnthread_info::bprio

Base priority.

5.3.2.3 int xnthread_info::cprio

Current priority.

May change through Priority Inheritance.

5.3.2.4 int xnthread_info::cpu

CPU the thread currently runs on.

5.3.2.5 unsigned long xnthread_info::ctxswitches

Number of context switches.

5.3.2.6 unsigned long long xnthread_info::exectime

Execution time in primary mode in nanoseconds.

5.3.2.7 unsigned long xnthread_info::modeswitches

Number of primary->secondary mode switches.

5.3.2.8 char xnthread_info::name[XNOBJECT_NAME_LEN]

Symbolic name assigned at creation.

5.3.2.9 unsigned long xnthread_info::pagefaults

Number of triggered page faults.

5.3.2.10 unsigned long long xnthread_info::relpoint

Time of next release.

5.3.2.11 unsigned long xnthread_info::state

Thread state,.

See also

Thread state flags.

The documentation for this struct was generated from the following file:

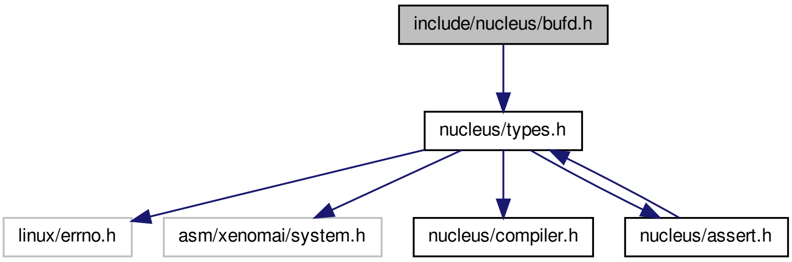
- include/nucleus/thread.h

Chapter 6

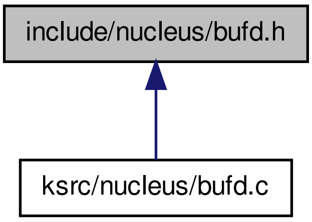
File Documentation

6.1 include/nucleus/bufd.h File Reference

Include dependency graph for bufd.h:



This graph shows which files directly or indirectly include this file:



Functions

- static void xnbufd_map_uread (struct xnbufd *bufd, const void __user *ptr, size_t len)

  Initialize a buffer descriptor for reading from user memory.
- static void xnbufd_map_uwrite (struct xnbufd *bufd, void __user *ptr, size_t len)

  Initialize a buffer descriptor for writing to user memory.
- ssize_t xnbufd_unmap_uread (struct xnbufd *bufd)

  Finalize a buffer descriptor obtained from xnbufd_map_uread().
- ssize_t xnbufd_unmap_uwrite (struct xnbufd *bufd)

  Finalize a buffer descriptor obtained from xnbufd_map_uwrite().
- static void xnbufd_map_kread (struct xnbufd *bufd, const void *ptr, size_t len)

  Initialize a buffer descriptor for reading from kernel memory.
- static void xnbufd_map_kwrite (struct xnbufd *bufd, void *ptr, size_t len)

  Initialize a buffer descriptor for writing to kernel memory.
- ssize_t xnbufd_unmap_kread (struct xnbufd *bufd)

  Finalize a buffer descriptor obtained from xnbufd_map_kread().
- ssize_t xnbufd_unmap_kwrite (struct xnbufd *bufd)

  Finalize a buffer descriptor obtained from xnbufd_map_kwrite().
- ssize_t xnbufd_copy_to_kmem (void *ptr, struct xnbufd *bufd, size_t len)

  Copy memory covered by a buffer descriptor to kernel memory.
- ssize_t xnbufd_copy_from_kmem (struct xnbufd *bufd, void *from, size_t len)

  Copy kernel memory to the area covered by a buffer descriptor.
- void xnbufd_invalidate (struct xnbufd *bufd)

Invalidate a buffer descriptor.

- static void xnbufd_reset (struct xnbufd *bufd)

  Reset a buffer descriptor.

6.1.1 Detailed Description

Note

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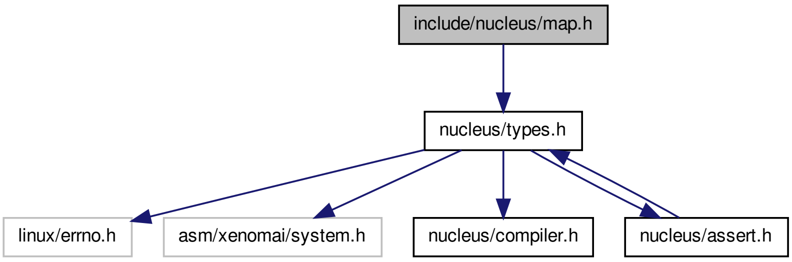
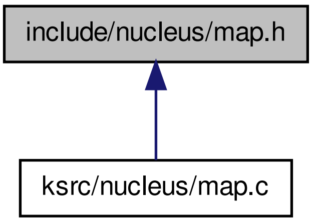
6.2 include/nucleus/map.h File Reference

Include dependency graph for map.h:



This graph shows which files directly or indirectly include this file:



Functions

- xnmap_t * xnmap_create (int nkeys, int reserve, int offset)

  Create a map.
- void xnmap_delete (xnmap_t *map)

  Delete a map.
- int xnmap_enter (xnmap_t *map, int key, void *objaddr)

  Index an object into a map.
- int xnmap_remove (xnmap_t *map, int key)

  Remove an object reference from a map.
- static void * xnmap_fetch_nocheck (xnmap_t *map, int key)

  Search an object into a map - unchecked form.
- static void * xnmap_fetch (xnmap_t *map, int key)

  Search an object into a map.

6.2.1 Detailed Description

Note

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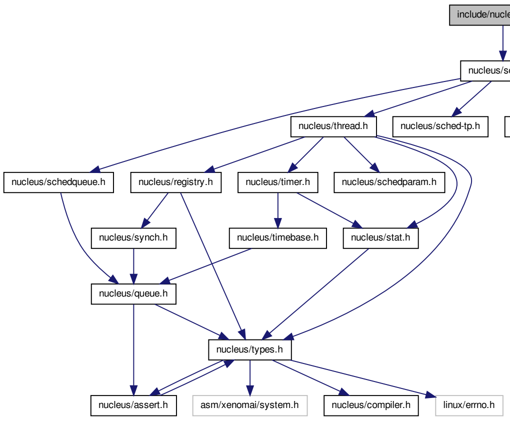
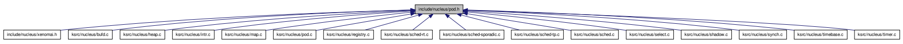
6.3 include/nucleus/pod.h File Reference

Real-time pod interface header.

Include dependency graph for pod.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct xnpod

  Real-time pod descriptor.

Functions

- int xnpod_init (void)

  Initialize the core pod.
- int xnpod_enable_timesource (void)

  Activate the core time source.

- void xnpod_disable_timesource (void)

  Stop the core time source.
- void xnpod_shutdown (int xtype)

  Shutdown the current pod.
- int xnpod_init_thread (struct xnthread *thread, const struct xnthread_init_attr *attr, struct xnsched_class *sched_class, const union xnsched_policy_param *sched_param)

  Initialize a new thread.
- int xnpod_start_thread (xnthread_t *thread, const struct xnthread_start_attr *attr)

  Initial start of a newly created thread.
- void xnpod_stop_thread (xnthread_t *thread)

  Stop a thread.
- void xnpod_restart_thread (xnthread_t *thread)

  Restart a thread.
- void xnpod_delete_thread (xnthread_t *thread)

  Delete a thread.
- void xnpod_abort_thread (xnthread_t *thread)

  Abort a thread.
- xnflags_t xnpod_set_thread_mode (xnthread_t *thread, xnflags_t clrmask, xnflags_t setmask)

  Change a thread's control mode.
- void xnpod_suspend_thread (xnthread_t *thread, xnflags_t mask, xnticks_t timeout, xntmode_t timeout_mode, struct xnsynch *wchan)

  Suspend a thread.
- void xnpod_resume_thread (xnthread_t *thread, xnflags_t mask)

  Resume a thread.
- int xnpod_unblock_thread (xnthread_t *thread)

  Unblock a thread.
- int xnpod_set_thread_schedparam (struct xnthread *thread, struct xnsched_class *sched_class, const union xnsched_policy_param *sched_param)

  Change the base scheduling parameters of a thread.
- int xnpod_migrate_thread (int cpu)

  Migrate the current thread.
- void xnpod_dispatch_signals (void)

  Deliver pending asynchronous signals to the running thread.
- static void xnpod_schedule (void)

  Rescheduling procedure entry point.
- int xnpod_set_thread_periodic (xnthread_t *thread, xnticks_t idate, xnticks_t period)

  Make a thread periodic.
- int xnpod_wait_thread_period (unsigned long *overruns_r)

  Wait for the next periodic release point.

