Xenomai

2.99.0

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Deprecated List

Global RTDM_EXECUTE_ATOMICALLY (code_block)

This construct will be phased out in Xenomai 3.0. Please use rtdm_waitqueue services instead.

Global rtdm_task_sleep_until (nanosecs_abs_t wakeup_time)

Use rtdm_task_sleep_abs instead!

Chapter 2

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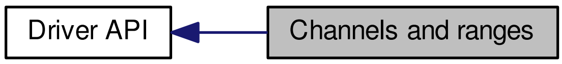
Module Documentation

5.1 Channels and ranges

Channels.

Collaboration diagram for Channels and ranges:



Data Structures

- struct a4l_channel

    Structure describing some channel's characteristics.
- struct a4l_channels_desc

    Structure describing a channels set.
- struct a4l_range

    Structure describing a (unique) range.

Macros

- #define A4L_CHAN_GLOBAL 0x10

    Internal use flag (must not be used by driver developer)
- #define A4L_RNG_GLOBAL 0x8

    Internal use flag (must not be used by driver developer)
- #define RANGE(x, y)

    Macro to declare a (unique) range with no unit defined.
- #define RANGE_V(x, y)

    Macro to declare a (unique) range in Volt.
- #define RANGE_mA(x, y)

    Macro to declare a (unique) range in milliAmpere.

- #define RANGE_ext(x, y)
  Macro to declare a (unique) range in some external reference.
- #define A4L_RNG_GLOBAL_RNGDESC 0
  Constant to define a ranges descriptor as global (inter-channel)
- #define A4L_RNG_PERCHAN_RNGDESC 1
  Constant to define a ranges descriptor as specific for a channel.
- #define RNG_GLOBAL(x)
  Macro to declare a ranges global descriptor in one line.

Channel reference

Flags to define the channel's reference

- #define A4L_CHAN_AREF_GROUND 0x1
  Ground reference.
- #define A4L_CHAN_AREF_COMMON 0x2
  Common reference.
- #define A4L_CHAN_AREF_DIFF 0x4
  Differential reference.
- #define A4L_CHAN_AREF_OTHER 0x8
  Misc reference.

Channels declaration mode

Constant to define whether the channels in a descriptor are identical

- #define A4L_CHAN_GLOBAL_CHANDESC 0
  Global declaration, the set contains channels with similar characteristics.
- #define A4L_CHAN_PERCHAN_CHANDESC 1
  Per channel declaration, the decriptor gathers differents channels.

5.1.1 Detailed Description

Channels. According to the Analogy nomenclature, the channel is the elementary acquisition entity. One channel is supposed to acquire one data at a time. A channel can be:

- an analog input or an analog ouput;
- a digital input or a digital ouput;

Channels are defined by their type and by some other characteristics like:

- their resolutions for analog channels (which usually ranges from 8 to 32 bits);
- their references;

Such parameters must be declared for each channel composing a subdevice. The structure a4l_channel (struct a4l_channel) is used to define one channel.

Another structure named a4l_channels_desc (struct a4l_channels_desc) gathers all channels for a specific subdevice. This latter structure also stores :

- the channels count;

- the channels declaration mode (A4L_CHAN_GLOBAL_CHANDESC or A4L_CHAN_PERCHAN_-CHANDESC): if all the channels composing a subdevice are identical, there is no need to declare the parameters for each channel; the global declaration mode eases the structure composition.

Usually the channels descriptor looks like this:

```
struct a4l_channels_desc example_chan = {
        mode: A4L_CHAN_GLOBAL_CHANDESC, -> Global declaration
                                         mode is set
        length: 8, -> 8 channels
        chans: {
                {A4L_CHAN_AREF_GROUND, 16}, -> Each channel is 16 bits
                                             wide with the ground as
                                             reference
        },
};
```

Ranges

So as to perform conversion from logical values acquired by the device to physical units, some range structure(s) must be declared on the driver side.

Such structures contain:

- the physical unit type (Volt, Ampere, none);
- the minimal and maximal values;

These range structures must be associated with the channels at subdevice registration time as a channel can work with many ranges. At configuration time (thanks to an Analogy command), one range will be selected for each enabled channel.

Consequently, for each channel, the developer must declare all the possible ranges in a structure called struct a4l_rngtab. Here is an example:

```
struct a4l_rngtab example_tab = {
    length: 2,
    rngs: {
        RANGE_V(-5,5),
        RANGE_V(-10,10),
    },
};
```

For each subdevice, a specific structure is designed to gather all the ranges tabs of all the channels. In this structure, called struct a4l_rngdesc, three fields must be filled:

- the declaration mode (A4L_RNG_GLOBAL_RNGDESC or A4L_RNG_PERCHAN_RNGDESC);
- the number of ranges tab;
- the tab of ranges tabs pointers;

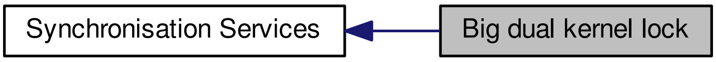
Most of the time, the channels which belong to the same subdevice use the same set of ranges. So, there is no need to declare the same ranges for each channel. A macro is defined to prevent redundant declarations: RNG_GLOBAL().

Here is an example:

```
struct a4l_rngdesc example_rng = RNG_GLOBAL(example_tab);
```

5.2 Big dual kernel lock

Collaboration diagram for Big dual kernel lock:



Macros

- #define cobalt_atomic_enter(context)
  Enter atomic section (dual kernel only)
- #define cobalt_atomic_leave(context)
  Leave atomic section (dual kernel only)
- #define RTDM_EXECUTE_ATOMICALLY(code_block)
  Execute code block atomically (DEPRECATED)

5.2.1 Detailed Description

5.2.2 Macro Definition Documentation

5.2.2.1 #define cobalt_atomic_enter(context)

Value:

```
do {                                    \
                xnlock_get_irqsave(&nklock, (context)); \
                __xnsched_lock();                       \
        } while (0)
```

Enter atomic section (dual kernel only)

This call opens a fully atomic section, serializing execution with respect to all interrupt handlers (including for real-time IRQs) and Xenomai threads running on all CPUs.

Parameters

context	name of local variable to store the context in. This variable updated by the real-time core will hold the information required to leave the atomic section properly.

Note

Atomic sections may be nested.
Since the strongest lock is acquired by this service, it can be used to synchronize real-time and non-real-time contexts.

Warning

This service is not portable to the Mercury core, and should be restricted to Cobalt-specific use cases.

5.2.2.2 #define cobalt_atomic_leave(context)

Value:

```
do {                                                    \
                __xnsched_unlock();                             \
                xnlock_put_irqrestore(&nklock, (context));      \
        } while (0)
```

Leave atomic section (dual kernel only)

This call closes an atomic section previously opened by a call to cobalt_atomic_enter(), restoring the preemption and interrupt state which prevailed prior to entering the exited section.

Parameters

context	name of local variable which stored the context.

Warning

This service is not portable to the Mercury core, and should be restricted to Cobalt-specific use cases.

5.2.2.3 #define RTDM_EXECUTE_ATOMICALLY(code_block)

Value:

```
{                                               \
        <ENTER_ATOMIC_SECTION>                  \
        code_block;                             \
        <LEAVE_ATOMIC_SECTION>                  \
}
```

Execute code block atomically (DEPRECATED)

Generally, it is illegal to suspend the current task by calling rtdm_task_sleep(), rtdm_event_wait(), etc. while holding a spinlock. In contrast, this macro allows to combine several operations including a potentially rescheduling call to an atomic code block with respect to other RTDM_EXECUTE_ATOMICALLY() blocks. The macro is a light-weight alternative for protecting code blocks via mutexes, and it can even be used to synchronise real-time and non-real-time contexts.

Parameters

code_block	Commands to be executed atomically

Note

It is not allowed to leave the code block explicitly by using `break`, `return`, `goto`, etc. This would leave the global lock held during the code block execution in an inconsistent state. Moreover, do not embed complex operations into the code bock. Consider that they will be executed under preemption lock with interrupts switched-off. Also note that invocation of rescheduling calls may break the atomicity until the task gains the CPU again.

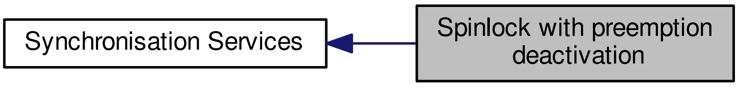
Tags

unrestricted

Deprecated This construct will be phased out in Xenomai 3.0. Please use rtdm_waitqueue services instead.

5.3 Spinlock with preemption deactivation

Collaboration diagram for Spinlock with preemption deactivation:



Macros

- #define RTDM_LOCK_UNLOCKED(__name) IPIPE_SPIN_LOCK_UNLOCKED

    Static lock initialisation.
- #define rtdm_lock_irqsave(context) splhigh(context)

    Disable preemption locally.
- #define rtdm_lock_irqrestore(context) splexit(context)

    Restore preemption state.

Typedefs

- typedef ipipe_spinlock_t rtdm_lock_t

    Lock variable.
- typedef unsigned long rtdm_lockctx_t

    Variable to save the context while holding a lock.

Functions

- static void rtdm_lock_init (rtdm_lock_t *lock)

    Dynamic lock initialisation.
- static void rtdm_lock_get (rtdm_lock_t *lock)

    Acquire lock from non-preemptible contexts.
- static void rtdm_lock_put (rtdm_lock_t *lock)

    Release lock without preemption restoration.
- static void rtdm_lock_put_irqrestore (rtdm_lock_t *lock, rtdm_lockctx_t context)

    Release lock and restore preemption state.

5.3.1 Detailed Description

5.3.2 Macro Definition Documentation

5.3.2.1 #define rtdm_lock_irqrestore(context) **splexit**(context)

Restore preemption state.

Parameters

context	name of local variable which stored the context

Tags

unrestricted

5.3.2.2 #define rtdm_lock_irqsave(context) **splhigh**(context)

Disable preemption locally.

Parameters

context	name of local variable to store the context in

Tags

unrestricted

5.3.3 Function Documentation

5.3.3.1 static void rtdm_lock_get (**rtdm_lock_t** * lock) [inline], [static]

Acquire lock from non-preemptible contexts.

Parameters

lock	Address of lock variable

Tags

unrestricted

References spltest.

5.3.3.2 static void rtdm_lock_init (**rtdm_lock_t** * lock) [inline], [static]

Dynamic lock initialisation.

Parameters

lock	Address of lock variable

Tags

task-unrestricted

5.3.3.3 static void rtdm_lock_put (**rtdm_lock_t** * lock) [inline], [static]

Release lock without preemption restoration.

Parameters

lock	Address of lock variable

Tags

unrestricted, might-switch

5.3.3.4 static void rtdm_lock_put_irqrestore (**rtdm_lock_t** * lock, **rtdm_lockctx_t** context) [inline], [static]

Release lock and restore preemption state.

Parameters

lock	Address of lock variable
context	name of local variable which stored the context

Tags

unrestricted

Referenced by a4l_request_irq(), and rtdm_ratelimit().

5.4 Thread state flags

Bits reporting permanent or transient states of threads.

Collaboration diagram for Thread state flags:

Macros

- #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.
- #define XNZOMBIE 0x00000020

    Zombie thread in deletion process.
- #define XNMAPPED 0x00000040

    Thread is mapped to a linux task.
- #define XNRELAX 0x00000080

    Relaxed shadow thread (blocking bit)
- #define XNMIGRATE 0x00000100

    Thread is currently migrating to another CPU.
- #define XNHELD 0x00000200

    Thread is held to process emergency.
- #define XNBOOST 0x00000400

    Undergoes a PIP boost.
- #define XNDEBUG 0x00000800

    Hit a debugger breakpoint.
- #define XNLOCK 0x00001000

    Holds the scheduler lock (i.e.
- #define XNRRB 0x00002000

    Undergoes a round-robin scheduling.
- #define XNTRAPSW 0x00004000

    Trap execution mode switches.
- #define XNFPU 0x00008000

    Thread uses FPU.
- #define XNROOT 0x00010000

    Root thread (that is, Linux/IDLE)

- #define XNWEAK 0x00020000

  Non real-time shadow (from the WEAK class)
- #define XNUSER 0x00040000

  Shadow thread running in userland.
- #define XNJOINED 0x00080000

  Another thread waits for joining this thread.
- #define XNTRAPLB 0x00100000

  Trap lock break (i.e.

5.4.1 Detailed Description

Bits reporting permanent or transient states of threads.

5.4.2 Macro Definition Documentation

5.4.2.1 #define XNHELD 0x00000200

Thread is held to process emergency.

Referenced by xnthread_resume(), and xnthread_suspend().

5.4.2.2 #define XNLOCK 0x00001000

Holds the scheduler lock (i.e.

not preemptible)

Referenced by xnthread_set_mode(), and xnthread_suspend().

5.4.2.3 #define XNMIGRATE 0x00000100

Thread is currently migrating to another CPU.

5.4.2.4 #define XNPEND 0x00000002

Sleep-wait for a resource.

Referenced by xnsynch_acquire(), xnsynch_flush(), xnsynch_sleep_on(), xnsynch_wakeup_one_-sleeper(), xnsynch_wakeup_this_sleeper(), xnthread_resume(), and xnthread_unblock().

5.4.2.5 #define XNREADY 0x00000008

Linked to the ready queue.

Referenced by xnthread_resume(), and xnthread_suspend().

5.4.2.6 #define XNSUSP 0x00000001

Suspended.

Referenced by xnthread_init(), xnthread_start(), and xnthread_suspend().

5.4.2.7 #define XNTRAPLB 0x00100000

Trap lock break (i.e.

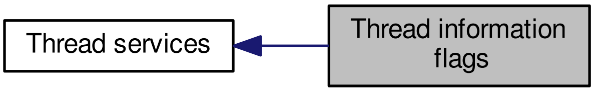
may not sleep with XNLOCK)

Referenced by xnthread_suspend().

5.5 Thread information flags

Bits reporting events notified to threads.

Collaboration diagram for Thread information flags:



Macros

- #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

    Forced out of primary mode.
- #define XNWAKEN 0x00000010

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

    Robbed from resource ownership.
- #define XNCANCELD 0x00000040

    Cancellation request is pending.
- #define XNSWREP 0x00000080

    Mode switch already reported.
- #define XNMOVED 0x00000100

    CPU migration in primary mode occurred.

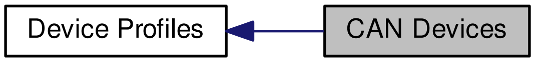
5.5.1 Detailed Description

Bits reporting events notified to threads.

5.6 CAN Devices

This is the common interface a RTDM-compliant CAN device has to provide.

Collaboration diagram for CAN Devices:



Data Structures

- struct can_bittime_std

  Standard bit-time parameters according to Bosch.
- struct can_bittime_btr

  Hardware-specific BTR bit-times.
- struct can_bittime

  Custom CAN bit-time definition.
- struct can_filter

  Filter for reception of CAN messages.
- struct sockaddr_can

  Socket address structure for the CAN address family.
- struct can_frame

  Raw CAN frame.

Macros

- #define AF_CAN 29

  CAN address family.
- #define PF_CAN AF_CAN

  CAN protocol family.
- #define SOL_CAN_RAW 103

  CAN socket levels.

Typedefs

- typedef uint32_t can_id_t

  Type of CAN id (see CAN_xxx_MASK and CAN_xxx_FLAG)
- typedef can_id_t can_err_mask_t

  Type of CAN error mask.
- typedef uint32_t can_baudrate_t

  Baudrate definition in bits per second.
- typedef enum CAN_BITTIME_TYPE can_bittime_type_t

  See CAN_BITTIME_TYPE.
- typedef enum CAN_MODE can_mode_t

See CAN_MODE.
- typedef int can_ctrlmode_t

  See CAN_CTRLMODE.
- typedef enum CAN_STATE can_state_t

  See CAN_STATE.
- typedef struct can_filter can_filter_t

  Filter for reception of CAN messages.
- typedef struct can_frame can_frame_t

  Raw CAN frame.

Enumerations

- enum CAN_BITTIME_TYPE { CAN_BITTIME_STD, CAN_BITTIME_BTR }

  Supported CAN bit-time types.

CAN ID masks

Bit masks for masking CAN IDs

- #define CAN_EFF_MASK 0x1FFFFFFF

  Bit mask for extended CAN IDs.
- #define CAN_SFF_MASK 0x000007FF

  Bit mask for standard CAN IDs.

CAN ID flags

Flags within a CAN ID indicating special CAN frame attributes

- #define CAN_EFF_FLAG 0x80000000

  Extended frame.
- #define CAN_RTR_FLAG 0x40000000

  Remote transmission frame.
- #define CAN_ERR_FLAG 0x20000000

  Error frame (see Errors), not valid in struct can_filter.
- #define CAN_INV_FILTER CAN_ERR_FLAG

  Invert CAN filter definition, only valid in struct can_filter.

Particular CAN protocols

Possible protocols for the PF_CAN protocol family

Currently only the RAW protocol is supported.

- #define CAN_RAW 1

  Raw protocol of `PF_CAN`, applicable to socket type `SOCK_RAW`.

CAN operation modes

Modes into which CAN controllers can be set

- enum CAN_MODE { CAN_MODE_STOP = 0, CAN_MODE_START, CAN_MODE_SLEEP }

CAN controller modes

Special CAN controllers modes, which can be or'ed together.

Note

These modes are hardware-dependent. Please consult the hardware manual of the CAN controller for more detailed information.

- #define CAN_CTRLMODE_LISTENONLY 0x1
- #define CAN_CTRLMODE_LOOPBACK 0x2
- #define CAN_CTRLMODE_3_SAMPLES 0x4

CAN controller states

States a CAN controller can be in.

- enum CAN_STATE {
  CAN_STATE_ERROR_ACTIVE = 0, CAN_STATE_ACTIVE = 0, CAN_STATE_ERROR_WARNING = 1, CAN_STATE_BUS_WARNING = 1,
  CAN_STATE_ERROR_PASSIVE = 2, CAN_STATE_BUS_PASSIVE = 2, CAN_STATE_BUS_OFF, CAN_STATE_SCANNING_BAUDRATE,
  CAN_STATE_STOPPED, CAN_STATE_SLEEPING }

Timestamp switches

Arguments to pass to RTCAN_RTIOC_TAKE_TIMESTAMP

- #define RTCAN_TAKE_NO_TIMESTAMPS 0

  Switch off taking timestamps.
- #define RTCAN_TAKE_TIMESTAMPS 1

  Do take timestamps.

RAW socket options

Setting and getting CAN RAW socket options.

- #define CAN_RAW_FILTER 0x1

  CAN filter definition.
- #define CAN_RAW_ERR_FILTER 0x2

  CAN error mask.
- #define CAN_RAW_LOOPBACK 0x3

  CAN TX loopback.
- #define CAN_RAW_RECV_OWN_MSGS 0x4

  CAN receive own messages.

IOCTLs

CAN device IOCTLs

- #define SIOCGIFINDEX defined_by_kernel_header_file

Get CAN interface index by name.
- #define SIOCSCANBAUDRATE _IOW(RTIOC_TYPE_CAN, 0x01, struct ifreq)

  Set baud rate.
- #define SIOCGCANBAUDRATE _IOWR(RTIOC_TYPE_CAN, 0x02, struct ifreq)

  Get baud rate.
- #define SIOCSCANCUSTOMBITTIME _IOW(RTIOC_TYPE_CAN, 0x03, struct ifreq)

  Set custom bit time parameter.
- #define SIOCGCANCUSTOMBITTIME _IOWR(RTIOC_TYPE_CAN, 0x04, struct ifreq)

  Get custom bit-time parameters.
- #define SIOCSCANMODE _IOW(RTIOC_TYPE_CAN, 0x05, struct ifreq)

  Set operation mode of CAN controller.
- #define SIOCGCANSTATE _IOWR(RTIOC_TYPE_CAN, 0x06, struct ifreq)

  Get current state of CAN controller.
- #define SIOCSCANCTRLMODE _IOW(RTIOC_TYPE_CAN, 0x07, struct ifreq)

  Set special controller modes.
- #define SIOCGCANCTRLMODE _IOWR(RTIOC_TYPE_CAN, 0x08, struct ifreq)

  Get special controller modes.
- #define RTCAN_RTIOC_TAKE_TIMESTAMP _IOW(RTIOC_TYPE_CAN, 0x09, int)

  Enable or disable storing a high precision timestamp upon reception of a CAN frame.
- #define RTCAN_RTIOC_RCV_TIMEOUT _IOW(RTIOC_TYPE_CAN, 0x0A, nanosecs_rel_t)

  Specify a reception timeout for a socket.
- #define RTCAN_RTIOC_SND_TIMEOUT _IOW(RTIOC_TYPE_CAN, 0x0B, nanosecs_rel_t)

  Specify a transmission timeout for a socket.

Error mask

Error class (mask) in `can_id` field of struct can_frame to be used with CAN_RAW_ERR_FILTER.

Note: Error reporting is hardware dependent and most CAN controllers report less detailed error conditions than the SJA1000.

Note: In case of a bus-off error condition (CAN_ERR_BUSOFF), the CAN controller is **not** restarted automatically. It is the application's responsibility to react appropriately, e.g. calling CAN_MODE_START.

Note: Bus error interrupts (CAN_ERR_BUSERROR) are enabled when an application is calling a Recv function on a socket listening on bus errors (using CAN_RAW_ERR_FILTER). After one bus error has occured, the interrupt will be disabled to allow the application time for error processing and to efficiently avoid bus error interrupt flooding.

- #define CAN_ERR_TX_TIMEOUT 0x00000001U

  TX timeout (netdevice driver)
- #define CAN_ERR_LOSTARB 0x00000002U

  Lost arbitration (see data[0])
- #define CAN_ERR_CRTL 0x00000004U

  Controller problems (see data[1])
- #define CAN_ERR_PROT 0x00000008U

  Protocol violations (see data[2], data[3])
- #define CAN_ERR_TRX 0x00000010U

  Transceiver status (see data[4])
- #define CAN_ERR_ACK 0x00000020U

  Received no ACK on transmission.
- #define CAN_ERR_BUSOFF 0x00000040U

Bus off.

- #define CAN_ERR_BUSERROR 0x00000080U

  Bus error (may flood!)
- #define CAN_ERR_RESTARTED 0x00000100U

  Controller restarted.
- #define CAN_ERR_MASK 0x1FFFFFFFU

  Omit EFF, RTR, ERR flags.

Arbitration lost error

Error in the data[0] field of struct can_frame.

- #define CAN_ERR_LOSTARB_UNSPEC 0x00

  unspecified

Controller problems

Error in the data[1] field of struct can_frame.

- #define CAN_ERR_CRTL_UNSPEC 0x00

  unspecified
- #define CAN_ERR_CRTL_RX_OVERFLOW 0x01

  RX buffer overflow.
- #define CAN_ERR_CRTL_TX_OVERFLOW 0x02

  TX buffer overflow.
- #define CAN_ERR_CRTL_RX_WARNING 0x04

  reached warning level for RX errors
- #define CAN_ERR_CRTL_TX_WARNING 0x08

  reached warning level for TX errors
- #define CAN_ERR_CRTL_RX_PASSIVE 0x10

  reached passive level for RX errors
- #define CAN_ERR_CRTL_TX_PASSIVE 0x20

  reached passive level for TX errors

Protocol error type

Error in the data[2] field of struct can_frame.

- #define CAN_ERR_PROT_UNSPEC 0x00

  unspecified
- #define CAN_ERR_PROT_BIT 0x01

  single bit error
- #define CAN_ERR_PROT_FORM 0x02

  frame format error
- #define CAN_ERR_PROT_STUFF 0x04

  bit stuffing error
- #define CAN_ERR_PROT_BIT0 0x08

  unable to send dominant bit
- #define CAN_ERR_PROT_BIT1 0x10

unable to send recessive bit

- #define CAN_ERR_PROT_OVERLOAD 0x20

  bus overload
- #define CAN_ERR_PROT_ACTIVE 0x40

  active error announcement
- #define CAN_ERR_PROT_TX 0x80

  error occured on transmission

Protocol error location

Error in the data[4] field of struct can_frame.

- #define CAN_ERR_PROT_LOC_UNSPEC 0x00

  unspecified
- #define CAN_ERR_PROT_LOC_SOF 0x03

  start of frame
- #define CAN_ERR_PROT_LOC_ID28_21 0x02

  ID bits 28 - 21 (SFF: 10 - 3)
- #define CAN_ERR_PROT_LOC_ID20_18 0x06

  ID bits 20 - 18 (SFF: 2 - 0)
- #define CAN_ERR_PROT_LOC_SRTR 0x04

  substitute RTR (SFF: RTR)
- #define CAN_ERR_PROT_LOC_IDE 0x05

  identifier extension
- #define CAN_ERR_PROT_LOC_ID17_13 0x07

  ID bits 17-13.
- #define CAN_ERR_PROT_LOC_ID12_05 0x0F

  ID bits 12-5.
- #define CAN_ERR_PROT_LOC_ID04_00 0x0E

  ID bits 4-0.
- #define CAN_ERR_PROT_LOC_RTR 0x0C

  RTR.
- #define CAN_ERR_PROT_LOC_RES1 0x0D

  reserved bit 1
- #define CAN_ERR_PROT_LOC_RES0 0x09

  reserved bit 0
- #define CAN_ERR_PROT_LOC_DLC 0x0B

  data length code
- #define CAN_ERR_PROT_LOC_DATA 0x0A

  data section
- #define CAN_ERR_PROT_LOC_CRC_SEQ 0x08

  CRC sequence.
- #define CAN_ERR_PROT_LOC_CRC_DEL 0x18

  CRC delimiter.
- #define CAN_ERR_PROT_LOC_ACK 0x19

  ACK slot.
- #define CAN_ERR_PROT_LOC_ACK_DEL 0x1B

  ACK delimiter.
- #define CAN_ERR_PROT_LOC_EOF 0x1A

  end of frame

- #define CAN_ERR_PROT_LOC_INTERM 0x12
  intermission
- #define CAN_ERR_TRX_UNSPEC 0x00
  0000 0000
- #define CAN_ERR_TRX_CANH_NO_WIRE 0x04
  0000 0100
- #define CAN_ERR_TRX_CANH_SHORT_TO_BAT 0x05
  0000 0101
- #define CAN_ERR_TRX_CANH_SHORT_TO_VCC 0x06
  0000 0110
- #define CAN_ERR_TRX_CANH_SHORT_TO_GND 0x07
  0000 0111
- #define CAN_ERR_TRX_CANL_NO_WIRE 0x40
  0100 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_BAT 0x50
  0101 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_VCC 0x60
  0110 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_GND 0x70
  0111 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_CANH 0x80
  1000 0000

5.6.1 Detailed Description

This is the common interface a RTDM-compliant CAN device has to provide. Feel free to report bugs and comments on this profile to the "Socketcan" mailing list (`Socketcan-core@lists.berlios.de`) or directly to the authors (`wg@grandegger.com` or `Sebastian.Smolorz@stud.uni-hannover.de`).

Profile Revision: 2

Device Characteristics

Device Flags: `RTDM_PROTOCOL_DEVICE`
Protocol Family: `PF_CAN`
Socket Type: `SOCK_RAW`
Device Class: `RTDM_CLASS_CAN`

Supported Operations

Socket

Tags

secondary-only
Specific return values:

- -EPROTONOSUPPORT (Protocol is not supported by the driver. See CAN protocols for possible protocols.)

Close
Blocking calls to any of the Send or Receive functions will be unblocked when the socket is closed and return with an error.

Tags

secondary-only
Specific return values: none
IOCTL

Tags

task-unrestricted. see below Specific return values: see below
Bind
Binds a socket to one or all CAN devices (see struct sockaddr_can). If a filter list has been defined with setsockopt (see Sockopts), it will be used upon reception of CAN frames to decide whether the bound socket will receive a frame. If no filter has been defined, the socket will receive **all** CAN frames on the specified interface(s).
Binding to special interface index `0` will make the socket receive CAN frames from all CAN interfaces.
Binding to an interface index is also relevant for the Send functions because they will transmit a message over the interface the socket is bound to when no socket address is given to them.

Tags

secondary-only
Specific return values:

- -EFAULT (It was not possible to access user space memory area at the specified address.)
- -ENOMEM (Not enough memory to fulfill the operation)
- -EINVAL (Invalid address family, or invalid length of address structure)
- -ENODEV (Invalid CAN interface index)
- -ENOSPC (No enough space for filter list)
- -EBADF (Socket is about to be closed)
- -EAGAIN (Too many receivers. Old binding (if any) is still active. Close some sockets and try again.)

Setsockopt, Getsockopt
These functions allow to set and get various socket options. Currently, only CAN raw sockets are supported.
Supported Levels and Options:

- Level **SOL_CAN_RAW** : CAN RAW protocol (see CAN_RAW)
  - Option CAN_RAW_FILTER : CAN filter list
  - Option CAN_RAW_ERR_FILTER : CAN error mask
  - Option CAN_RAW_LOOPBACK : CAN TX loopback to local sockets

Tags

task-unrestricted Specific return values: see links to options above.
Recv, Recvfrom, Recvmsg
These functions receive CAN messages from a socket. Only one message per call can be received, so only one buffer with the correct length must be passed. For `SOCK_RAW`, this is the size of struct can_frame.
Unlike a call to one of the Send functions, a Recv function will not return with an error if an interface is down (due to bus-off or setting of stop mode) or in sleep mode. Moreover, in such a case there may still be some CAN messages in the socket buffer which could be read out successfully.
It is possible to receive a high precision timestamp with every CAN message. The condition is a former instruction to the socket via RTCAN_RTIOC_TAKE_TIMESTAMP. The timestamp will be copied to the `msg_control` buffer of `struct msghdr` if it points to a valid memory location with size of nanosecs_abs_t. If this is a NULL pointer the timestamp will be discarded silently.
Note: A `msg_controllen` of `0` upon completion of the function call indicates that no timestamp is available for that message.
Supported Flags [in]:

- MSG_DONTWAIT (By setting this flag the operation will only succeed if it would not block, i.e. if there is a message in the socket buffer. This flag takes precedence over a timeout specified by RTCAN_RTIOC_RCV_TIMEOUT.)
- MSG_PEEK (Receive a message but leave it in the socket buffer. The next receive operation will get that message again.)