- int xnpod_set_thread_tslice (struct xnthread *thread, xnticks_t quantum)

  Set thread time-slicing information.

- int xnpod_add_hook (int type, void(*routine)(xnthread_t *))

  Install a nucleus hook.

- int xnpod_remove_hook (int type, void(*routine)(xnthread_t *))

  Remove a nucleus hook.

6.3.1 Detailed Description

Real-time pod interface header.

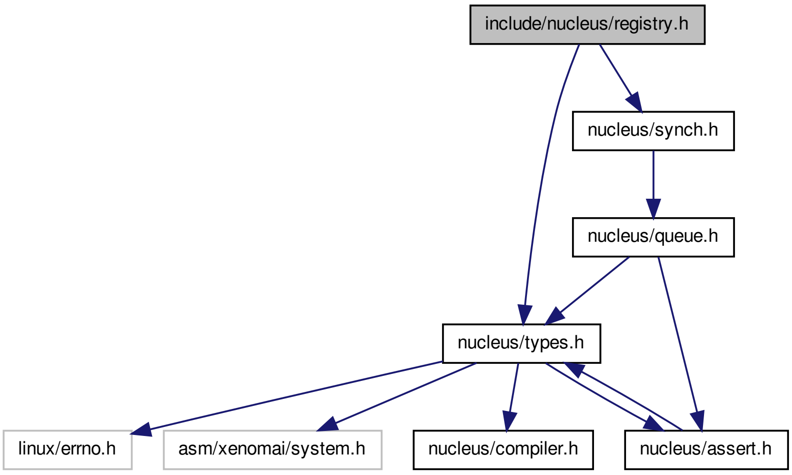
Author

Philippe Gerum

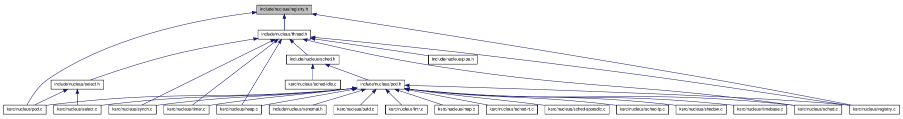
6.4 include/nucleus/registry.h File Reference

This file is part of the Xenomai project.

Include dependency graph for registry.h:



This graph shows which files directly or indirectly include this file:



Functions

- int xnregistry_enter (const char ∗key, void ∗objaddr, xnhandle_t ∗phandle, xnpnode_t ∗pnode)

  Register a real-time object.
- int xnregistry_bind (const char ∗key, xnticks_t timeout, int timeout_mode, xnhandle_t ∗phandle)

  Bind to a real-time object.
- int xnregistry_remove (xnhandle_t handle)

  Forcibly unregister a real-time object.
- int xnregistry_remove_safe (xnhandle_t handle, xnticks_t timeout)

  Unregister an idle real-time object.
- void ∗ xnregistry_get (xnhandle_t handle)

  Find and lock a real-time object into the registry.
- void ∗ xnregistry_fetch (xnhandle_t handle)

Find a real-time object into the registry.

- u_long xnregistry_put (xnhandle_t handle)

  Unlock a real-time object from the registry.

6.4.1 Detailed Description

This file is part of the Xenomai project.

Note

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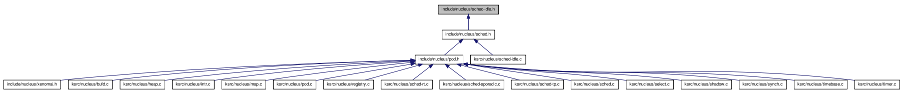
6.5 include/nucleus/sched-idle.h File Reference

Definitions for the IDLE scheduling class.

This graph shows which files directly or indirectly include this file:



6.5.1 Detailed Description

Definitions for the IDLE scheduling class.

Author

Philippe Gerum

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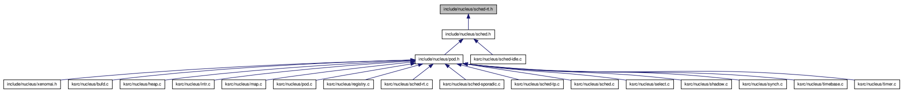
6.6 include/nucleus/sched-rt.h File Reference

Definitions for the RT scheduling class.

This graph shows which files directly or indirectly include this file:



6.6.1 Detailed Description

Definitions for the RT scheduling class.

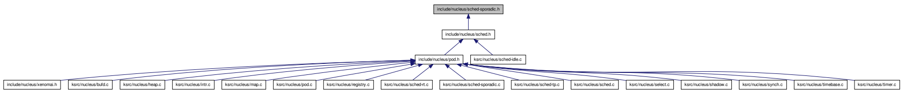
Author

Philippe Gerum

6.7 include/nucleus/sched-sporadic.h File Reference

Definitions for the SSP scheduling class.

This graph shows which files directly or indirectly include this file:



6.7.1 Detailed Description

Definitions for the SSP scheduling class.

Author

Philippe Gerum

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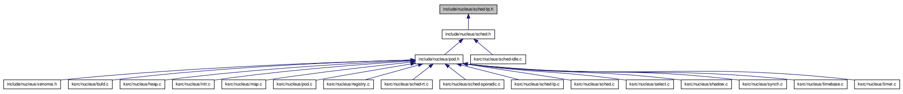
6.8 include/nucleus/sched-tp.h File Reference

Definitions for the TP scheduling class.

This graph shows which files directly or indirectly include this file:



6.8.1 Detailed Description

Definitions for the TP scheduling class.

Author

Philippe Gerum

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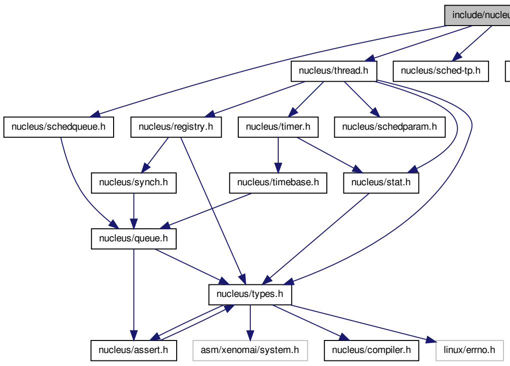
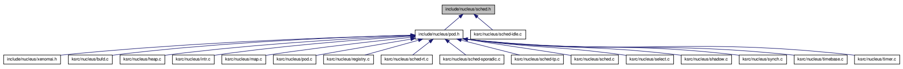
6.9 include/nucleus/sched.h File Reference

Scheduler interface header.

Include dependency graph for sched.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct xnsched

  Scheduling information structure.

Typedefs

- typedef struct xnsched xnsched_t

  Scheduling information structure.

Functions

- static void xnsched_rotate (struct xnsched ∗sched, struct xnsched_class ∗sched_class, const union xnsched_policy_param ∗sched_param)

  Rotate a scheduler runqueue.

6.9.1 Detailed Description

Scheduler interface header.

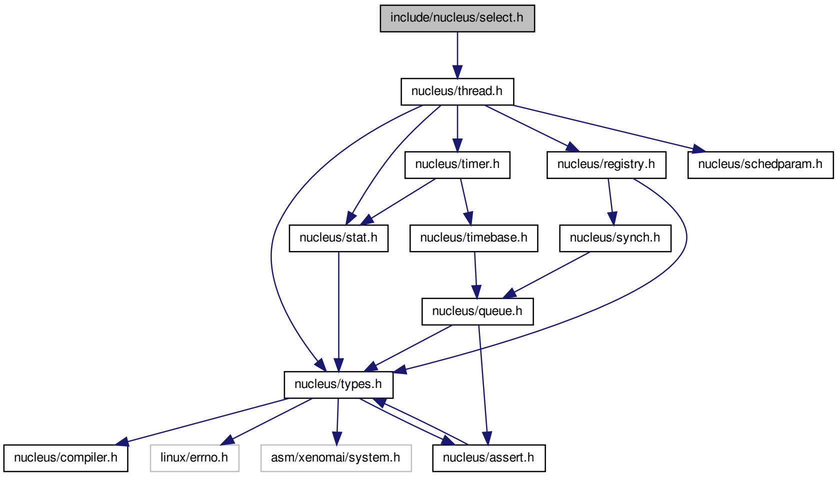
Author

Philippe Gerum

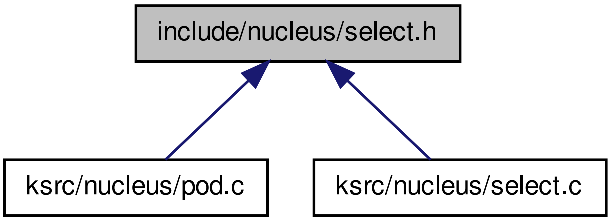
6.10 include/nucleus/select.h File Reference

file descriptors events multiplexing header.

Include dependency graph for select.h:



This graph shows which files directly or indirectly include this file:



6.10.1 Detailed Description

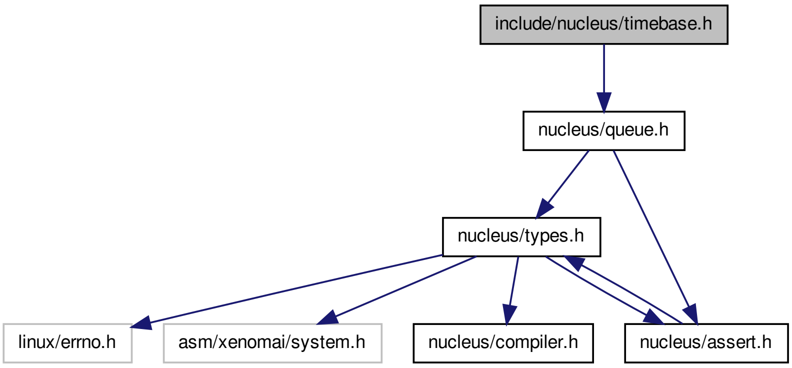
file descriptors events multiplexing header.

Author

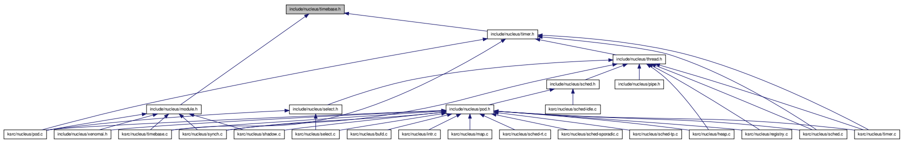
Gilles Chanteperdrix

6.11 include/nucleus/timebase.h File Reference

Include dependency graph for timebase.h:



This graph shows which files directly or indirectly include this file:



Functions

- int xntbase_alloc (const char *name, u_long period, u_long flags, xntbase_t **basep)

  Allocate a time base.
- void xntbase_free (xntbase_t *base)

  Free a time base.
- int xntbase_update (xntbase_t *base, u_long period)

  Change the period of a time base.
- int xntbase_switch (const char *name, u_long period, xntbase_t **basep)

  Replace a time base.
- void xntbase_start (xntbase_t *base)

  Start a time base.
- void xntbase_stop (xntbase_t *base)

  Stop a time base.
- void xntbase_tick (xntbase_t *base)

  Announce a clock tick to a time base.
- xnticks_t xntbase_convert (xntbase_t *srcbase, xnticks_t ticks, xntbase_t *dstbase)

  Convert a clock value into another time base.
- static xnticks_t xntbase_get_time (xntbase_t *base)

  Get the clock time for a given time base.
- void xntbase_adjust_time (xntbase_t *base, xnsticks_t delta)

  Adjust the clock time for the system.

6.11.1 Detailed Description

Note

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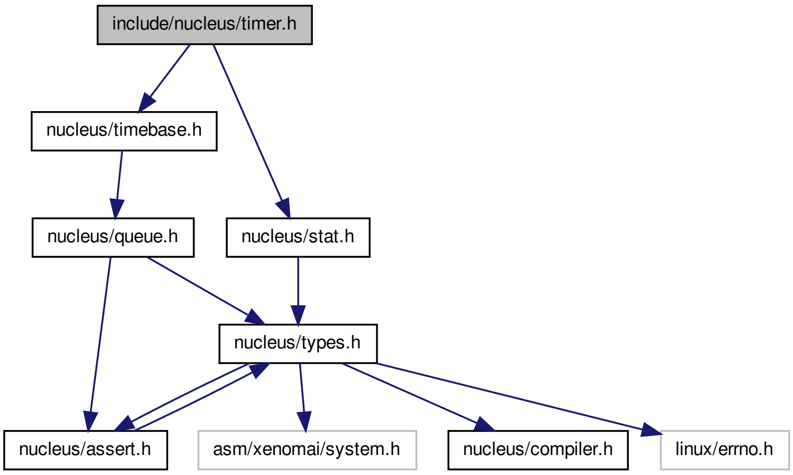
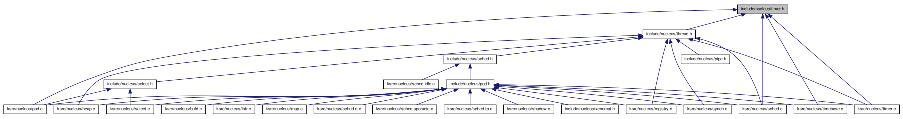
6.12 include/nucleus/timer.h File Reference

Include dependency graph for timer.h:



This graph shows which files directly or indirectly include this file:



Functions

- void xntimer_destroy (xntimer_t ∗timer)

  Release a timer object.
- static int xntimer_start (xntimer_t ∗timer, xnticks_t value, xnticks_t interval, xntmode_t mode)

  Arm a timer.
- static void xntimer_stop (xntimer_t ∗timer)

  Disarm a timer.
- static xnticks_t xntimer_get_date (xntimer_t ∗timer)

  Return the absolute expiration date.
- static xnticks_t xntimer_get_timeout (xntimer_t ∗timer)

Return the relative expiration date.

- static xnticks_t xntimer_get_interval (xntimer_t *timer)

    Return the timer interval value.

- unsigned long xntimer_get_overruns (xntimer_t *timer, xnticks_t now)

    Get the count of overruns for the last tick.

- void xntimer_freeze (void)

    Freeze all timers (from every time bases).

- void xntimer_tick_aperiodic (void)

    Process a timer tick for the aperiodic master time base.

- void xntimer_tick_periodic (xntimer_t *timer)

    Process a timer tick for a slave periodic time base.

6.12.1 Detailed Description

Note

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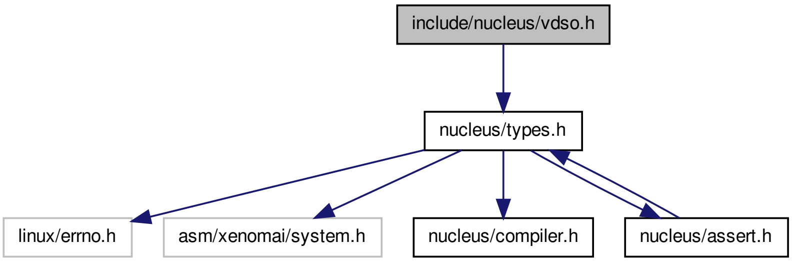
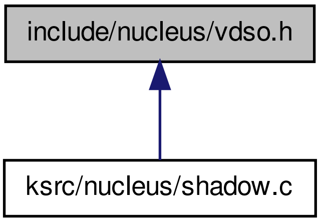
6.13 include/nucleus/vdso.h File Reference

Definitions for global semaphore heap shared objects.

Include dependency graph for vdso.h:



This graph shows which files directly or indirectly include this file:



6.13.1 Detailed Description

Definitions for global semaphore heap shared objects.

Author

Wolfgang Mauerer

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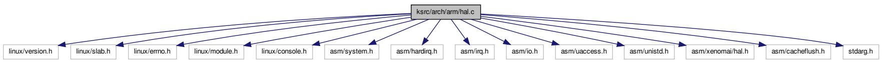
6.14 ksrc/arch/arm/hal.c File Reference

Adeos-based Real-Time Abstraction Layer for ARM.

Include dependency graph for hal.c:



Functions

- int rthal_timer_request (void(*tick_handler)(void), void(*mode_emul)(enum clock_event_mode mode, struct clock_event_device *cdev), int(*tick_emul)(unsigned long delay, struct clock_event_device *cdev), int cpu)

    Grab the hardware timer.
- void rthal_timer_release (int cpu)

    Release the hardware timer.
- int rthal_irq_host_request (unsigned irq, rthal_irq_host_handler_t handler, char *name, void *dev_id)

    Install a shared Linux interrupt handler.
- int rthal_irq_host_release (unsigned irq, void *dev_id)

    Uninstall a shared Linux interrupt handler.

6.14.1 Detailed Description

Adeos-based Real-Time Abstraction Layer for ARM. ARM port Copyright (C) 2005 Stelian Pop

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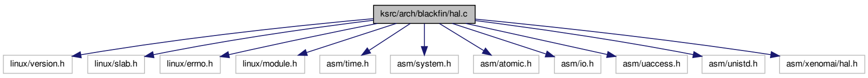
6.15 ksrc/arch/blackfin/hal.c File Reference

Adeos-based Real-Time Abstraction Layer for the Blackfin architecture.

Include dependency graph for hal.c:



Functions

- int rthal_timer_request (void(∗tick_handler)(void), void(∗mode_emul)(enum clock_event_mode mode, struct clock_event_device ∗cdev), int(∗tick_emul)(unsigned long delay, struct clock_event_device ∗cdev), int cpu)

  Grab the hardware timer.
- void rthal_timer_release (int cpu)

  Release the hardware timer.
- int rthal_irq_enable (unsigned irq)

  Enable an interrupt source.
- int rthal_irq_disable (unsigned irq)

  Disable an interrupt source.
- int rthal_irq_host_request (unsigned irq, rthal_irq_host_handler_t handler, char ∗name, void ∗dev_id)

  Install a shared Linux interrupt handler.
- int rthal_irq_host_release (unsigned irq, void ∗dev_id)

  Uninstall a shared Linux interrupt handler.