Supported Flags [out]: none

Tags

mode-unrestricted
Specific return values:

- Non-negative value (Indicating the successful reception of a CAN message. For `SOCK_RAW`, this is the size of struct can_frame regardless of the actual size of the payload.)
- -EFAULT (It was not possible to access user space memory area at one of the specified addresses.)
- -EINVAL (Unsupported flag detected, or invalid length of socket address buffer, or invalid length of message control buffer)
- -EMSGSIZE (Zero or more than one iovec buffer passed, or buffer too small)
- -EAGAIN (No data available in non-blocking mode)
- -EBADF (Socket was closed.)
- -EINTR (Operation was interrupted explicitly or by signal.)
- -ETIMEDOUT (Timeout)

Send, Sendto, Sendmsg
These functions send out CAN messages. Only one message per call can be transmitted, so only one buffer with the correct length must be passed. For `SOCK_RAW`, this is the size of struct can_frame. The following only applies to `SOCK_RAW`: If a socket address of struct sockaddr_can is given, only `can_ifindex` is used. It is also possible to omit the socket address. Then the interface the socket is bound to will be used for sending messages.
If an interface goes down (due to bus-off or setting of stop mode) all senders that were blocked on this interface will be woken up.
Supported Flags:

- MSG_DONTWAIT (By setting this flag the transmit operation will only succeed if it would not block. This flag takes precedence over a timeout specified by RTCAN_RTIOC_SND_TIMEOUT.)

Tags

mode-unrestricted
Specific return values:

- Non-negative value equal to given buffer size (Indicating the successful completion of the function call. See also note.)
- -EOPNOTSUPP (MSG_OOB flag is not supported.)
- -EINVAL (Unsupported flag detected *or:* Invalid length of socket address *or:* Invalid address family *or:* Data length code of CAN frame not between 0 and 15 *or:* CAN standard frame has got an ID not between 0 and 2031)
- -EMSGSIZE (Zero or more than one buffer passed or invalid size of buffer)
- -EFAULT (It was not possible to access user space memory area at one of the specified addresses.)
- -ENXIO (Invalid CAN interface index - `0` is not allowed here - or socket not bound or rather bound to all interfaces.)
- -ENETDOWN (Controller is bus-off or in stopped state.)
- -ECOMM (Controller is sleeping)
- -EAGAIN (Cannot transmit without blocking but a non-blocking call was requested.)
- -EINTR (Operation was interrupted explicitly or by signal)
- -EBADF (Socket was closed.)
- -ETIMEDOUT (Timeout)

Note: A successful completion of the function call does not implicate a successful transmission of the message.

5.6.2 Macro Definition Documentation

5.6.2.1 #define CAN_CTRLMODE_3_SAMPLES 0x4

Triple sampling mode

In this mode the CAN controller uses Triple sampling.

5.6.2.2 #define CAN_CTRLMODE_LISTENONLY 0x1

Listen-Only mode

In this mode the CAN controller would give no acknowledge to the CAN-bus, even if a message is received successfully and messages would not be transmitted. This mode might be useful for bus-monitoring, hot-plugging or throughput analysis.

Examples:

rtcanconfig.c.

5.6.2.3 #define CAN_CTRLMODE_LOOPBACK 0x2

Loopback mode

In this mode the CAN controller does an internal loop-back, a message is transmitted and simultaneously received. That mode can be used for self test operation.

Examples:

rtcanconfig.c.

5.6.2.4 #define CAN_ERR_LOSTARB_UNSPEC 0x00

unspecified

else bit number in bitstream

5.6.2.5 #define CAN_RAW_ERR_FILTER 0x2

CAN error mask.

A CAN error mask (see Errors) can be set with `setsockopt`. This mask is then used to decide if error frames are delivered to this socket in case of error condidtions. The error frames are marked with the CAN_ERR_FLAG of CAN_xxx_FLAG and must be handled by the application properly. A detailed description of the errors can be found in the `can_id` and the `data` fields of struct can_frame (see Errors for futher details).

Parameters

in	*level*	**SOL_CAN_RAW**
in	*optname*	**CAN_RAW_ERR_FILTER**
in	*optval*	Pointer to error mask of type can_err_mask_t.

in	*optlen*	Size of error mask: sizeof(can_err_mask_t).

Tags

task-unrestricted
Specific return values:

- -EFAULT (It was not possible to access user space memory area at the specified address.)
- -EINVAL (Invalid length "optlen")

Examples:

rtcanrecv.c.

5.6.2.6 #define CAN_RAW_FILTER 0x1

CAN filter definition.

A CAN raw filter list with elements of struct can_filter can be installed with `setsockopt`. This list is used upon reception of CAN frames to decide whether the bound socket will receive a frame. An empty filter list can also be defined using optlen = 0, which is recommanded for write-only sockets.

If the socket was already bound with Bind, the old filter list gets replaced with the new one. Be aware that already received, but not read out CAN frames may stay in the socket buffer.

Parameters

in	*level*	**SOL_CAN_RAW**
in	*optname*	**CAN_RAW_FILTER**
in	*optval*	Pointer to array of struct can_filter.
in	*optlen*	Size of filter list: count * sizeof(struct can_filter).

Tags

task-unrestricted
Specific return values:

- -EFAULT (It was not possible to access user space memory area at the specified address.)
- -ENOMEM (Not enough memory to fulfill the operation)
- -EINVAL (Invalid length "optlen")
- -ENOSPC (No space to store filter list, check RT-Socket-CAN kernel parameters)

Examples:

can-rtt.c, rtcanrecv.c, and rtcansend.c.

5.6.2.7 #define CAN_RAW_LOOPBACK 0x3

CAN TX loopback.

The TX loopback to other local sockets can be selected with this `setsockopt`.

Note

The TX loopback feature must be enabled in the kernel and then the loopback to other local TX sockets is enabled by default.

Parameters

in	*level*	**SOL_CAN_RAW**
in	*optname*	**CAN_RAW_LOOPBACK**
in	*optval*	Pointer to integer value.
in	*optlen*	Size of int: sizeof(int).

Tags

task-unrestricted

Specific return values:

- -EFAULT (It was not possible to access user space memory area at the specified address.)
- -EINVAL (Invalid length "optlen")
- -EOPNOTSUPP (not supported, check RT-Socket-CAN kernel parameters).

Examples:

rtcansend.c.

5.6.2.8 #define CAN_RAW_RECV_OWN_MSGS 0x4

CAN receive own messages.

Not supported by RT-Socket-CAN, but defined for compatibility with Socket-CAN.

5.6.2.9 #define RTCAN_RTIOC_RCV_TIMEOUT _IOW(RTIOC_TYPE_CAN, 0x0A, nanosecs_rel_t)

Specify a reception timeout for a socket.

Defines a timeout for all receive operations via a socket which will take effect when one of the receive functions is called without the `MSG_DONTWAIT` flag set.

The default value for a newly created socket is an infinite timeout.

Note

The setting of the timeout value is not done atomically to avoid locks. Please set the value before receiving messages from the socket.

Parameters

in	*arg*	Pointer to nanosecs_rel_t variable. The value is interpreted as relative timeout in nanoseconds in case of a positive value. See Timeouts for special timeouts.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.

Tags

task-unrestricted

Examples:

rtcanrecv.c.

5.6.2.10 #define RTCAN_RTIOC_SND_TIMEOUT _IOW(RTIOC_TYPE_CAN, 0x0B, nanosecs_rel_t)

Specify a transmission timeout for a socket.

Defines a timeout for all send operations via a socket which will take effect when one of the send functions is called without the `MSG_DONTWAIT` flag set.

The default value for a newly created socket is an infinite timeout.

Note

The setting of the timeout value is not done atomically to avoid locks. Please set the value before sending messages to the socket.

Parameters

in	*arg*	Pointer to nanosecs_rel_t variable. The value is interpreted as relative timeout in nanoseconds in case of a positive value. See Timeouts for special timeouts.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.

Tags

task-unrestricted

Examples:

rtcansend.c.

5.6.2.11 #define RTCAN_RTIOC_TAKE_TIMESTAMP _IOW(RTIOC_TYPE_CAN, 0x09, int)

Enable or disable storing a high precision timestamp upon reception of a CAN frame.

A newly created socket takes no timestamps by default.

Parameters

in	*arg*	int variable, see Timestamp switches

Returns

0 on success.

Tags

task-unrestricted

Note

Activating taking timestamps only has an effect on newly received CAN messages from the bus. Frames that already are in the socket buffer do not have timestamps if it was deactivated before. See Receive for more details.

Examples:

rtcanrecv.c.

5.6.2.12 #define SIOCGCANBAUDRATE _IOWR(RTIOC_TYPE_CAN, 0x02, struct ifreq)

Get baud rate.

Parameters

in,out	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` will be filled with an instance of can_baudrate_t.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No baud rate was set yet.

Tags

task-unrestricted

5.6.2.13 #define SIOCGCANCTRLMODE _IOWR(RTIOC_TYPE_CAN, 0x08, struct ifreq)

Get special controller modes.

Parameters

in	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` must be filled with an instance of can_ctrlmode_t.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No baud rate was set yet.

Tags

task-unrestricted, might-switch

5.6.2.14 #define SIOCGCANCUSTOMBITTIME _IOWR(RTIOC_TYPE_CAN, 0x04, struct ifreq)

Get custom bit-time parameters.

Parameters

in,out	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` will be filled with an instance of struct can_bittime.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No baud rate was set yet.

Tags

task-unrestricted

5.6.2.15 #define SIOCGCANSTATE _IOWR(RTIOC_TYPE_CAN, 0x06, struct ifreq)

Get current state of CAN controller.

States are divided into main states and additional error indicators. A CAN controller is always in exactly one main state. CAN bus errors are registered by the CAN hardware and collected by the driver. There is one error indicator (bit) per error type. If this IOCTL is triggered the error types which occured since the last call of this IOCTL are reported and thereafter the error indicators are cleared. See also CAN controller states.

Parameters

`in,out`	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` will be filled with an instance of can_mode_t.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.

Tags

task-unrestricted, might-switch

5.6.2.16 #define SIOCGIFINDEX defined_by_kernel_header_file

Get CAN interface index by name.

Parameters

`in,out`	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). If `ifr_name` holds a valid CAN interface name `ifr_ifindex` will be filled with the corresponding interface index.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.

Tags

task-unrestricted

Examples:

can-rtt.c, rtcanconfig.c, rtcanrecv.c, and rtcansend.c.

5.6.2.17 #define SIOCSCANBAUDRATE _IOW(RTIOC_TYPE_CAN, 0x01, struct ifreq)

Set baud rate.

The baudrate must be specified in bits per second. The driver will try to calculate resonable CAN bit-timing parameters. You can use SIOCSCANCUSTOMBITTIME to set custom bit-timing.

Parameters

in	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` must be filled with an instance of can_baudrate_t.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No valid baud rate, see can_baudrate_t.
- -EDOM : Baud rate not possible.
- -EAGAIN: Request could not be successully fulfilled. Try again.

Tags

task-unrestricted, might-switch

Note

Setting the baud rate is a configuration task. It should be done deliberately or otherwise CAN messages will likely be lost.

Examples:

rtcanconfig.c.

5.6.2.18 #define SIOCSCANCTRLMODE _IOW(RTIOC_TYPE_CAN, 0x07, struct ifreq)

Set special controller modes.

Various special controller modes could be or'ed together (see CAN_CTRLMODE for further information).

Parameters

in	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` must be filled with an instance of can_ctrlmode_t.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No valid baud rate, see can_baudrate_t.
- -EAGAIN: Request could not be successully fulfilled. Try again.

Tags

task-unrestricted, might-switch

Note

Setting special controller modes is a configuration task. It should be done deliberately or otherwise CAN messages will likely be lost.

Examples:

rtcanconfig.c.

5.6.2.19 #define SIOCSCANCUSTOMBITTIME _IOW(RTIOC_TYPE_CAN, 0x03, struct ifreq)

Set custom bit time parameter.

Custem-bit time could be defined in various formats (see struct can_bittime).

Parameters

in	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` must be filled with an instance of struct can_bittime.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EINVAL: No valid baud rate, see can_baudrate_t.
- -EAGAIN: Request could not be successully fulfilled. Try again.

Tags

task-unrestricted, might-switch

Note

Setting the bit-time is a configuration task. It should be done deliberately or otherwise CAN messages will likely be lost.

Examples:

rtcanconfig.c.

5.6.2.20 #define SIOCSCANMODE _IOW(RTIOC_TYPE_CAN, 0x05, struct ifreq)

Set operation mode of CAN controller.

See CAN controller modes for available modes.

Parameters

in	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). `ifr_name` must hold a valid CAN interface name, `ifr_ifru` must be filled with an instance of can_mode_t.

Returns

0 on success, otherwise:

- -EFAULT: It was not possible to access user space memory area at the specified address.
- -ENODEV: No device with specified name exists.
- -EAGAIN: (CAN_MODE_START, CAN_MODE_STOP) Could not successfully set mode, hardware is busy. Try again.
- -EINVAL: (CAN_MODE_START) Cannot start controller, set baud rate first.
- -ENETDOWN: (CAN_MODE_SLEEP) Cannot go into sleep mode because controller is stopped or bus off.
- -EOPNOTSUPP: unknown mode

Tags

task-unrestricted, might-switch

Note

Setting a CAN controller into normal operation after a bus-off can take some time (128 occurrences of 11 consecutive recessive bits). In such a case, although this IOCTL will return immediately with success and SIOCGCANSTATE will report CAN_STATE_ACTIVE, bus-off recovery may still be in progress.
If a controller is bus-off, setting it into stop mode will return no error but the controller remains bus-off.

Examples:

rtcanconfig.c.

5.6.2.21 #define SOL_CAN_RAW 103

CAN socket levels.

Used for Sockopts for the particular protocols.

Examples:

can-rtt.c, rtcanrecv.c, and rtcansend.c.

5.6.3 Typedef Documentation

5.6.3.1 typedef struct **can_filter can_filter_t**

Filter for reception of CAN messages.

This filter works as follows: A received CAN ID is AND'ed bitwise with `can_mask` and then compared to `can_id`. This also includes the CAN_EFF_FLAG and CAN_RTR_FLAG of CAN_xxx_FLAG. If this comparison is true, the message will be received by the socket. The logic can be inverted with the `can_id` flag CAN_INV_FILTER :

```
if (can_id & CAN_INV_FILTER) {
   if ((received_can_id & can_mask) != (can_id & ~CAN_INV_FILTER))
      accept-message;
} else {
   if ((received_can_id & can_mask) == can_id)
      accept-message;
}
```

Multiple filters can be arranged in a filter list and set with Sockopts. If one of these filters matches a CAN ID upon reception of a CAN frame, this frame is accepted.