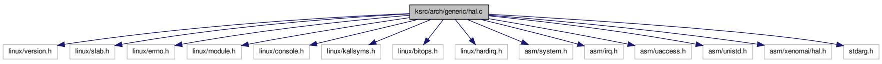
6.15.1 Detailed Description

Adeos-based Real-Time Abstraction Layer for the Blackfin architecture. - Copyright (C) 2005-2006 Philippe Gerum.

6.16 ksrc/arch/generic/hal.c File Reference

Generic Real-Time HAL.

Include dependency graph for hal.c:



Functions

- int rthal_irq_request (unsigned irq, rthal_irq_handler_t handler, rthal_irq_ackfn_t ackfn, void *cookie)

  Install a real-time interrupt handler.
- int rthal_irq_release (unsigned irq)

  Uninstall a real-time interrupt handler.
- int rthal_irq_affinity (unsigned irq, cpumask_t cpumask, cpumask_t *oldmask)

  Set/Get processor affinity for external interrupt.
- rthal_trap_handler_t rthal_trap_catch (rthal_trap_handler_t handler)

  Installs a fault handler.
- int rthal_apc_alloc (const char *name, void(*handler)(void *cookie), void *cookie)

  Allocate an APC slot.
- void rthal_apc_free (int apc)

  Releases an APC slot.

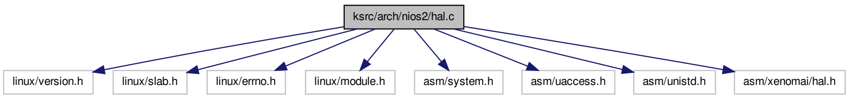
6.16.1 Detailed Description

Generic Real-Time HAL. Copyright ©2005 Philippe Gerum.

6.17 ksrc/arch/nios2/hal.c File Reference

Adeos-based Real-Time Abstraction Layer for the NIOS2 architecture.

Include dependency graph for hal.c:



Functions

- void rthal_timer_release (int cpu)

  Release the hardware timer.
- int rthal_irq_enable (unsigned irq)

  Enable an interrupt source.
- int rthal_irq_disable (unsigned irq)

  Disable an interrupt source.
- int rthal_irq_host_request (unsigned irq, rthal_irq_host_handler_t handler, char *name, void *dev_id)

  Install a shared Linux interrupt handler.
- int rthal_irq_host_release (unsigned irq, void *dev_id)

  Uninstall a shared Linux interrupt handler.

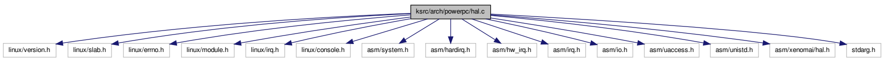
6.17.1 Detailed Description

Adeos-based Real-Time Abstraction Layer for the NIOS2 architecture. - Copyright (C) 2009 Philippe Gerum.

6.18 ksrc/arch/powerpc/hal.c File Reference

Adeos-based Real-Time Abstraction Layer for PowerPC.

Include dependency graph for hal.c:



Functions

- int rthal_timer_request (void(*tick_handler)(void), void(*mode_emul)(enum clock_event_mode mode, struct clock_event_device *cdev), int(*tick_emul)(unsigned long delay, struct clock_event_device *cdev), int cpu)

  Grab the hardware timer.
- void rthal_timer_release (int cpu)

  Release the hardware timer.
- int rthal_irq_host_request (unsigned irq, rthal_irq_host_handler_t handler, char *name, void *dev_id)

  Install a shared Linux interrupt handler.
- int rthal_irq_host_release (unsigned irq, void *dev_id)

  Uninstall a shared Linux interrupt handler.
- int rthal_irq_enable (unsigned irq)

  Enable an interrupt source.
- int rthal_irq_disable (unsigned irq)

  Disable an interrupt source.

6.18.1 Detailed Description

Adeos-based Real-Time Abstraction Layer for PowerPC. Copyright (C) 2004-2006 Philippe Gerum.

64-bit PowerPC adoption copyright (C) 2005 Taneli Vähäkangas and Heikki Lindholm

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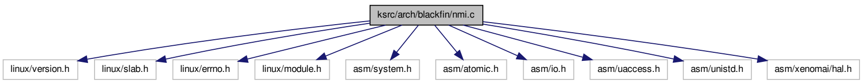
6.19 ksrc/arch/blackfin/nmi.c File Reference

NMI watchdog support.

Include dependency graph for nmi.c:



6.19.1 Detailed Description

NMI watchdog support. Copyright (C) 2005 Philippe Gerum.

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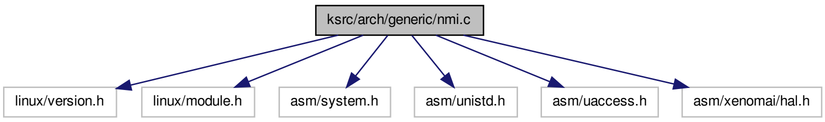
6.20 ksrc/arch/generic/nmi.c File Reference

Adeos-based Real-Time Abstraction Layer for x86.

Include dependency graph for nmi.c:



6.20.1 Detailed Description

Adeos-based Real-Time Abstraction Layer for x86. Copyright ©2005 Gilles Chanteperdrix.

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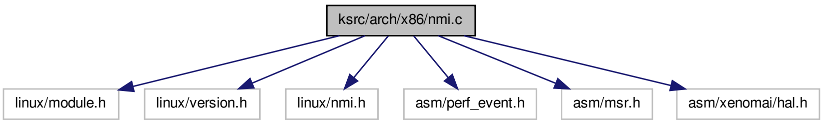
6.21 ksrc/arch/x86/nmi.c File Reference

NMI watchdog for x86, from linux/arch/i386/kernel/nmi.c.

Include dependency graph for nmi.c:



6.21.1 Detailed Description

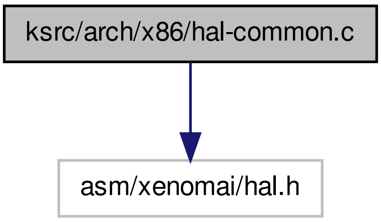
NMI watchdog for x86, from linux/arch/i386/kernel/nmi.c. Original authors: Ingo Molnar, Mikael Pettersson, Pavel Machek.

Adaptation to Xenomai by Gilles Chanteperdrix

6.22 ksrc/arch/x86/hal-common.c File Reference

Adeos-based Real-Time Abstraction Layer for x86.

Include dependency graph for hal-common.c:



Functions

- int rthal_irq_host_request (unsigned irq, rthal_irq_host_handler_t handler, char *name, void *dev_id)

  Install a shared Linux interrupt handler.
- int rthal_irq_host_release (unsigned irq, void *dev_id)

Uninstall a shared Linux interrupt handler.

- int rthal_irq_enable (unsigned irq)

  Enable an interrupt source.
- int rthal_irq_disable (unsigned irq)

  Disable an interrupt source.

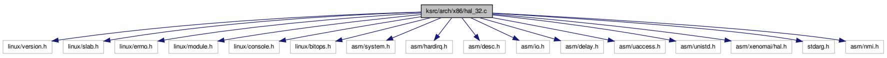
6.22.1 Detailed Description

Adeos-based Real-Time Abstraction Layer for x86. Common code of i386 and x86_64.

6.23 ksrc/arch/x86/hal_32.c File Reference

Adeos-based Real-Time Abstraction Layer for x86.

Include dependency graph for hal_32.c:



Functions

- int rthal_timer_request (void(*tick_handler)(void), void(*mode_emul)(enum clock_event_mode mode, struct clock_event_device *cdev), int(*tick_emul)(unsigned long delay, struct clock_event_device *cdev), int cpu)

  Grab the hardware timer.
- void rthal_timer_release (int cpu)

  Release the hardware timer.

6.23.1 Detailed Description

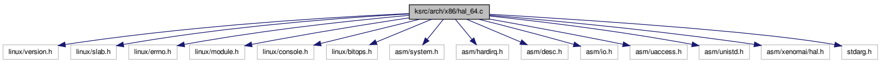
Adeos-based Real-Time Abstraction Layer for x86. Inspired from original RTAI/x86 HAL interface:

RTAI/x86 rewrite over Adeos:

6.24 ksrc/arch/x86/hal_64.c File Reference

Adeos-based Real-Time Abstraction Layer for x86_64.

Include dependency graph for hal_64.c:



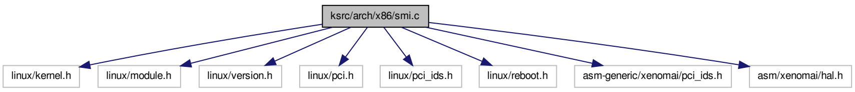
6.24.1 Detailed Description

Adeos-based Real-Time Abstraction Layer for x86_64. Derived from the -Xenomai/i386 HAL.

6.25 ksrc/arch/x86/smi.c File Reference

SMI workaround for x86.

Include dependency graph for smi.c:

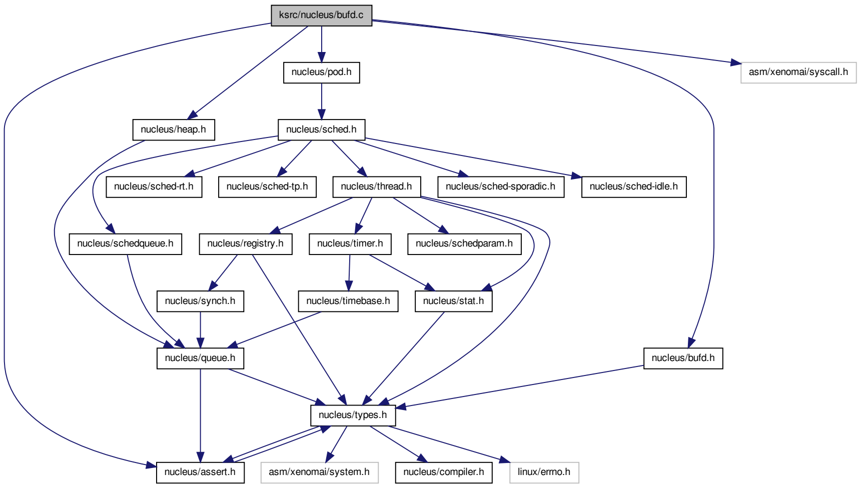


6.25.1 Detailed Description

SMI workaround for x86. Cut/Pasted from Vitor Angelo "smi" module. Adapted by Gilles Chanteperdrix <gilles.chanteperdrix@xenomai.org>.

6.26 ksrc/nucleus/bufd.c File Reference

Include dependency graph for bufd.c:



Functions

- ssize_t xnbufd_copy_to_kmem (void *ptr, struct xnbufd *bufd, size_t len)

    Copy memory covered by a buffer descriptor to kernel memory.
- ssize_t xnbufd_copy_from_kmem (struct xnbufd *bufd, void *from, size_t len)

    Copy kernel memory to the area covered by a buffer descriptor.
- ssize_t xnbufd_unmap_uread (struct xnbufd *bufd)

    Finalize a buffer descriptor obtained from xnbufd_map_uread().
- ssize_t xnbufd_unmap_uwrite (struct xnbufd *bufd)

    Finalize a buffer descriptor obtained from xnbufd_map_uwrite().
- void xnbufd_invalidate (struct xnbufd *bufd)

    Invalidate a buffer descriptor.
- ssize_t xnbufd_unmap_kread (struct xnbufd *bufd)

    Finalize a buffer descriptor obtained from xnbufd_map_kread().
- ssize_t xnbufd_unmap_kwrite (struct xnbufd *bufd)

    Finalize a buffer descriptor obtained from xnbufd_map_kwrite().

6.26.1 Detailed Description

Note

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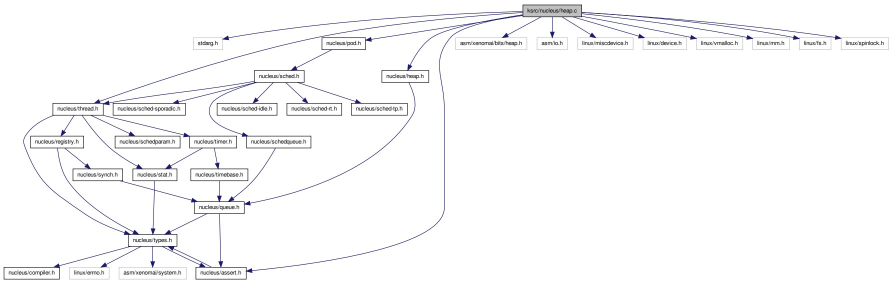
6.27 ksrc/nucleus/heap.c File Reference

Dynamic memory allocation services.

Include dependency graph for heap.c:



Functions

- int xnheap_init (xnheap_t *heap, void *heapaddr, u_long heapsize, u_-long pagesize)

  Initialize a memory heap.

- void xnheap_set_label (xnheap_t *heap, const char *label,...)

  Set the heap's label string.

- void xnheap_destroy (xnheap_t *heap, void(*flushfn)(xnheap_t *heap, void *extaddr, u_long extsize, void *cookie), void *cookie)

  Destroys a memory heap.

- void * xnheap_alloc (xnheap_t *heap, u_long size)

  Allocate a memory block from a memory heap.

- int xnheap_test_and_free (xnheap_t *heap, void *block, int(*ckfn)(void *block))

  Test and release a memory block to a memory heap.

- int xnheap_free (xnheap_t *heap, void *block)

  Release a memory block to a memory heap.

- int xnheap_extend (xnheap_t *heap, void *extaddr, u_long extsize)

  Extend a memory heap.

- void xnheap_schedule_free (xnheap_t *heap, void *block, xnholder_t *link)

  Schedule a memory block for release.

6.27.1 Detailed Description

Dynamic memory allocation services.

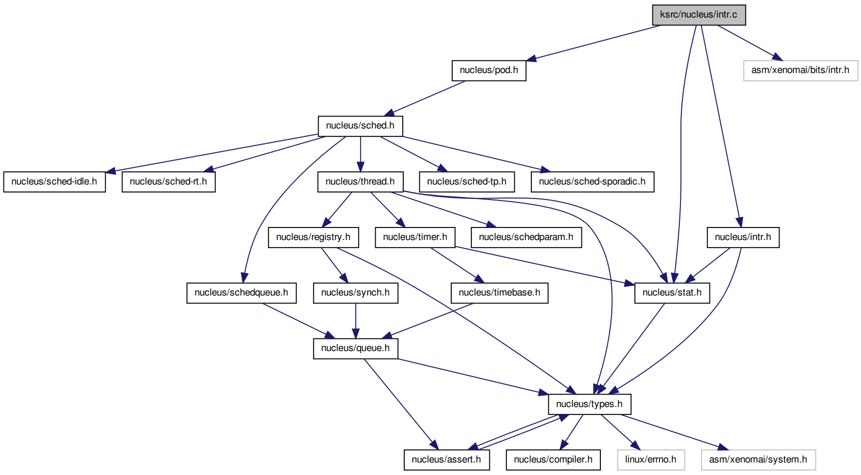
Author

Philippe Gerum

6.28 ksrc/nucleus/intr.c File Reference

Interrupt management.

Include dependency graph for intr.c:



Functions

- int xnintr_init (xnintr_t *intr, const char *name, unsigned irq, xnisr_t isr, xniack_t iack, xnflags_t flags)

  Initialize an interrupt object.
- int xnintr_destroy (xnintr_t *intr)

  Destroy an interrupt object.
- int xnintr_attach (xnintr_t *intr, void *cookie)

  Attach an interrupt object.
- int xnintr_detach (xnintr_t *intr)

  Detach an interrupt object.
- int xnintr_enable (xnintr_t *intr)

  Enable an interrupt object.
- int xnintr_disable (xnintr_t *intr)

  Disable an interrupt object.
- xnarch_cpumask_t xnintr_affinity (xnintr_t *intr, xnarch_cpumask_t cpumask)

  Set interrupt's processor affinity.

6.28.1 Detailed Description

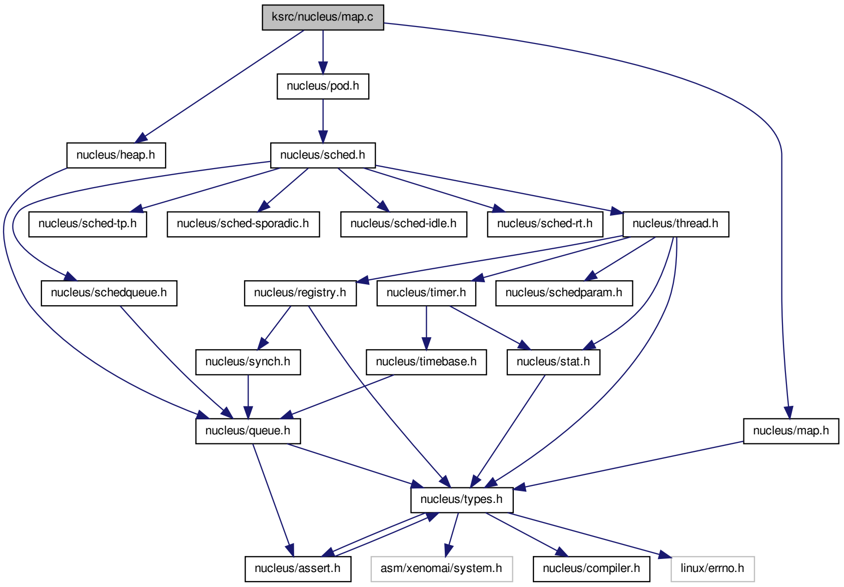
Interrupt management.