5.6.3.2 typedef struct **can_frame can_frame_t**

Raw CAN frame.

Central structure for receiving and sending CAN frames.

Examples:

rtcanrecv.c.

5.6.4 Enumeration Type Documentation

5.6.4.1 enum **CAN_BITTIME_TYPE**

Supported CAN bit-time types.

Enumerator

CAN_BITTIME_STD Standard bit-time definition according to Bosch.

CAN_BITTIME_BTR Hardware-specific BTR bit-time definition.

5.6.4.2 enum **CAN_MODE**

Enumerator

CAN_MODE_STOP Set controller in Stop mode (no reception / transmission possible)

CAN_MODE_START Set controller into normal operation.

Coming from stopped mode or bus off, the controller begins with no errors in CAN_STATE_ACTIVE.

CAN_MODE_SLEEP Set controller into Sleep mode.

This is only possible if the controller is not stopped or bus-off.

Notice that sleep mode will only be entered when there is no bus activity. If the controller detects bus activity while "sleeping" it will go into operating mode again.

To actively leave sleep mode again trigger `CAN_MODE_START`.

5.6.4.3 enum **CAN_STATE**

Enumerator

CAN_STATE_ERROR_ACTIVE CAN controller is error active.

CAN_STATE_ACTIVE CAN controller is active.

CAN_STATE_ERROR_WARNING CAN controller is error active, warning level is reached.

CAN_STATE_BUS_WARNING CAN controller is error active, warning level is reached.

CAN_STATE_ERROR_PASSIVE CAN controller is error passive.

CAN_STATE_BUS_PASSIVE CAN controller is error passive.

CAN_STATE_BUS_OFF CAN controller went into Bus Off.

CAN_STATE_SCANNING_BAUDRATE CAN controller is scanning to get the baudrate.

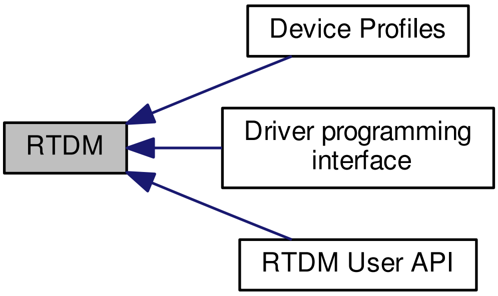
CAN_STATE_STOPPED CAN controller is in stopped mode.

CAN_STATE_SLEEPING CAN controller is in Sleep mode.

5.7 RTDM

The Real-Time Driver Model (RTDM) provides a unified interface to both users and developers of real-time device drivers.

Collaboration diagram for RTDM:



Modules

- RTDM User API

  Application interface to RTDM services.
- Driver programming interface

  RTDM driver programming interface.
- Device Profiles

  Pre-defined classes of real-time devices.

Typedefs

- typedef uint64_t nanosecs_abs_t

  RTDM type for representing absolute dates.
- typedef int64_t nanosecs_rel_t

  RTDM type for representing relative intervals.

API Versioning

- #define RTDM_API_VER 9

  Common user and driver API version.
- #define RTDM_API_MIN_COMPAT_VER 9

  Minimum API revision compatible with the current release.

RTDM_TIMEOUT_xxx

Special timeout values

- #define RTDM_TIMEOUT_INFINITE 0

  Block forever.
- #define RTDM_TIMEOUT_NONE (-1)

  Any negative timeout means non-blocking.

5.7.1 Detailed Description

The Real-Time Driver Model (RTDM) provides a unified interface to both users and developers of real-time device drivers. Specifically, it addresses the constraints of mixed RT/non-RT systems like Xenomai. RTDM conforms to POSIX semantics (IEEE Std 1003.1) where available and applicable.

API Revision: 8

5.7.2 Macro Definition Documentation

5.7.2.1 #define RTDM_TIMEOUT_INFINITE 0

Block forever.

5.7.2.2 #define RTDM_TIMEOUT_NONE (-1)

Any negative timeout means non-blocking.

5.7.3 Typedef Documentation

5.7.3.1 typedef uint64_t **nanosecs_abs_t**

RTDM type for representing absolute dates.

Its base type is a 64 bit unsigned integer. The unit is 1 nanosecond.

Examples:

rtcanrecv.c.

5.7.3.2 typedef int64_t **nanosecs_rel_t**

RTDM type for representing relative intervals.

Its base type is a 64 bit signed integer. The unit is 1 nanosecond. Relative intervals can also encode the special timeouts "infinite" and "non-blocking", see RTDM_TIMEOUT_xxx.

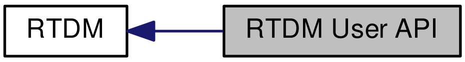
Examples:

rtcanrecv.c.

5.8 RTDM User API

Application interface to RTDM services.

Collaboration diagram for RTDM User API:



Files

- file rtdm.h

  Real-Time Driver Model for Xenomai, user API header.

Functions

- int rt_dev_open (const char *path, int oflag,...)

  Open a device.
- int rt_dev_socket (int protocol_family, int socket_type, int protocol)

  Create a socket.
- int rt_dev_close (int fd)

  Close a device or socket.
- int rt_dev_ioctl (int fd, int request,...)

  Issue an IOCTL.
- ssize_t rt_dev_read (int fd, void *buf, size_t nbyte)

  Read from device.
- ssize_t rt_dev_write (int fd, const void *buf, size_t nbyte)

  Write to device.
- ssize_t rt_dev_recvmsg (int fd, struct msghdr *msg, int flags)

  Receive message from socket.
- ssize_t rt_dev_recvfrom (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)

  Receive message from socket.
- ssize_t rt_dev_recv (int fd, void *buf, size_t len, int flags)

  Receive message from socket.
- ssize_t rt_dev_sendmsg (int fd, const struct msghdr *msg, int flags)

  Transmit message to socket.
- ssize_t rt_dev_sendto (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)

  Transmit message to socket.
- ssize_t rt_dev_send (int fd, const void *buf, size_t len, int flags)

  Transmit message to socket.
- int rt_dev_bind (int fd, const struct sockaddr *my_addr, socklen_t addrlen)

  Bind to local address.
- int rt_dev_connect (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)

Connect to remote address.

- int rt_dev_listen (int fd, int backlog)

  Listen for incomming connection requests.
- int rt_dev_accept (int fd, struct sockaddr *addr, socklen_t *addrlen)

  Accept connection requests.
- int rt_dev_shutdown (int fd, int how)

  Shut down parts of a connection.
- int rt_dev_getsockopt (int fd, int level, int optname, void *optval, socklen_t *optlen)

  Get socket option.
- int rt_dev_setsockopt (int fd, int level, int optname, const void *optval, socklen_t optlen)

  Set socket option.
- int rt_dev_getsockname (int fd, struct sockaddr *name, socklen_t *namelen)

  Get local socket address.
- int rt_dev_getpeername (int fd, struct sockaddr *name, socklen_t *namelen)

  Get socket destination address.

5.8.1 Detailed Description

Application interface to RTDM services. This is the upper interface of RTDM provided to application programs both in kernel and user space. Note that certain functions may not be implemented by every device. Refer to the Device Profiles for precise information.

5.8.2 Function Documentation

5.8.2.1 int rt_dev_accept (int fd, struct sockaddr * addr, socklen_t * addrlen)

Accept connection requests.

Parameters

`in`	*fd*	File descriptor as returned by rt_dev_socket()
`out`	*addr*	Buffer for remote address
`in,out`	*addrlen*	Address buffer size

Returns

0 on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`accept()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

mode-unrestricted, might-switch

5.8.2.2 int rt_dev_bind (int fd, const struct sockaddr * my_addr, socklen_t addrlen)

Bind to local address.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
in	*my_addr*	Address buffer
in	*addrlen*	Address buffer size

Returns

0 on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`bind()` in IEEE Std 1003.1, http://www.opengroup.org/onlinepubs/009695399

Tags

mode-unrestricted, might-switch

Examples:

rtcanrecv.c, and rtcansend.c.

5.8.2.3 int rt_dev_close (int fd)

Close a device or socket.

Parameters

in	*fd*	File descriptor as returned by rt_dev_open() or rt_dev_socket()

Returns

0 on success, otherwise a negative error code.

Note

If the matching rt_dev_open() or rt_dev_socket() call took place in non-real-time context, rt_dev_close() must be issued within non-real-time as well. Otherwise, the call will fail.

Action depends on driver implementation, see Device Profiles.

See Also

`close()` in IEEE Std 1003.1, http://www.opengroup.org/onlinepubs/009695399

Tags

secondary-only, might-switch

Examples:

cross-link.c, rtcanconfig.c, rtcanrecv.c, and rtcansend.c.

5.8.2.4 int rt_dev_connect (int fd, const struct sockaddr * serv_addr, socklen_t addrlen)

Connect to remote address.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
in	*serv_addr*	Address buffer
in	*addrlen*	Address buffer size

Returns

0 on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`connect()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

mode-unrestricted, might-switch

5.8.2.5 int rt_dev_getpeername (int fd, struct sockaddr * name, socklen_t * namelen)

Get socket destination address.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
out	*name*	Address buffer
in,out	*namelen*	Address buffer size

Returns

0 on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`getpeername()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

task-unrestricted, might-switch

5.8.2.6 int rt_dev_getsockname (int fd, struct sockaddr * name, socklen_t * namelen)

Get local socket address.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
out	*name*	Address buffer

`in,out`	*namelen*	Address buffer size

Returns

0 on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`getsockname()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

task-unrestricted, might-switch

5.8.2.7 int rt_dev_getsockopt (int fd, int level, int optname, void * optval, socklen_t * optlen)

Get socket option.

Parameters

`in`	*fd*	File descriptor as returned by rt_dev_socket()
`in`	*level*	Addressed stack level
`in`	*optname*	Option name ID
`out`	*optval*	Value buffer
`in,out`	*optlen*	Value buffer size

Returns

0 on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`getsockopt()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

task-unrestricted, might-switch

5.8.2.8 int rt_dev_ioctl (int fd, int request, ...)

Issue an IOCTL.

Parameters

`in`	*fd*	File descriptor as returned by rt_dev_open() or rt_dev_socket()
`in`	*request*	IOCTL code
	...	Optional third argument, depending on IOCTL function (`void *` or `unsigned long`)

Returns

Positiv value on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`ioctl()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

task-unrestricted, might-switch

Examples:

cross-link.c, rtcanconfig.c, rtcanrecv.c, and rtcansend.c.

5.8.2.9 int rt_dev_listen (int fd, int backlog)

Listen for incomming connection requests.

Parameters

`in`	*fd*	File descriptor as returned by rt_dev_socket()
`in`	*backlog*	Maximum queue length

Returns

0 on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`listen()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

task-unrestricted, might-switch

5.8.2.10 int rt_dev_open (const char * path, int oflag, ...)

Open a device.

Parameters

`in`	*path*	Device name
`in`	*oflag*	Open flags
	...	Further parameters will be ignored.

Returns

Positive file descriptor value on success, otherwise a negative error code.

Action depends on driver implementation, see Device Profiles.

See Also

`open()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

secondary-only, might-switch

Examples:

cross-link.c.

5.8.2.11 ssize_t rt_dev_read (int fd, void * buf, size_t nbyte)

Read from device.

Parameters

in	*fd*	File descriptor as returned by rt_dev_open()
out	*buf*	Input buffer
in	*nbyte*	Number of bytes to read

Returns

Number of bytes read, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`read()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

mode-unrestricted, might-switch

Examples:

cross-link.c.

5.8.2.12 ssize_t rt_dev_recv (int fd, void * buf, size_t len, int flags)

Receive message from socket.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
out	*buf*	Message buffer
in	*len*	Message buffer size
in	*flags*	Message flags

Returns

Number of bytes received, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`recv()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

mode-unrestricted, might-switch

5.8.2.13 ssize_t rt_dev_recvfrom (int fd, void * buf, size_t len, int flags, struct sockaddr * from, socklen_t * fromlen)

Receive message from socket.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
out	*buf*	Message buffer
in	*len*	Message buffer size
in	*flags*	Message flags
out	*from*	Buffer for message sender address
in,out	*fromlen*	Address buffer size

Returns

Number of bytes received, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`recvfrom()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

mode-unrestricted, might-switch

Examples:

rtcanrecv.c.

5.8.2.14 ssize_t rt_dev_recvmsg (int fd, struct msghdr * msg, int flags)

Receive message from socket.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
in,out	*msg*	Message descriptor
in	*flags*	Message flags

Returns

Number of bytes received, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`recvmsg()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

mode-unrestricted, might-switch

Examples:

rtcanrecv.c.

5.8.2.15 ssize_t rt_dev_send (int fd, const void * buf, size_t len, int flags)

Transmit message to socket.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
in	*buf*	Message buffer
in	*len*	Message buffer size
in	*flags*	Message flags

Returns

Number of bytes sent, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`send()` in IEEE Std 1003.1, http://www.opengroup.org/onlinepubs/009695399

Tags

mode-unrestricted, might-switch

Examples:

rtcansend.c.

5.8.2.16 ssize_t rt_dev_sendmsg (int fd, const struct msghdr * msg, int flags)

Transmit message to socket.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
in	*msg*	Message descriptor
in	*flags*	Message flags

Returns

Number of bytes sent, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`sendmsg()` in IEEE Std 1003.1, http://www.opengroup.org/onlinepubs/009695399

Tags

mode-unrestricted, might-switch

5.8.2.17 ssize_t rt_dev_sendto (int fd, const void * buf, size_t len, int flags, const struct sockaddr * to, socklen_t tolen)

Transmit message to socket.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
in	*buf*	Message buffer
in	*len*	Message buffer size
in	*flags*	Message flags
in	*to*	Buffer for message destination address
in	*tolen*	Address buffer size

Returns

Number of bytes sent, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`sendto()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

mode-unrestricted, might-switch

Examples:

rtcansend.c.

5.8.2.18 int rt_dev_setsockopt (int fd, int level, int optname, const void * optval, socklen_t optlen)

Set socket option.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
in	*level*	Addressed stack level
in	*optname*	Option name ID
in	*optval*	Value buffer
in	*optlen*	Value buffer size

Returns

0 on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`setsockopt()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

task-unrestricted, might-switch

Examples:

rtcanrecv.c, and rtcansend.c.

5.8.2.19 int rt_dev_shutdown (int fd, int how)

Shut down parts of a connection.

Parameters

in	*fd*	File descriptor as returned by rt_dev_socket()
in	*how*	Specifies the part to be shut down (`SHUT_xxx`)

Returns

0 on success, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`shutdown()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

secondary-only, might-switch

5.8.2.20 int rt_dev_socket (int protocol_family, int socket_type, int protocol)

Create a socket.