Author

Philippe Gerum

6.29 ksrc/nucleus/map.c File Reference

Include dependency graph for map.c:



Functions

- xnmap_t * xnmap_create (int nkeys, int reserve, int offset)

  Create a map.

- void xnmap_delete (xnmap_t *map)

  Delete a map.

- int xnmap_enter (xnmap_t *map, int key, void *objaddr)

  Index an object into a map.

- int xnmap_remove (xnmap_t *map, int key)

  Remove an object reference from a map.

6.29.1 Detailed Description

Note

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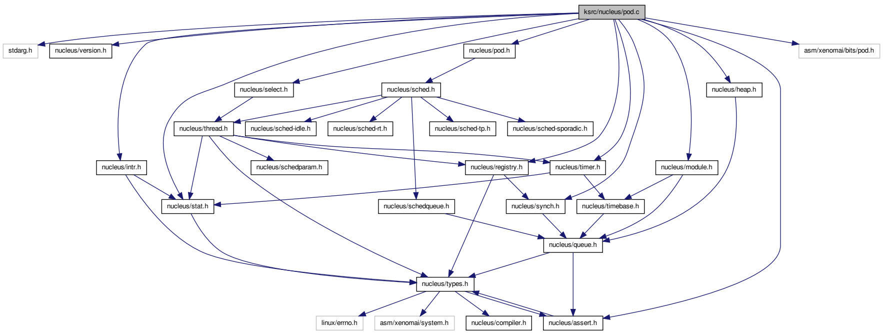
6.30 ksrc/nucleus/pod.c File Reference

Real-time pod services.

Include dependency graph for pod.c:



Functions

- int xnpod_init (void)

  Initialize the core pod.
- void xnpod_shutdown (int xtype)

  Shutdown the current pod.
- int xnpod_init_thread (struct xnthread *thread, const struct xnthread_init_attr *attr, struct xnsched_class *sched_class, const union xnsched_policy_param *sched_param)

  Initialize a new thread.
- int xnpod_start_thread (xnthread_t *thread, const struct xnthread_start_attr *attr)

  Initial start of a newly created thread.
- void xnpod_stop_thread (xnthread_t *thread)

  Stop a thread.
- void xnpod_restart_thread (xnthread_t *thread)

  Restart a thread.
- xnflags_t xnpod_set_thread_mode (xnthread_t *thread, xnflags_t clrmask, xnflags_t setmask)

  Change a thread's control mode.
- void xnpod_delete_thread (xnthread_t *thread)

  Delete a thread.
- void xnpod_abort_thread (xnthread_t *thread)

  Abort a thread.
- void xnpod_suspend_thread (xnthread_t *thread, xnflags_t mask, xnticks_t timeout, xntmode_t timeout_mode, struct xnsynch *wchan)

  Suspend a thread.
- void xnpod_resume_thread (xnthread_t *thread, xnflags_t mask)

  Resume a thread.

- int xnpod_unblock_thread (xnthread_t *thread)

  Unblock a thread.
- int xnpod_set_thread_schedparam (struct xnthread *thread, struct xnsched_class *sched_class, const union xnsched_policy_param *sched_param)

  Change the base scheduling parameters of a thread.
- int xnpod_migrate_thread (int cpu)

  Migrate the current thread.
- void xnpod_dispatch_signals (void)

  Deliver pending asynchronous signals to the running thread.
- void xnpod_welcome_thread (xnthread_t *thread, int imask)

  Thread prologue.
- int xnpod_add_hook (int type, void(*routine)(xnthread_t *))

  Install a nucleus hook.
- int xnpod_remove_hook (int type, void(*routine)(xnthread_t *))

  Remove a nucleus hook.
- int xnpod_trap_fault (xnarch_fltinfo_t *fltinfo)

  Default fault handler.
- int xnpod_enable_timesource (void)

  Activate the core time source.
- void xnpod_disable_timesource (void)

  Stop the core time source.
- int xnpod_set_thread_periodic (xnthread_t *thread, xnticks_t idate, xnticks_t period)

  Make a thread periodic.
- int xnpod_wait_thread_period (unsigned long *overruns_r)

  Wait for the next periodic release point.
- int xnpod_set_thread_tslice (struct xnthread *thread, xnticks_t quantum)

  Set thread time-slicing information.

6.30.1 Detailed Description

Real-time pod services.

Author

Philippe Gerum

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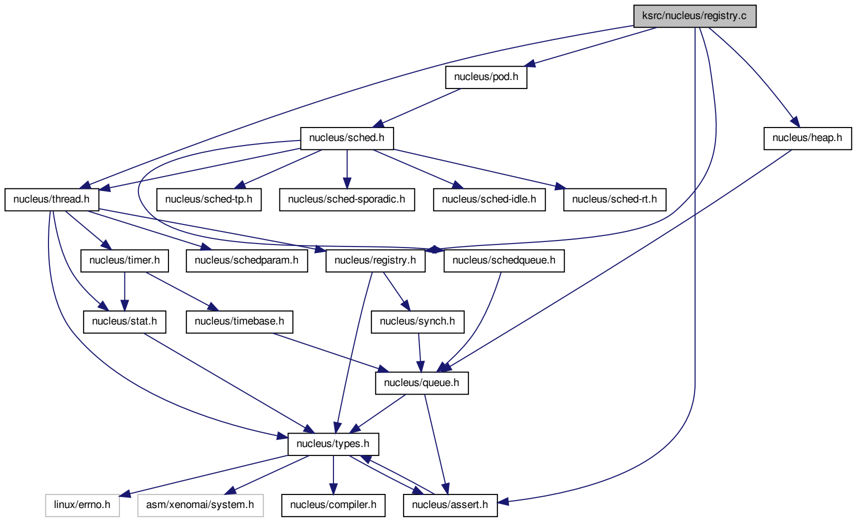
6.31 ksrc/nucleus/registry.c File Reference

This file is part of the Xenomai project.

Include dependency graph for registry.c:



Functions

- int xnregistry_enter (const char ∗key, void ∗objaddr, xnhandle_t ∗phandle, xnpnode_t ∗pnode)

  Register a real-time object.
- int xnregistry_bind (const char ∗key, xnticks_t timeout, int timeout_mode, xnhandle_t ∗phandle)

  Bind to a real-time object.

- int xnregistry_remove (xnhandle_t handle)

  Forcibly unregister a real-time object.

- int xnregistry_remove_safe (xnhandle_t handle, xnticks_t timeout)

  Unregister an idle real-time object.

- void * xnregistry_get (xnhandle_t handle)

  Find and lock a real-time object into the registry.

- u_long xnregistry_put (xnhandle_t handle)

  Unlock a real-time object from the registry.

- void * xnregistry_fetch (xnhandle_t handle)

  Find a real-time object into the registry.

6.31.1 Detailed Description

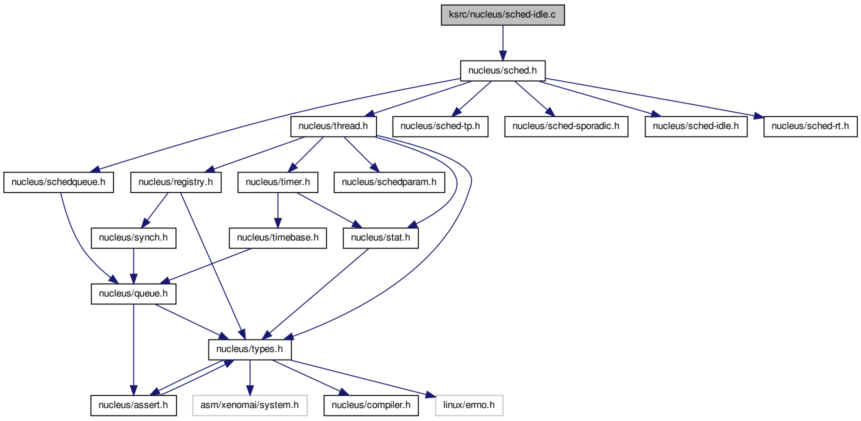
This file is part of the Xenomai project.

Note

6.32 ksrc/nucleus/sched-idle.c File Reference

Idle scheduling class implementation (i.e. Linux placeholder).

Include dependency graph for sched-idle.c:



6.32.1 Detailed Description

Idle scheduling class implementation (i.e. Linux placeholder).

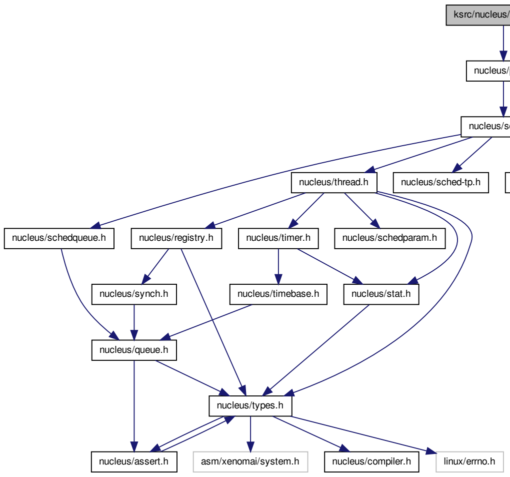
Author

Philippe Gerum Copyright (C) 2008 Philippe Gerum <rpm@xenomai.org>.