Parameters

in	*protocol_family*	Protocol family (`PF_xxx`)
in	*socket_type*	Socket type (`SOCK_xxx`)
in	*protocol*	Protocol ID, 0 for default

Returns

Positive file descriptor value on success, otherwise a negative error code.

Action depends on driver implementation, see Device Profiles.

See Also

`socket()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

secondary-only, might-switch

Examples:

rtcanconfig.c, rtcanrecv.c, and rtcansend.c.

5.8.2.21 ssize_t rt_dev_write (int fd, const void * buf, size_t nbyte)

Write to device.

Parameters

in	*fd*	File descriptor as returned by rt_dev_open()
in	*buf*	Output buffer
in	*nbyte*	Number of bytes to write

Returns

Number of bytes written, otherwise negative error code

Action depends on driver implementation, see Device Profiles.

See Also

`write()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399`

Tags

mode-unrestricted, might-switch

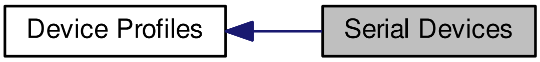
Examples:

cross-link.c.

5.9 Serial Devices

This is the common interface a RTDM-compliant serial device has to provide.

Collaboration diagram for Serial Devices:



This is the common interface a RTDM-compliant serial device has to provide. Feel free to comment on this profile via the Xenomai mailing list (`Xenomai-core@gna.org`) or directly to the author (`jan.-kiszka@web.de`).

Profile Revision: 3

Device Characteristics

Device Flags: `RTDM_NAMED_DEVICE`, `RTDM_EXCLUSIVE`
Device Name: `"rtser<N>"`, N >= 0
Device Class: `RTDM_CLASS_SERIAL`

Supported Operations

Open

Tags

secondary-only Specific return values: none
Close

Tags

secondary-only Specific return values: none
IOCTL

Tags

task-unrestricted. See below
Specific return values: see below
Read

Tags

mode-unrestricted Specific return values:

- -ETIMEDOUT
- -EINTR (interrupted explicitly or by signal)
- -EAGAIN (no data available in non-blocking mode)
- -EBADF (device has been closed while reading)
- -EIO (hardware error or broken bit stream)

Write

Tags

mode-unrestricted Specific return values:

- -ETIMEDOUT
- -EINTR (interrupted explicitly or by signal)
- -EAGAIN (no data written in non-blocking mode)
- -EBADF (device has been closed while writing)

5.10 Testing Devices

This group of devices is intended to provide in-kernel testing results.

Collaboration diagram for Testing Devices:

This group of devices is intended to provide in-kernel testing results. Feel free to comment on this profile via the Xenomai mailing list (`xenomai-core@gna.org`) or directly to the author (`jan.kiszka@web.de`).

Profile Revision: 2

Device Characteristics

Device Flags: `RTDM_NAMED_DEVICE`
Device Name: `"rttest[-<subclass>]<N>"`, N >= 0, optional subclass name to simplify device discovery
Device Class: `RTDM_CLASS_TESTING`

Supported Operations

Open

Tags

secondary-only Specific return values: none
Close

Tags

secondary-only Specific return values: none
IOCTL

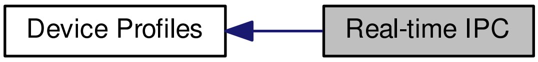
Tags

task-unrestricted. See TSTIOCTLs below
Specific return values: see TSTIOCTLs below

5.11 Real-time IPC

Profile Revision: 1

Collaboration diagram for Real-time IPC:



Data Structures

- struct rtipc_port_label

  Port label information structure.
- struct sockaddr_ipc

  Socket address structure for the RTIPC address family.

Typedefs

- typedef int16_t rtipc_port_t

  Port number type for the RTIPC address family.

Supported operations

Standard socket operations supported by the RTIPC protocols.

- int socket__AF_RTIPC (int domain=AF_RTIPC, int type=SOCK_DGRAM, int protocol)

  Create an endpoint for communication in the AF_RTIPC domain.
- int close__AF_RTIPC (int sockfd)

  Close a RTIPC socket descriptor.
- int bind__AF_RTIPC (int sockfd, const struct sockaddr_ipc *addr, socklen_t addrlen)

  Bind a RTIPC socket to a port.
- int connect__AF_RTIPC (int sockfd, const struct sockaddr_ipc *addr, socklen_t addrlen)

  Initiate a connection on a RTIPC socket.
- int setsockopt__AF_RTIPC (int sockfd, int level, int optname, const void *optval, socklen_t optlen)

  Set options on RTIPC sockets.
- int getsockopt__AF_RTIPC (int sockfd, int level, int optname, void *optval, socklen_t *optlen)

  Get options on RTIPC sockets.
- ssize_t sendmsg__AF_RTIPC (int sockfd, const struct msghdr *msg, int flags)

  Send a message on a RTIPC socket.
- ssize_t recvmsg__AF_RTIPC (int sockfd, struct msghdr *msg, int flags)

  Receive a message from a RTIPC socket.
- int getsockname__AF_RTIPC (int sockfd, struct sockaddr_ipc *addr, socklen_t *addrlen)

  Get socket name.
- int getpeername__AF_RTIPC (int sockfd, struct sockaddr_ipc *addr, socklen_t *addrlen)

  Get socket peer.

RTIPC protocol list

protocols for the PF_RTIPC protocol family

- enum { IPCPROTO_IPC = 0, IPCPROTO_XDDP = 1, IPCPROTO_IDDP = 2, IPCPROTO_BUFP = 3 }

XDDP socket options

Setting and getting XDDP socket options.

- #define XDDP_LABEL 1

  XDDP label assignment.
- #define XDDP_POOLSZ 2

  XDDP local pool size configuration.
- #define XDDP_BUFSZ 3

  XDDP streaming buffer size configuration.
- #define XDDP_MONITOR 4

  XDDP monitoring callback.

XDDP events

Specific events occurring on XDDP channels, which can be monitored via the XDDP_MONITOR socket option.

- #define XDDP_EVTIN 1

  Monitor writes to the non real-time endpoint.
- #define XDDP_EVTOUT 2

  Monitor reads from the non real-time endpoint.
- #define XDDP_EVTDOWN 3

  Monitor close from the non real-time endpoint.
- #define XDDP_EVTNOBUF 4

  Monitor memory shortage for non real-time datagrams.

IDDP socket options

Setting and getting IDDP socket options.

- #define IDDP_LABEL 1

  IDDP label assignment.
- #define IDDP_POOLSZ 2

  IDDP local pool size configuration.

BUFP socket options

Setting and getting BUFP socket options.

- #define BUFP_LABEL 1

  BUFP label assignment.
- #define BUFP_BUFSZ 2

  BUFP buffer size configuration.

Socket level options

Setting and getting supported standard socket level options.

- #define SO_SNDTIMEO defined_by_kernel_header_file

  IPCPROTO_IDDP and IPCPROTO_BUFP protocols support the standard SO_SNDTIMEO socket option, from the `SOL_SOCKET` *level.*
- #define SO_RCVTIMEO defined_by_kernel_header_file

  All RTIPC protocols support the standard SO_RCVTIMEO socket option, from the `SOL_SOCKET` *level.*

5.11.1 Detailed Description

Profile Revision: 1

Device Characteristics

Device Flags: `RTDM_PROTOCOL_DEVICE`
Protocol Family: `PF_RTIPC`
Socket Type: `SOCK_DGRAM`
Device Class: `RTDM_CLASS_RTIPC`

5.11.2 Macro Definition Documentation

5.11.2.1 #define BUFP_BUFSZ 2

BUFP buffer size configuration.

All messages written to a BUFP socket are buffered in a single per-socket memory area. Configuring the size of such buffer prior to binding the socket to a destination port is mandatory.

It is not allowed to configure a buffer size after the socket was bound. However, multiple configuration calls are allowed prior to the binding; the last value set will be used.

Note

: the buffer memory is obtained from the host allocator by the bind call.

Parameters

`in`	*level*	SOL_BUFP
`in`	*optname*	**BUFP_BUFSZ**
`in`	*optval*	Pointer to a variable of type size_t, containing the required size of the buffer to reserve at binding time
`in`	*optlen*	sizeof(size_t)

Returns

0 is returned upon success. Otherwise:

- -EFAULT (Invalid data address given)
- -EALREADY (socket already bound)
- -EINVAL (*optlen* is invalid or $*$*optval* is zero)

Calling context:

RT/non-RT

Examples:

bufp-label.c, and bufp-readwrite.c.

5.11.2.2 #define BUFP_LABEL 1

BUFP label assignment.

ASCII label strings can be attached to BUFP ports, in order to connect sockets to them in a more descriptive way than using plain numeric port values.

When available, this label will be registered when binding, in addition to the port number (see BUFP port binding).

It is not allowed to assign a label after the socket was bound. However, multiple assignment calls are allowed prior to the binding; the last label set will be used.

Parameters

in	*level*	SOL_BUFP
in	*optname*	**BUFP_LABEL**
in	*optval*	Pointer to struct rtipc_port_label
in	*optlen*	sizeof(struct rtipc_port_label)

Returns

0 is returned upon success. Otherwise:

- -EFAULT (Invalid data address given)
- -EALREADY (socket already bound)
- -EINVAL (*optlen* is invalid)

Calling context:

RT/non-RT

Examples:

bufp-label.c.

5.11.2.3 #define IDDP_LABEL 1

IDDP label assignment.

ASCII label strings can be attached to IDDP ports, in order to connect sockets to them in a more descriptive way than using plain numeric port values.

When available, this label will be registered when binding, in addition to the port number (see IDDP port binding).

It is not allowed to assign a label after the socket was bound. However, multiple assignment calls are allowed prior to the binding; the last label set will be used.

Parameters

in	*level*	SOL_IDDP
in	*optname*	**IDDP_LABEL**
in	*optval*	Pointer to struct rtipc_port_label
in	*optlen*	sizeof(struct rtipc_port_label)

Returns

0 is returned upon success. Otherwise:

- -EFAULT (Invalid data address given)
- -EALREADY (socket already bound)
- -EINVAL (*optlen* is invalid)

Calling context:

RT/non-RT

Examples:

iddp-label.c.

5.11.2.4 #define IDDP_POOLSZ 2

IDDP local pool size configuration.

By default, the memory needed to convey the data is pulled from Xenomai's system pool. Setting a local pool size overrides this default for the socket.

If a non-zero size was configured, a local pool is allocated at binding time. This pool will provide storage for pending datagrams.

It is not allowed to configure a local pool size after the socket was bound. However, multiple configuration calls are allowed prior to the binding; the last value set will be used.

Note

: the pool memory is obtained from the host allocator by the bind call.

Parameters

in	*level*	SOL_IDDP
in	*optname*	**IDDP_POOLSZ**
in	*optval*	Pointer to a variable of type size_t, containing the required size of the local pool to reserve at binding time
in	*optlen*	sizeof(size_t)

Returns

0 is returned upon success. Otherwise:

- -EFAULT (Invalid data address given)
- -EALREADY (socket already bound)
- -EINVAL (*optlen* is invalid or **optval* is zero)

Calling context:

RT/non-RT

Examples:

iddp-sendrecv.c.

5.11.2.5 #define SO_RCVTIMEO defined_by_kernel_header_file

All RTIPC protocols support the standard SO_RCVTIMEO socket option, from the `SOL_SOCKET` level.

See Also

`setsockopt()`, `getsockopt()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399/`

Examples:

xddp-label.c.

Referenced by rt_pipe_read_timed().

5.11.2.6 #define SO_SNDTIMEO defined_by_kernel_header_file

IPCPROTO_IDDP and IPCPROTO_BUFP protocols support the standard SO_SNDTIMEO socket option, from the `SOL_SOCKET` level.

See Also

`setsockopt()`, `getsockopt()` in IEEE Std 1003.1, `http://www.opengroup.org/onlinepubs/009695399/`

5.11.2.7 #define XDDP_BUFSZ 3

XDDP streaming buffer size configuration.

In addition to sending datagrams, real-time threads may stream data in a byte-oriented mode through the port as well. This increases the bandwidth and reduces the overhead, when the overall data to send to the Linux domain is collected by bits, and keeping the message boundaries is not required.

This feature is enabled when a non-zero buffer size is set for the socket. In that case, the real-time data accumulates into the streaming buffer when MSG_MORE is passed to any of the send functions, until:

- the receiver from the Linux domain wakes up and consumes it,
- a different source port attempts to send data to the same destination port,
- MSG_MORE is absent from the send flags,
- the buffer is full,

whichever comes first.

Setting **optval* to zero disables the streaming buffer, in which case all sendings are conveyed in separate datagrams, regardless of MSG_MORE.

Note

only a single streaming buffer exists per socket. When this buffer is full, the real-time data stops accumulating and sending operations resume in mere datagram mode. Accumulation may happen again after some or all data in the streaming buffer is consumed from the Linux domain endpoint.

The streaming buffer size may be adjusted multiple times during the socket lifetime; the latest configuration change will take effect when the accumulation resumes after the previous buffer was flushed.

Parameters

in	*level*	SOL_XDDP
in	*optname*	**XDDP_BUFSZ**
in	*optval*	Pointer to a variable of type size_t, containing the required size of the streaming buffer
in	*optlen*	sizeof(size_t)

Returns

0 is returned upon success. Otherwise:

- -EFAULT (Invalid data address given)
- -ENOMEM (Not enough memory)
- -EINVAL (*optlen* is invalid)

Calling context:

RT/non-RT

Examples:

xddp-stream.c.

Referenced by rt_pipe_create().

5.11.2.8 #define XDDP_EVTDOWN 3

Monitor close from the non real-time endpoint.

XDDP_EVTDOWN is sent when the non real-time endpoint is closed. The argument is always 0.

5.11.2.9 #define XDDP_EVTIN 1

Monitor writes to the non real-time endpoint.

XDDP_EVTIN is sent when data is written to the non real-time endpoint the socket is bound to (i.e. via /dev/rtp*N*), which means that some input is pending for the real-time endpoint. The argument is the size of the incoming message.

5.11.2.10 #define XDDP_EVTNOBUF 4

Monitor memory shortage for non real-time datagrams.

XDDP_EVTNOBUF is sent when no memory is available from the pool to hold the message currently sent from the non real-time endpoint. The argument is the size of the failed allocation. Upon return from the callback, the caller will block and retry until enough space is available from the pool; during that process, the callback might be invoked multiple times, each time a new attempt to get the required memory fails.

5.11.2.11 #define XDDP_EVTOUT 2

Monitor reads from the non real-time endpoint.

XDDP_EVTOUT is sent when the non real-time endpoint successfully reads a complete message (i.e. via /dev/rtp*N*). The argument is the size of the outgoing message.

5.11.2.12 #define XDDP_LABEL 1

XDDP label assignment.

ASCII label strings can be attached to XDDP ports, so that opening the non-RT endpoint can be done by specifying this symbolic device name rather than referring to a raw pseudo-device entry (i.e. /dev/rtp*N*).

When available, this label will be registered when binding, in addition to the port number (see XDDP port binding).

It is not allowed to assign a label after the socket was bound. However, multiple assignment calls are allowed prior to the binding; the last label set will be used.