6.33 ksrc/nucleus/sched-rt.c File Reference

Common real-time scheduling class implementation (FIFO + RR)

Include dependency graph for sched-rt.c:



6.33.1 Detailed Description

Common real-time scheduling class implementation (FIFO + RR)

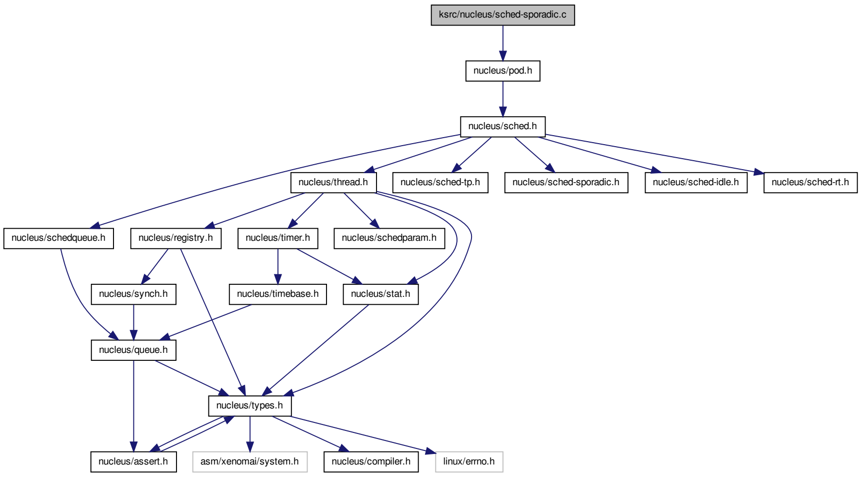
Author

Philippe Gerum Copyright (C) 2008 Philippe Gerum <rpm@xenomai.org>.

6.34 ksrc/nucleus/sched-sporadic.c File Reference

POSIX SCHED_SPORADIC scheduling class.

Include dependency graph for sched-sporadic.c:



6.34.1 Detailed Description

POSIX SCHED_SPORADIC scheduling class.

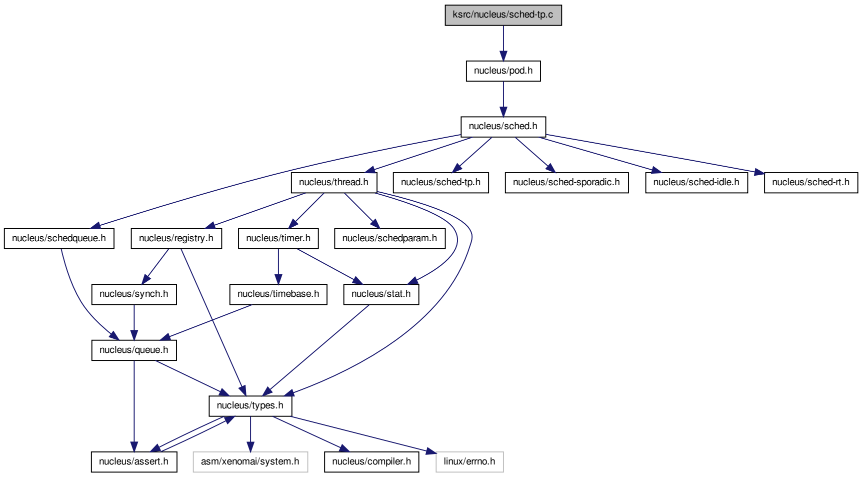
Author

Philippe Gerum Copyright (C) 2009 Philippe Gerum <rpm@xenomai.org>.

6.35 ksrc/nucleus/sched-tp.c File Reference

Temporal partitioning (typical of IMA systems).

Include dependency graph for sched-tp.c:



6.35.1 Detailed Description

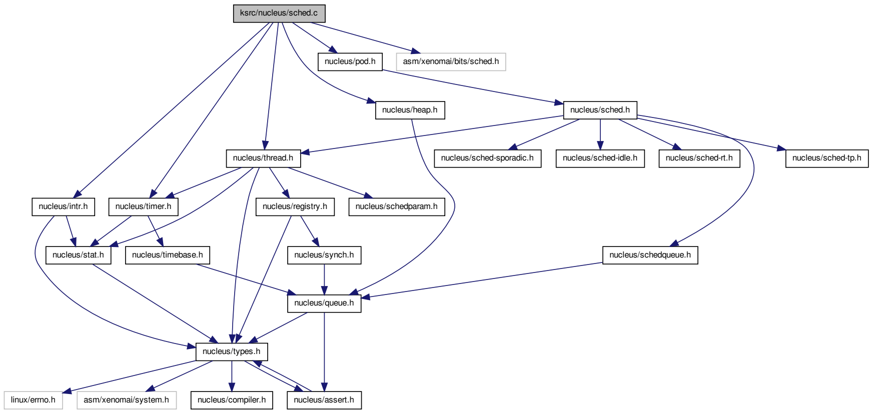
Temporal partitioning (typical of IMA systems).

Author

Philippe Gerum Copyright (C) 2008 Philippe Gerum <rpm@xenomai.org>.

6.36 ksrc/nucleus/sched.c File Reference

Include dependency graph for sched.c:



6.36.1 Detailed Description

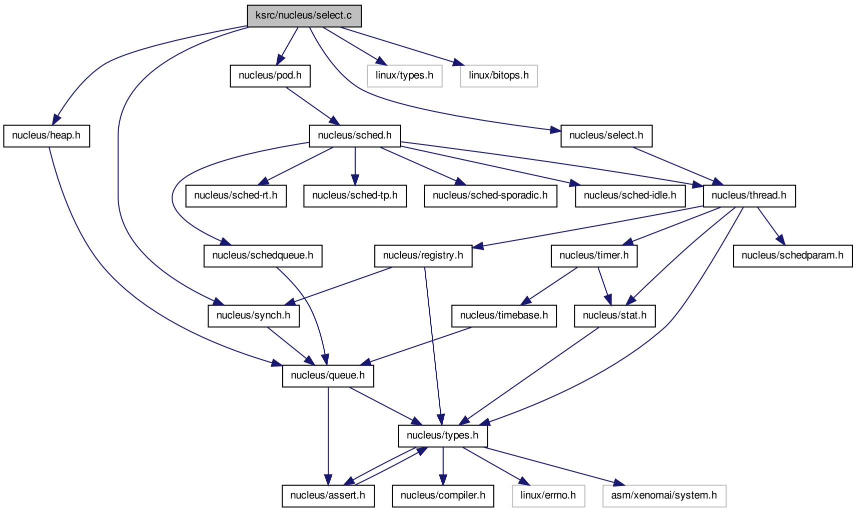
Author

Philippe Gerum

6.37 ksrc/nucleus/select.c File Reference

file descriptors events multiplexing.

Include dependency graph for select.c:



Functions

- void xnselect_init (struct xnselect *select_block)

  Initialize a struct xnselect structure.
- int xnselect_bind (struct xnselect *select_block, struct xnselect_binding *binding, struct xnselector *selector, unsigned type, unsigned index, unsigned state)

  Bind a file descriptor (represented by its xnselect structure) to a selector block.
- void xnselect_destroy (struct xnselect *select_block)

  Destroy the xnselect structure associated with a file descriptor.
- int xnselector_init (struct xnselector *selector)

  Initialize a selector structure.
- int xnselect (struct xnselector *selector, fd_set *out_fds[XNSELECT_MAX_TYPES], fd_set *in_fds[XNSELECT_MAX_TYPES], int nfds, xnticks_t timeout, xntmode_t timeout_mode)

  Check the state of a number of file descriptors, wait for a state change if no descriptor is ready.
- void xnselector_destroy (struct xnselector *selector)

  Destroy a selector block.

6.37.1 Detailed Description

file descriptors events multiplexing.

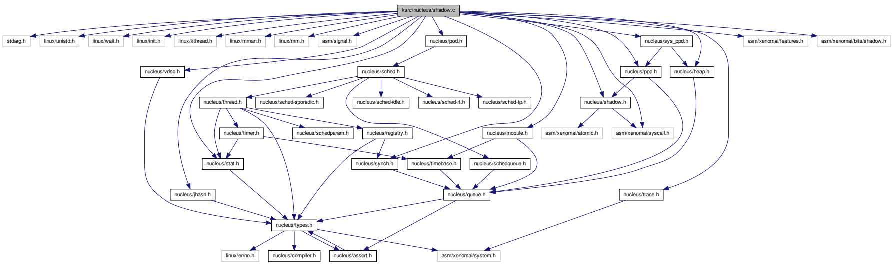
Author

Gilles Chanteperdrix

6.38 ksrc/nucleus/shadow.c File Reference

Real-time shadow services.