Parameters

`in`	*level*	SOL_XDDP
`in`	*optname*	**XDDP_LABEL**
`in`	*optval*	Pointer to struct rtipc_port_label
`in`	*optlen*	sizeof(struct rtipc_port_label)

Returns

0 is returned upon success. Otherwise:

- -EFAULT (Invalid data address given)
- -EALREADY (socket already bound)
- -EINVAL (*optlen* invalid)

Calling context:

RT/non-RT

Examples:

xddp-label.c.

Referenced by rt_pipe_create().

5.11.2.13 #define XDDP_MONITOR 4

XDDP monitoring callback.

Other RTDM drivers may install a user-defined callback via the rtdm_setsockopt call from the inter-driver API, in order to collect particular events occurring on the channel.

This notification mechanism is particularly useful to monitor a channel asynchronously while performing other tasks.

The user-provided routine will be passed the RTDM file descriptor of the socket receiving the event, the event code, and an optional argument. Four events are currently defined, see XDDP_EVENTS.

The XDDP_EVTIN and XDDP_EVTOUT events are fired on behalf of a fully atomic context; therefore, care must be taken to keep their overhead low. In those cases, the Xenomai services that may be called from the callback are restricted to the set allowed to a real-time interrupt handler.

Parameters

in	*level*	SOL_XDDP
in	*optname*	**XDDP_MONITOR**
in	*optval*	Pointer to a pointer to function of type int (*)(int fd, int event, long arg), containing the address of the user-defined callback.Passing a NULL callback pointer in *optval* disables monitoring.
in	*optlen*	sizeof(int (*)(int fd, int event, long arg))

Returns

0 is returned upon success. Otherwise:

- -EFAULT (Invalid data address given)
- -EPERM (Operation not allowed from user-space)
- -EINVAL (*optlen* is invalid)

Calling context:

RT/non-RT, kernel space only

5.11.2.14 #define XDDP_POOLSZ 2

XDDP local pool size configuration.

By default, the memory needed to convey the data is pulled from Xenomai's system pool. Setting a local pool size overrides this default for the socket.

If a non-zero size was configured, a local pool is allocated at binding time. This pool will provide storage for pending datagrams.

It is not allowed to configure a local pool size after the socket was bound. However, multiple configuration calls are allowed prior to the binding; the last value set will be used.

Note

: the pool memory is obtained from the host allocator by the bind call.

Parameters

in	*level*	SOL_XDDP
in	*optname*	**XDDP_POOLSZ**
in	*optval*	Pointer to a variable of type size_t, containing the required size of the local pool to reserve at binding time
in	*optlen*	sizeof(size_t)

Returns

0 is returned upon success. Otherwise:

- -EFAULT (Invalid data address given)
- -EALREADY (socket already bound)
- -EINVAL (*optlen* invalid or **optval* is zero)

Calling context:

RT/non-RT

Examples:

xddp-echo.c.

Referenced by rt_pipe_create().

5.11.3 Enumeration Type Documentation

5.11.3.1 anonymous enum

Enumerator

IPCPROTO_IPC Default protocol (IDDP)

IPCPROTO_XDDP Cross-domain datagram protocol (RT <-> non-RT). Real-time Xenomai threads and regular Linux threads may want to exchange data in a way that does not require the former to leave the real-time domain (i.e. primary mode). The RTDM-based XDDP protocol is available for this purpose.

On the Linux domain side, pseudo-device files named /dev/rtp<*minor*> give regular POSIX threads access to non real-time communication endpoints, via the standard character-based I/O interface. On the Xenomai domain side, sockets may be bound to XDDP ports, which act as proxies to send and receive data to/from the associated pseudo-device files. Ports and pseudo-device minor numbers are paired, meaning that e.g. socket port 7 will proxy the traffic to/from /dev/rtp7.

All data sent through a bound/connected XDDP socket via `sendto(2)` or `write(2)` will be passed to the peer endpoint in the Linux domain, and made available for reading via the standard `read(2)` system call. Conversely, all data sent using `write(2)` through the non real-time endpoint will be conveyed to the real-time socket endpoint, and made available to the `recvfrom(2)` or `read(2)` system calls.

IPCPROTO_IDDP Intra-domain datagram protocol (RT <-> RT). The RTDM-based IDDP protocol enables real-time threads to exchange datagrams within the Xenomai domain, via socket endpoints.

IPCPROTO_BUFP Buffer protocol (RT <-> RT, byte-oriented). The RTDM-based BUFP protocol implements a lightweight, byte-oriented, one-way Producer-Consumer data path. All messages written are buffered into a single memory area in strict FIFO order, until read by the consumer.

This protocol always prevents short writes, and only allows short reads when a potential deadlock situation arises (i.e. readers and writers waiting for each other indefinitely).

5.11.4 Function Documentation

5.11.4.1 int bind__AF_RTIPC (int sockfd, const struct **sockaddr_ipc** * addr, socklen_t addrlen)

Bind a RTIPC socket to a port.

Bind the socket to a destination port.

Parameters

`in`	*sockfd*	The RTDM file descriptor obtained from the socket creation call.
`in`	*addr*	The address to bind the socket to (see struct sockaddr_ipc). The meaning of such address depends on the RTIPC protocol in use for the socket:

- IPCPROTO_XDDP

  This action creates an endpoint for channelling traffic between the Xenomai and Linux domains.

sipc_family must be AF_RTIPC, *sipc_port* is either -1, or a valid free port number between 0 and CONFIG_XENO_OPT_PIPE_NRDEV-1.

If *sipc_port* is -1, a free port will be assigned automatically.

Upon success, the pseudo-device /dev/rtp*N* will be reserved for this communication channel, where *N* is the assigned port number. The non real-time side shall open this device to exchange data over the bound socket.

If a label was assigned (see XDDP_LABEL) prior to binding the socket to a port, a registry link referring to the created pseudo-device will be automatically set up as `/proc/xenomai/registry/rtipc/xddp/label`, where *label* is the label string passed to setsockopt() for the XDDP_LABEL option.

- IPCPROTO_IDDP

  This action creates an endpoint for exchanging datagrams within the Xenomai domain.

  sipc_family must be AF_RTIPC, *sipc_port* is either -1, or a valid free port number between 0 and CONFIG_XENO_OPT_IDDP_NRPORT-1.

  If *sipc_port* is -1, a free port will be assigned automatically. The real-time peer shall connect to the same port for exchanging data over the bound socket.

If a label was assigned (see IDDP_LABEL) prior to binding the socket to a port, a registry link referring to the assigned port number will be automatically set up as `/proc/xenomai/registry/rtipc/iddp/label`, where *label* is the label string passed to setsockopt() for the IDDP_LABEL option.

- IPCPROTO_BUFP

  This action creates an endpoint for a one-way byte stream within the Xenomai domain.

  sipc_family must be AF_RTIPC, *sipc_port* is either -1, or a valid free port number between 0 and CONFIG_XENO_OPT_BUFP_NRPORT-1.

  If *sipc_port* is -1, an available port will be assigned automatically. The real-time peer shall connect to the same port for exchanging data over the bound socket.

If a label was assigned (see BUFP_LABEL) prior to binding the socket to a port, a registry link referring to the assigned port number will be automatically set up as `/proc/xenomai/registry/rtipc/bufp/label`, where *label* is the label string passed to setsockopt() for the *BUFP_LABEL* option.

Parameters

in	*addrlen*	The size in bytes of the structure pointed to by *addr*.

Returns

In addition to the standard error codes for `bind(2)`, the following specific error code may be returned:

- -EFAULT (Invalid data address given)
- -ENOMEM (Not enough memory)
- -EINVAL (Invalid parameter)
- -EADDRINUSE (Socket already bound to a port, or no port available)

Calling context:

non-RT

5.11.4.2 int close__AF_RTIPC (int sockfd)

Close a RTIPC socket descriptor.

Blocking calls to any of the sendmsg or recvmsg functions will be unblocked when the socket is closed and return with an error.

Parameters

in	*sockfd*	The socket descriptor to close.

Returns

In addition to the standard error codes for `close(2)`, the following specific error code may be returned: none

Calling context:

non-RT

5.11.4.3 int connect__AF_RTIPC (int sockfd, const struct **sockaddr_ipc** * addr, socklen_t addrlen)

Initiate a connection on a RTIPC socket.

Parameters

in	*sockfd*	The RTDM file descriptor obtained from the socket creation call.
in	*addr*	The address to connect the socket to (see struct sockaddr_ipc).

- If sipc_port is a valid port for the protocol, it is used verbatim and the connection succeeds immediately, regardless of whether the destination is bound at the time of the call.
- If sipc_port is -1 and a label was assigned to the socket, connect() blocks for the requested amount of time (see SO_RCVTIMEO) until a socket is bound to the same label via `bind(2)` (see XDDP_LABEL, IDDP_LABEL, BUFP_LABEL), in which case a connection is established between both endpoints.
- If sipc_port is -1 and no label was assigned to the socket, the default destination address is cleared, meaning that any subsequent write to the socket will return -EDESTADDRREQ, until a valid destination address is set via `connect(2)` or `bind(2)`.

Parameters

in	*addrlen*	The size in bytes of the structure pointed to by *addr*.

Returns

In addition to the standard error codes for `connect(2)`, the following specific error code may be returned: none.

Calling context:

RT/non-RT

5.11.4.4 int getpeername__AF_RTIPC (int sockfd, struct **sockaddr_ipc** * addr, socklen_t * addrlen)

Get socket peer.

The name of the remote endpoint for the socket is copied back (see struct sockaddr_ipc). This is the default destination address for messages sent on the socket. It can be set either explicitly via `connect(2)`, or implicitly via `bind(2)` if no `connect(2)` was called prior to binding the socket to a port, in which case both the local and remote names are equal.

Returns

In addition to the standard error codes for `getpeername(2)`, the following specific error code may be returned: none.

Calling context:

RT/non-RT

5.11.4.5 int getsockname__AF_RTIPC (int sockfd, struct **sockaddr_ipc** * addr, socklen_t * addrlen)

Get socket name.

The name of the local endpoint for the socket is copied back (see struct sockaddr_ipc).

Returns

In addition to the standard error codes for `getsockname(2)`, the following specific error code may be returned: none.

Calling context:

RT/non-RT

5.11.4.6 int getsockopt__AF_RTIPC (int sockfd, int level, int optname, void * optval, socklen_t * optlen)

Get options on RTIPC sockets.

These functions allow to get various socket options. Supported Levels and Options:

- Level SOL_SOCKET
- Level SOL_XDDP
- Level SOL_IDDP
- Level SOL_BUFP

Returns

In addition to the standard error codes for `getsockopt(2)`, the following specific error code may be returned: follow the option links above.

Calling context:

RT/non-RT

5.11.4.7 ssize_t recvmsg__AF_RTIPC (int sockfd, struct msghdr * msg, int flags)

Receive a message from a RTIPC socket.

Parameters

in	*sockfd*	The RTDM file descriptor obtained from the socket creation call.
out	*msg*	The address the message header will be copied at.
in	*flags*	Operation flags:

- MSG_DONTWAIT Non-blocking I/O operation. The caller will not be blocked whenever no message is immediately available for receipt at the time of the call, but will rather return with -EWOULDBLOCK.

Note

IPCPROTO_BUFP does not allow for short reads and always returns the requested amount of bytes, except in one situation: whenever some writer is waiting for sending data upon a buffer full condition, while the caller would have to wait for receiving a complete message. This is usually the sign of a pathological use of the BUFP socket, like defining an incorrect buffer size via BUFP_BUFSZ. In that case, a short read is allowed to prevent a deadlock.

Returns

In addition to the standard error codes for `recvmsg(2)`, the following specific error code may be returned: none.

Calling context:

RT

5.11.4.8 ssize_t sendmsg__AF_RTIPC (int sockfd, const struct msghdr * msg, int flags)

Send a message on a RTIPC socket.

Parameters

in	*sockfd*	The RTDM file descriptor obtained from the socket creation call.
in	*msg*	The address of the message header conveying the datagram.
in	*flags*	Operation flags:

- MSG_OOB Send out-of-band message. For all RTIPC protocols except IPCPROTO_BUFP, sending out-of-band data actually means pushing them to the head of the receiving queue, so that the reader will always receive them before normal messages. IPCPROTO_BUFP does not support out-of-band sending.
- MSG_DONTWAIT Non-blocking I/O operation. The caller will not be blocked whenever the message cannot be sent immediately at the time of the call (e.g. memory shortage), but will rather return with -EWOULDBLOCK. Unlike other RTIPC protocols, IPCPROTO_XDDP accepts but never considers MSG_DONTWAIT since writing to a real-time XDDP endpoint is inherently a non-blocking operation.
- MSG_MORE Accumulate data before sending. This flag is accepted by the IPCPROTO_XDDP protocol only, and tells the send service to accumulate the outgoing data into an internal streaming buffer, instead of issuing a datagram immediately for it. See XDDP_BUFSZ for more.

Note

No RTIPC protocol allows for short writes, and only complete messages are sent to the peer.

Returns

In addition to the standard error codes for `sendmsg(2)`, the following specific error code may be returned: none.

Calling context:

RT

5.11.4.9 int setsockopt__AF_RTIPC (int sockfd, int level, int optname, const void * optval, socklen_t optlen)

Set options on RTIPC sockets.

These functions allow to set various socket options. Supported Levels and Options:

- Level SOL_SOCKET
- Level SOL_XDDP
- Level SOL_IDDP
- Level SOL_BUFP

Returns

In addition to the standard error codes for `setsockopt(2)`, the following specific error code may be returned: follow the option links above.

Calling context:

non-RT

5.11.4.10 int socket__AF_RTIPC (int domain = `AF_RTIPC`, int type = `SOCK_DGRAM`, int protocol)

Create an endpoint for communication in the AF_RTIPC domain.

Parameters

`in`	*domain*	The communication domain. Must be AF_RTIPC.
`in`	*type*	The socket type. Must be SOCK_DGRAM.
`in`	*protocol*	Any of IPCPROTO_XDDP, IPCPROTO_IDDP, or IPCPROTO_BUFP. IPCPROTO_IPC is also valid, and refers to the default RTIPC protocol, namely IPCPROTO_IDDP.

Returns

In addition to the standard error codes for `socket(2)`, the following specific error code may be returned:

- -ENOPROTOOPT (Protocol is known, but not compiled in the RTIPC driver). See RTIPC protocols for available protocols.

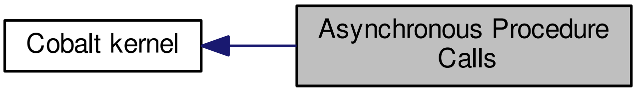
Calling context:

non-RT

5.12 Asynchronous Procedure Calls

Services for scheduling function calls in the Linux domain.

Collaboration diagram for Asynchronous Procedure Calls:



Functions

- int xnapc_alloc (const char *name, void(*handler)(void *cookie), void *cookie)

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

  Releases an APC slot.
- static void xnapc_schedule (int apc)

  Schedule an APC invocation.

5.12.1 Detailed Description

Services for scheduling function calls in the Linux domain. 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 the interrupt pipeline's virtual interrupt support.

5.12.2 Function Documentation

5.12.2.1 int xnapc_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 the interrupt pipeline's virtual interrupt support.

Any Linux kernel service which is callable from a regular Linux interrupt handler is in essence available to APC handlers.

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 pointer the APC handler receives as its sole argument.

Returns

a valid APC identifier 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.

Tags

unrestricted

5.12.2.2 void xnapc_free (int apc)

Releases an APC slot.

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

Parameters

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

Tags

unrestricted

5.12.2.3 static inline int xnapc_schedule (int apc) [inline], [static]

Schedule an APC invocation.

This service marks the APC as pending for the Linux domain, so that its handler will be called as soon as possible, when the Linux domain gets back in control.

When posted from the Linux domain, the APC handler is fired as soon as the interrupt mask is explicitly cleared by some kernel code. When posted from the Xenomai domain, the APC handler is fired as soon as the Linux domain is resumed, i.e. after Xenomai has completed all its pending duties.

Parameters

apc	The APC id. to schedule.

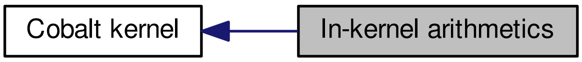
This service can be called from:

- Any domain context, albeit the usual calling place is from the Xenomai domain.

5.13 In-kernel arithmetics

A collection of helpers performing arithmetics not implicitly available from kernel context via GCC helpers.

Collaboration diagram for In-kernel arithmetics:



Functions

- unsigned long long xnarch_generic_full_divmod64 (unsigned long long a, unsigned long long b, unsigned long long *rem)

    Architecture-independent div64 operation with remainder.

5.13.1 Detailed Description

A collection of helpers performing arithmetics not implicitly available from kernel context via GC-C helpers. Many of these routines enable 64bit arithmetics on 32bit systems. Xenomai architecture ports normally implement the performance critical ones in hand-crafted assembly code (see kernel/cobalt/arch/<arch>/include/asm/xenomai/uapi/arith.h).

5.13.2 Function Documentation

5.13.2.1 unsigned long long xnarch_generic_full_divmod64 (unsigned long long a, unsigned long long b, unsigned long long * rem)

Architecture-independent div64 operation with remainder.

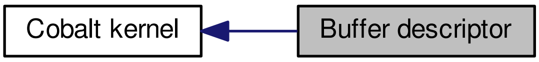
Parameters

a	dividend
b	divisor
rem	if non-NULL, a pointer to a 64bit variable for collecting the remainder from the division.

5.14 Buffer descriptor

Abstraction for copying data to/from different address spaces.

Collaboration diagram for Buffer descriptor:



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.

5.14.1 Detailed Description

Abstraction for copying data to/from different address spaces. 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;
}
```

5.14.2 Function Documentation

5.14.2.1 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.

Tags

unrestricted

Note

Calling this routine while holding the nklock and/or running with interrupts disabled is invalid, and doing so will trigger a debug assertion.

This routine 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).

5.14.2.2 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.

Tags

task-unrestricted

Note

Calling this routine while holding the nklock and/or running with interrupts disabled is invalid, and doing so will trigger a debug assertion.

This routine 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).

5.14.2.3 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.

Tags

unrestricted

5.14.2.4 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*.

Tags

unrestricted

5.14.2.5 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*.

Tags

unrestricted

5.14.2.6 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*.

Tags

task-unrestricted

5.14.2.7 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*.

Tags

task-unrestricted

5.14.2.8 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.

Tags

unrestricted

5.14.2.9 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*.

Tags

task-unrestricted

5.14.2.10 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*.

Tags

task-unrestricted

5.14.2.11 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*.

Tags

task-unrestricted

Note

Calling this routine while holding the nklock and/or running with interrupts disabled is invalid, and doing so will trigger a debug assertion.

5.14.2.12 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*.

Tags

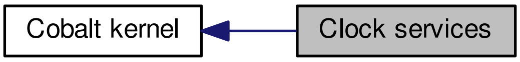
task-unrestricted

Note

Calling this routine while holding the nklock and/or running with interrupts disabled is invalid, and doing so will trigger a debug assertion.

5.15 Clock services

Collaboration diagram for Clock services:



Functions

- int xnclock_register (struct xnclock *clock)

    Register a Xenomai clock.
- void xnclock_deregister (struct xnclock *clock)

    Deregister a Xenomai clock.
- void xnclock_tick (struct xnclock *clock)

    Process a clock tick.
- void xnclock_adjust (struct xnclock *clock, xnsticks_t delta)

    Adjust a clock time.

5.15.1 Detailed Description

5.15.2 Function Documentation

5.15.2.1 void xnclock_adjust (struct xnclock * clock, xnsticks_t delta)

Adjust a clock time.

This service changes the epoch for the given clock by applying the specified tick delta on its wallclock offset.

Parameters

clock	The clock to adjust.
delta	The adjustment value expressed in nanoseconds.

Tags

task-unrestricted, atomic-entry

Note

Xenomai tracks the system time in *nkclock*, as a monotonously increasing count of ticks since the epoch. The epoch is initially the same as the underlying machine time.

5.15.2.2 void xnclock_deregister (struct xnclock * clock)

Deregister a Xenomai clock.

This service uninstalls a Xenomai clock previously registered with xnclock_register().

This service may be called once all timers driven by *clock* have been stopped.

Parameters

clock	The clock to deregister.

Tags

secondary-only

5.15.2.3 int xnclock_register (struct xnclock * clock)

Register a Xenomai clock.

This service installs a new clock which may be used to drive Xenomai timers.

Parameters

clock	The new clock to register.

Tags

secondary-only

5.15.2.4 void xnclock_tick (struct xnclock * clock)

Process a clock tick.

This routine processes an incoming *clock* event, firing elapsed timers as appropriate.

Parameters

clock	The clock for which a new event was received.

Tags

coreirq-only, atomic-entry

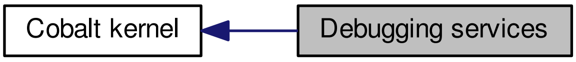
Note

The current CPU must be part of the real-time affinity set, otherwise weird things may happen.

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

5.16 Debugging services

Collaboration diagram for Debugging services:

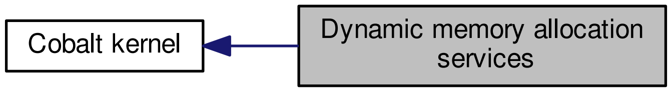


5.16.1 Detailed Description

5.17 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.

Collaboration diagram for Dynamic memory allocation services:



Functions

- int xnheap_init (struct xnheap *heap, void *heapaddr, unsigned long heapsize, unsigned long pagesize)

  Initialize a memory heap.
- void xnheap_set_label (struct xnheap *heap, const char *name,...)

  Set the heap's label string.
- void xnheap_destroy (struct xnheap *heap, void(*flushfn)(struct xnheap *heap, void *extaddr, unsigned long extsize, void *cookie), void *cookie)

  Destroys a memory heap.
- int xnheap_extend (struct xnheap *heap, void *extaddr, unsigned long extsize)

  Extend a memory heap.
- void * xnheap_alloc (struct xnheap *heap, unsigned long size)

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

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

  Release a memory block to a memory heap.

5.17.1 Detailed Description

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]
}
```

Implementation constraints

- Minimum page size is 2 ** XNHEAP_MINLOG2 (must be large enough to hold a pointer).
- Maximum page size is 2 ** XNHEAP_MAXLOG2.
- Minimum block size equals the minimum page size.
- Requested block size smaller than the minimum block size is rounded to the minimum block size.
- Requested block size larger than 2 times the page size is rounded to the next page boundary and obtained from the free page list. So we need a bucket for each power of two between XNHEAP_MINLOG2 and XNHEAP_MAXLOG2 inclusive, plus one to honor requests ranging from the maximum page size to twice this size.

5.17.2 Function Documentation

5.17.2.1 void * xnheap_alloc (struct xnheap * heap, unsigned 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.

Tags

unrestricted

Referenced by xnshadow_map_user().

5.17.2.2 void xnheap_destroy (struct xnheap * heap, void(*)(struct xnheap *heap, void *extaddr, unsigned 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*.

Tags

task-unrestricted

5.17.2.3 int xnheap_extend (struct xnheap * heap, void * extaddr, unsigned 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.

Tags

unrestricted

5.17.2.4 int xnheap_free (struct xnheap * 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.

Tags

unrestricted

References xnheap_test_and_free().

5.17.2.5 int xnheap_init (struct xnheap * heap, void * heapaddr, unsigned long heapsize, unsigned 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(struct xnextent) 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.
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.

Tags

task-unrestricted

5.17.2.6 void xnheap_set_label (struct xnheap * 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.

Tags

task-unrestricted

5.17.2.7 int xnheap_test_and_free (struct xnheap * 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.

Warning

ckfn must not reschedule 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.

Tags

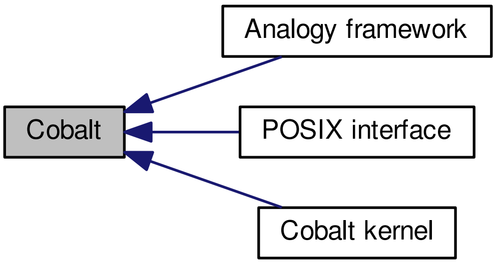
unrestricted

Referenced by xnheap_free().

5.18 Cobalt

Cobalt supplements the native Linux kernel in dual kernel configurations.

Collaboration diagram for Cobalt:



Modules

- Cobalt kernel

    The Cobalt kernel implements generic RTOS building blocks.
- Analogy framework

    A RTDM-based interface for implementing DAQ card drivers.
- POSIX interface

    The Cobalt/POSIX interface is an implementation of a subset of the `Single Unix specification` *over the Cobalt core.*

5.18.1 Detailed Description

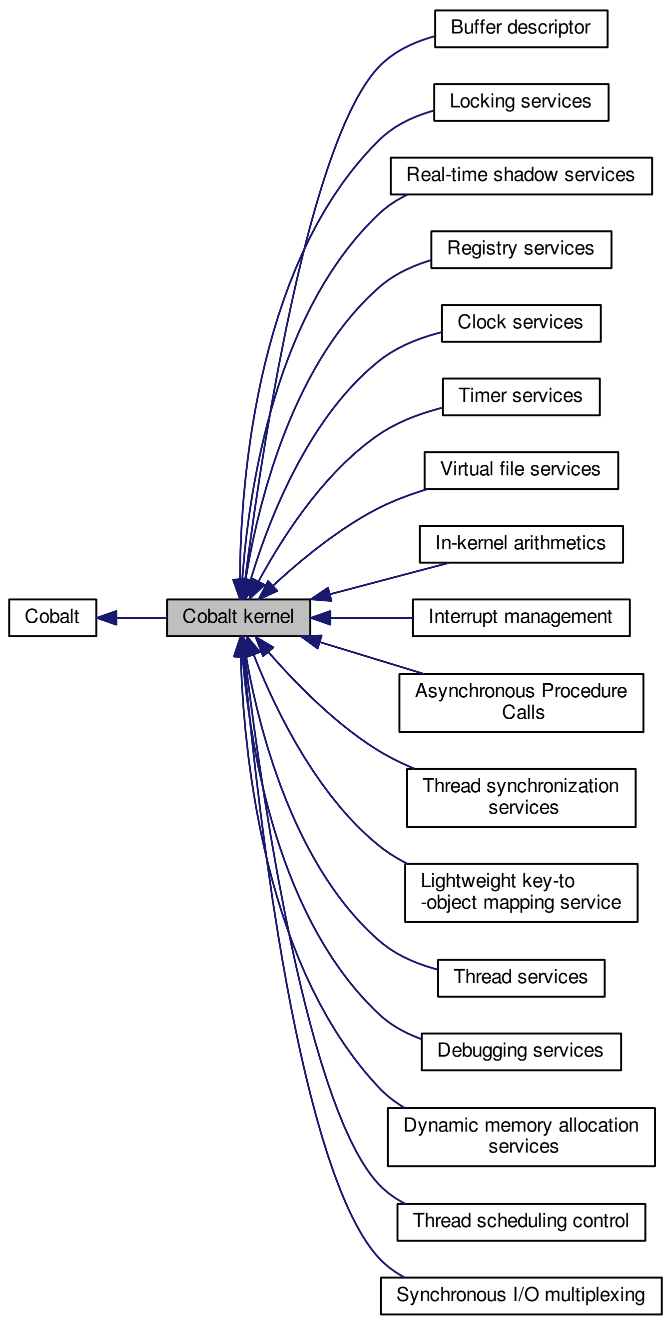
Cobalt supplements the native Linux kernel in dual kernel configurations. It deals with all time-critical activities, such as handling interrupts, and scheduling real-time threads. The Cobalt kernel has higher priority over all the native kernel activities.

Cobalt provides an implementation of the POSIX and RTDM interfaces based on a set of generic RTOS building blocks.

5.19 Cobalt kernel

The Cobalt kernel implements generic RTOS building blocks.

Collaboration diagram for Cobalt kernel:



Modules

- Asynchronous Procedure Calls

Services for scheduling function calls in the Linux domain.
- In-kernel arithmetics

  A collection of helpers performing arithmetics not implicitly available from kernel context via GCC helpers.
- Buffer descriptor

  Abstraction for copying data to/from different address spaces.
- Clock services
- Debugging services
- 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.
- Interrupt management
- Locking services

  The Xenomai core deals with concurrent activities from two distinct kernels running side-by-side.
- Lightweight key-to-object mapping service

  A map is a simple indexing structure which associates unique integer keys with pointers to objects.
- Registry services

  The registry provides a mean to index object descriptors on unique alphanumeric keys.
- Thread scheduling control
- Synchronous I/O multiplexing

  This module implements the services needed for implementing the POSIX select() service, or any other event multiplexing services.
- Real-time shadow services

  Real-time shadow services.
- Thread synchronization services
- Thread services
- Timer services

  The Xenomai timer facility depends on a clock source (xnclock) for scheduling the next activation times.
- Virtual file services

  Virtual files provide a mean to export Xenomai object states to user-space, based on common kernel interfaces.

5.19.1 Detailed Description

The Cobalt kernel implements generic RTOS building blocks.

5.19.1.1 Dual kernel service tags

Cobalt kernel services may be restricted to particular calling contexts, or entail specific side-effects.

To describe this information, each service documented by this manual bears a set of tags when applicable.

The table below matches the tags used throughout the documentation with the description of their meaning for the caller.