Include dependency graph for shadow.c:



Functions

- int xnshadow_mark_sig (xnthread_t *thread, unsigned muxid)

  Mark the per-thread per-skin signal condition for the skin whose muxid is muxid.

- void xnshadow_clear_sig (xnthread_t *thread, unsigned muxid)

  Clear the per-thrad per-skin signal condition.

- int xnshadow_harden (void)

  Migrate a Linux task to the Xenomai domain.

- void xnshadow_relax (int notify, int reason)

  Switch a shadow thread back to the Linux domain.

- int xnshadow_map (xnthread_t *thread, xncompletion_t __user *u_completion, unsigned long __user *u_mode)

  Create a shadow thread context.

- xnshadow_ppd_t * xnshadow_ppd_get (unsigned muxid)

  Return the per-process data attached to the calling process.

6.38.1 Detailed Description

Real-time shadow services.

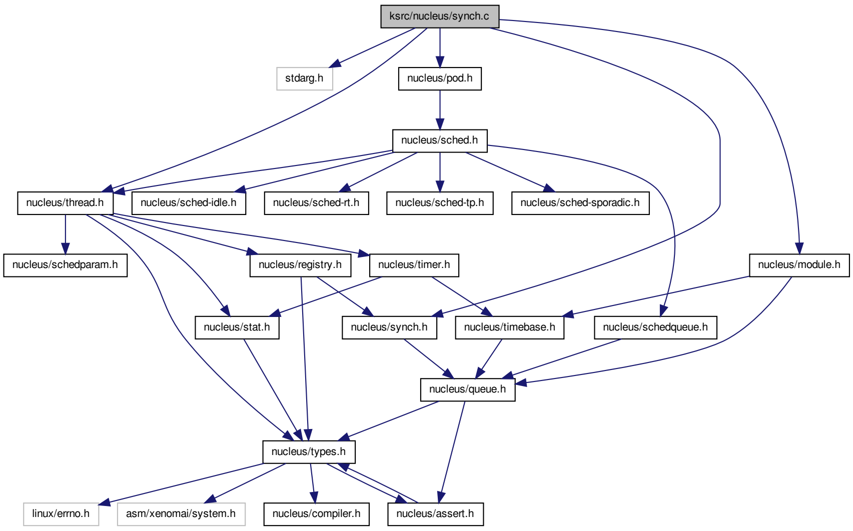
Author

Philippe Gerum

6.39 ksrc/nucleus/synch.c File Reference

Thread synchronization services.

Include dependency graph for synch.c:



Functions

- void xnsynch_init (struct xnsynch ∗synch, xnflags_t flags, xnarch_atomic_t ∗fastlock)

  Initialize a synchronization object.
- xnflags_t xnsynch_sleep_on (struct xnsynch ∗synch, xnticks_t timeout, xntmode_t timeout_mode)

  Sleep on an ownerless synchronization object.
- struct xnthread ∗ xnsynch_wakeup_one_sleeper (struct xnsynch ∗synch)

  Give the resource ownership to the next waiting thread.
- struct xnpholder ∗ xnsynch_wakeup_this_sleeper (struct xnsynch ∗synch, struct xnpholder ∗holder)

  Give the resource ownership to a given waiting thread.
- xnflags_t xnsynch_acquire (struct xnsynch ∗synch, xnticks_t timeout, xntmode_t timeout_mode)

  Acquire the ownership of a synchronization object.
- static void xnsynch_clear_boost (struct xnsynch ∗synch, struct xnthread ∗owner)

  Clear the priority boost.
- void xnsynch_requeue_sleeper (struct xnthread ∗thread)

  Change a sleeper's priority.
- struct xnthread ∗ xnsynch_release (struct xnsynch ∗synch)

Give the resource ownership to the next waiting thread.

- struct xnthread * xnsynch_peek_pendq (struct xnsynch *synch)

  Access the thread leading a synch object wait queue.

- int xnsynch_flush (struct xnsynch *synch, xnflags_t reason)

  Unblock all waiters pending on a resource.

- void xnsynch_forget_sleeper (struct xnthread *thread)

  Abort a wait for a resource.

- void xnsynch_release_all_ownerships (struct xnthread *thread)

  Release all ownerships.

6.39.1 Detailed Description

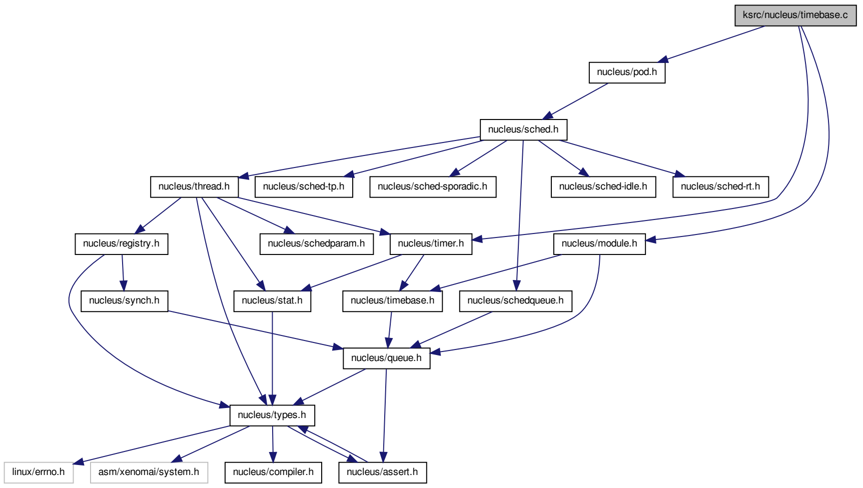
Thread synchronization services.

Author

Philippe Gerum

6.40 ksrc/nucleus/timebase.c File Reference

Include dependency graph for timebase.c:



Functions

- int xntbase_alloc (const char ∗name, u_long period, u_long flags, xntbase_t ∗∗basep)

  Allocate a time base.
- void xntbase_free (xntbase_t ∗base)

  Free a time base.
- int xntbase_update (xntbase_t ∗base, u_long period)

  Change the period of a time base.
- int xntbase_switch (const char ∗name, u_long period, xntbase_t ∗∗basep)

  Replace a time base.
- void xntbase_start (xntbase_t ∗base)

  Start a time base.
- void xntbase_stop (xntbase_t ∗base)

  Stop a time base.
- void xntbase_tick (xntbase_t ∗base)

  Announce a clock tick to a time base.
- xnticks_t xntbase_convert (xntbase_t ∗srcbase, xnticks_t ticks, xntbase_t ∗dstbase)

  Convert a clock value into another time base.
- void xntbase_adjust_time (xntbase_t ∗base, xnsticks_t delta)

  Adjust the clock time for the system.

6.40.1 Detailed Description

Note

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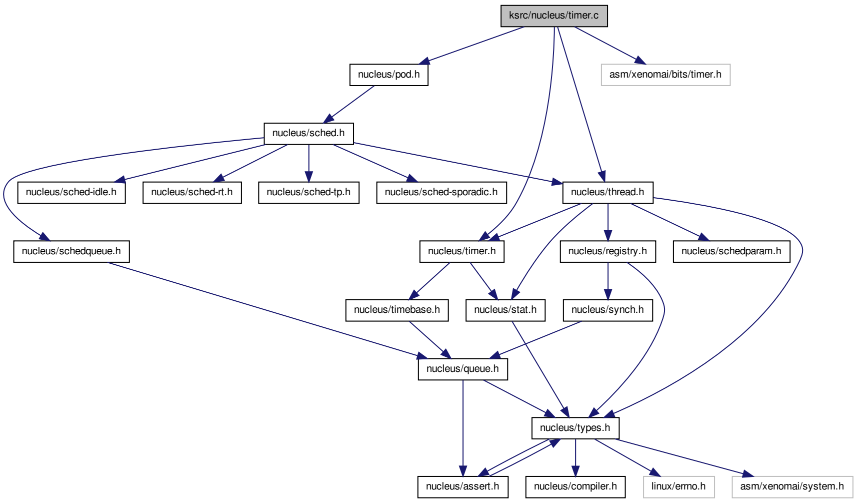
6.41 ksrc/nucleus/timer.c File Reference

Include dependency graph for timer.c:



Functions

- void xntimer_tick_aperiodic (void)

  Process a timer tick for the aperiodic master time base.
- void xntimer_tick_periodic (xntimer_t *mtimer)

Process a timer tick for a slave periodic time base.

- void xntimer_init (xntimer_t *timer, xntbase_t *base, void(*handler)(xntimer_t *timer))

  Initialize a timer object.
- void xntimer_destroy (xntimer_t *timer)

  Release a timer object.
- unsigned long xntimer_get_overruns (xntimer_t *timer, xnticks_t now)

  Get the count of overruns for the last tick.
- void xntimer_freeze (void)

  Freeze all timers (from every time bases).

6.41.1 Detailed Description

Note

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