Context tags

Tag	Context on entry
primary-only	Must be called from a Cobalt task in primary mode

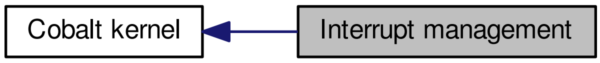
coreirq-only	Must be called from a Cobalt IRQ handler
secondary-only	Must be called from a Cobalt task in secondary mode or regular Linux task
rtdm-task	Must be called from a RTDM driver task
mode-unrestricted	Must be called from a Cobalt task in either primary or secondary mode
task-unrestricted	May be called from a Cobalt or regular Linux task indifferently
unrestricted	May be called from any context previously described
atomic-entry	Caller must currently hold the big Cobalt kernel lock (nklock)

Possible side-effects

Tag	Description
might-switch	The Cobalt kernel may switch context

5.20 Interrupt management

Collaboration diagram for Interrupt management:



Functions

- void xnintr_destroy (struct xnintr *intr)
  Destroy an interrupt object.
- int xnintr_attach (struct xnintr *intr, void *cookie)
  Attach an interrupt object.
- void xnintr_detach (struct xnintr *intr)
  Detach an interrupt object.
- void xnintr_enable (struct xnintr *intr)
  Enable an interrupt object.
- void xnintr_disable (struct xnintr *intr)
  Disable an interrupt object.
- void xnintr_affinity (struct xnintr *intr, cpumask_t cpumask)
  Set interrupt's processor affinity.
- int xnintr_init (struct xnintr *intr, const char *name, unsigned int irq, xnisr_t isr, xniack_t iack, int flags)
  Initialize an interrupt object.

5.20.1 Detailed Description

5.20.2 Function Documentation

5.20.2.1 void xnintr_affinity (struct xnintr * intr, cpumask_t cpumask)

Set interrupt's processor affinity.

Restricts 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.

Note

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

Tags

secondary-only

5.20.2.2 int xnintr_attach (struct xnintr * 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.

Tags

secondary-only

Note

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

Referenced by rtdm_irq_request().

5.20.2.3 void xnintr_destroy (struct xnintr * 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.

Tags

secondary-only

References xnintr_detach().

5.20.2.4 void xnintr_detach (struct xnintr * 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.

Note

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

Tags

secondary-only

Referenced by xnintr_destroy().

5.20.2.5 void xnintr_disable (struct xnintr * 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.

Tags

secondary-only

5.20.2.6 void xnintr_enable (struct xnintr * intr)

Enable an interrupt object.

Enables the hardware interrupt line associated with an interrupt object.

Parameters

intr	The descriptor address of the interrupt object to enable.

Tags

secondary-only

Referenced by rtdm_irq_request().

5.20.2.7 int xnintr_init (struct xnintr * intr, const char * name, unsigned int irq, xnisr_t isr, xniack_t iack, int 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-blocking 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 :

Warning

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 prevents the IRQ line from being re-enabled after the ISR has returned.
- XN_ISR_PROPAGATE causes the IRQ event to be propagated down the pipeline to Linux. This is the regular way to share interrupts between the nucleus and the regular Linux kernel. In effect, XN_ISR_PROPAGATE implies XN_ISR_NOENABLE since it would make no sense to re-enable the IRQ line before the Linux kernel had a chance to process the propagated interrupt.

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.
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.

Tags

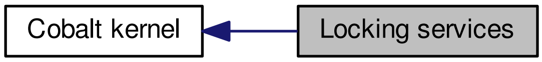
secondary-only

Referenced by rtdm_irq_request().

5.21 Locking services

The Xenomai core deals with concurrent activities from two distinct kernels running side-by-side.

Collaboration diagram for Locking services:



Macros

- #define splhigh(x) ((x) = ipipe_test_and_stall_head() & 1)

    Hard disable interrupts on the local processor, saving previous state.
- #define splexit(x) ipipe_restore_head(x & 1)

    Restore the saved hard interrupt state on the local processor.
- #define splmax() ipipe_stall_head()

    Hard disable interrupts on the local processor.
- #define splnone() ipipe_unstall_head()

    Hard enable interrupts on the local processor.
- #define spltest() ipipe_test_head()

    Test hard interrupt state on the local processor.

5.21.1 Detailed Description

The Xenomai core deals with concurrent activities from two distinct kernels running side-by-side. When interrupts are involved, the services from this section control the **hard** interrupt state exclusively, for protecting against processor-local or SMP concurrency.

Note

> In a dual kernel configuration, *hard interrupts* are gated by the CPU. When enabled, hard interrupts are immediately delivered to the Xenomai core if they belong to a real-time source, or deferred until enabled by a second-stage virtual interrupt mask, if they belong to regular Linux devices/sources.

5.21.2 Macro Definition Documentation

5.21.2.1 #define splexit(x) ipipe_restore_head(x & 1)

Restore the saved hard interrupt state on the local processor.

Parameters

in	*x*	The context variable previously updated by splhigh()

5.21.2.2 #define splhigh(x) ((x) = ipipe_test_and_stall_head() & 1)

Hard disable interrupts on the local processor, saving previous state.

Parameters

out	*x*	An unsigned long integer context variable

5.21.2.3 #define spltest( ) ipipe_test_head()

Test hard interrupt state on the local processor.

Returns

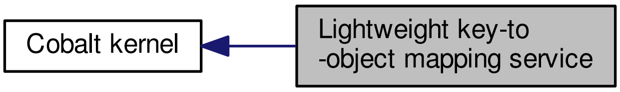
Zero if the local processor currently accepts interrupts, non-zero otherwise.

Referenced by rtdm_lock_get().

5.22 Lightweight key-to-object mapping service

A map is a simple indexing structure which associates unique integer keys with pointers to objects.

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



Functions

- struct xnmap * xnmap_create (int nkeys, int reserve, int offset)

  Create a map.
- void xnmap_delete (struct xnmap *map)

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

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

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

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

  Search an object into a map.

5.22.1 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 objects, 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).

5.22.2 Function Documentation

5.22.2.1 struct xnmap * 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.

Tags

task-unrestricted

5.22.2.2 void xnmap_delete (struct xnmap * 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.

Tags

task-unrestricted

5.22.2.3 int xnmap_enter (struct xnmap * 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.

Tags

unrestricted

5.22.2.4 void xnmap_fetch (struct xnmap * 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.

Tags

unrestricted

5.22.2.5 void xnmap_fetch_nocheck (struct xnmap * 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*.

Tags

unrestricted

5.22.2.6 int xnmap_remove (struct xnmap * 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.

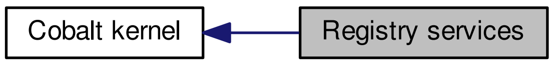
Tags

unrestricted

5.23 Registry services

The registry provides a mean to index object descriptors on unique alphanumeric keys.

Collaboration diagram for Registry services:



Functions

- int xnregistry_enter (const char *key, void *objaddr, xnhandle_t *phandle, struct xnpnode *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.
- static void * xnregistry_lookup (xnhandle_t handle, unsigned long *cstamp_r)
  Find a real-time object into the registry.
- int xnregistry_unlink (const char *key)
  Turn a named object into an anonymous object.

5.23.1 Detailed Description

The registry provides a mean to index object descriptors on unique alphanumeric keys. When labeled this way, an 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.

5.23.2 Function Documentation

5.23.2.1 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 as a count of nanoseconds. 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 xnthread_unblock() 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.

Tags

primary-only, might-switch

References XNBREAK, xnsynch_sleep_on(), and XNTIMEO.

5.23.2.2 int xnregistry_enter (const char * key, void * objaddr, xnhandle_t * phandle, struct xnpnode * 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 or NULL 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* is NULL, or if *key* is non-NULL and contains 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.

Tags

unrestricted, might-switch, atomic-entry

References xnsched_run().

Referenced by rtdm_dev_register().

5.23.2.3 void * xnregistry_lookup (xnhandle_t handle, unsigned long * cstamp_r) [inline], [static]

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. Optionally, it also copies back the object's creation stamp which is unique across object registration calls.

Parameters

handle	The generic handle of the object to fetch.
cstamp_r	If not-NULL, the object's creation stamp will be copied to this memory area.

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.

Tags

unrestricted

5.23.2.4 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.

Tags

unrestricted

Referenced by rtdm_dev_unregister().

5.23.2.5 int xnregistry_unlink (const char * key)

Turn a named object into an anonymous object.

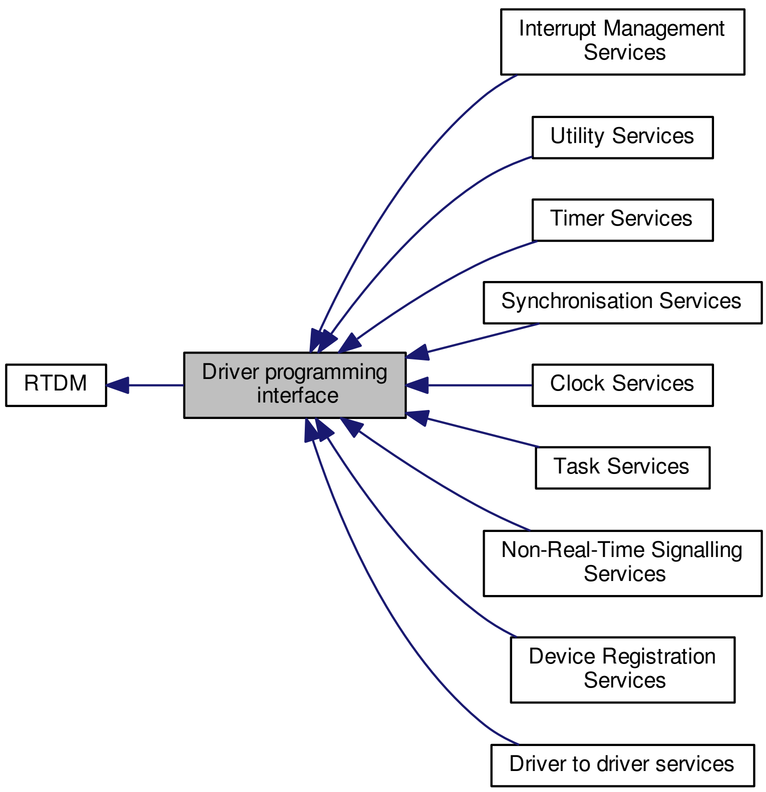
Tags

unrestricted

5.24 Driver programming interface

RTDM driver programming interface.

Collaboration diagram for Driver programming interface:



Modules

- Driver to driver services

  Inter-driver interface.
- Device Registration Services
- Clock Services
- Task Services
- Timer Services
- Synchronisation Services
- Interrupt Management Services
- Non-Real-Time Signalling Services

  These services provide a mechanism to request the execution of a specified handler in non-real-time context.
- Utility Services

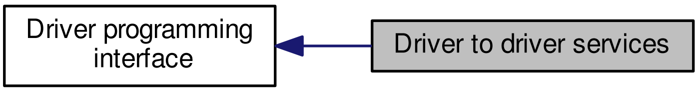
5.24.1 Detailed Description

RTDM driver programming interface.

5.25 Driver to driver services

Inter-driver interface.

Collaboration diagram for Driver to driver services:



Functions

- int rtdm_open (const char *path, int oflag,...)

  Open a device.
- int rtdm_socket (int protocol_family, int socket_type, int protocol)

  Create a socket.
- int rtdm_close (int fd)

  Close a device or socket.
- int rtdm_ioctl (int fd, int request,...)

  Issue an IOCTL.
- ssize_t rtdm_read (int fd, void *buf, size_t nbyte)

  Read from device.
- ssize_t rtdm_write (int fd, const void *buf, size_t nbyte)

  Write to device.
- ssize_t rtdm_recvmsg (int fd, struct msghdr *msg, int flags)

  Receive message from socket.
- ssize_t rtdm_recvfrom (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)

  Receive message from socket.
- ssize_t rtdm_recv (int fd, void *buf, size_t len, int flags)

  Receive message from socket.
- ssize_t rtdm_sendmsg (int fd, const struct msghdr *msg, int flags)

  Transmit message to socket.
- ssize_t rtdm_sendto (int fd, const void *buf, size_t len, int flags, const struct sockaddr *to, socklen_t tolen)

  Transmit message to socket.
- ssize_t rtdm_send (int fd, const void *buf, size_t len, int flags)

  Transmit message to socket.
- int rtdm_bind (int fd, const struct sockaddr *my_addr, socklen_t addrlen)

  Bind to local address.
- int rtdm_connect (int fd, const struct sockaddr *serv_addr, socklen_t addrlen)

  Connect to remote address.
- int rtdm_listen (int fd, int backlog)

  Listen to incoming connection requests.
- int rtdm_accept (int fd, struct sockaddr *addr, socklen_t *addrlen)

Accept a connection request.
- int rtdm_shutdown (int fd, int how)

  Shut down parts of a connection.
- int rtdm_getsockopt (int fd, int level, int optname, void *optval, socklen_t *optlen)

  Get socket option.
- int rtdm_setsockopt (int fd, int level, int optname, const void *optval, socklen_t optlen)

  Set socket option.
- int rtdm_getsockname (int fd, struct sockaddr *name, socklen_t *namelen)

  Get local socket address.
- int rtdm_getpeername (int fd, struct sockaddr *name, socklen_t *namelen)

  Get socket destination address.

5.25.1 Detailed Description

Inter-driver interface.

5.25.2 Function Documentation

5.25.2.1 int rtdm_accept (int fd, struct sockaddr * addr, socklen_t * addrlen)

Accept a connection request.

Refer to rt_dev_accept() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.25.2.2 int rtdm_bind (int fd, const struct sockaddr * my_addr, socklen_t addrlen)

Bind to local address.

Refer to rt_dev_bind() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

task-unrestricted, might-switch

5.25.2.3 int rtdm_close (int fd)

Close a device or socket.

Refer to rt_dev_close() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

secondary-only, might-switch

5.25.2.4 int rtdm_connect (int fd, const struct sockaddr * serv_addr, socklen_t addrlen)

Connect to remote address.

Refer to rt_dev_connect() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.25.2.5 int rtdm_getpeername (int fd, struct sockaddr * name, socklen_t * namelen)

Get socket destination address.

Refer to rt_dev_getpeername() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

task-unrestricted, might-switch

5.25.2.6 int rtdm_getsockname (int fd, struct sockaddr * name, socklen_t * namelen)

Get local socket address.

Refer to rt_dev_getsockname() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

task-unrestricted, might-switch

5.25.2.7 int rtdm_getsockopt (int fd, int level, int optname, void * optval, socklen_t * optlen)

Get socket option.

Refer to rt_dev_getsockopt() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

task-unrestricted, might-switch

5.25.2.8 int rtdm_ioctl (int fd, int request, ...)

Issue an IOCTL.

Refer to rt_dev_ioctl() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

task-unrestricted, might-switch

5.25.2.9 int rtdm_listen (int fd, int backlog)

Listen to incoming connection requests.

Refer to rt_dev_listen() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

task-unrestricted, might-switch

5.25.2.10 int rtdm_open (const char * path, int oflag, ...)

Open a device.

Refer to rt_dev_open() for parameters and return values

Tags

secondary-only, might-switch

5.25.2.11 ssize_t rtdm_read (int fd, void * buf, size_t nbyte)

Read from device.

Refer to rt_dev_read() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.25.2.12 ssize_t rtdm_recv (int fd, void * buf, size_t len, int flags)

Receive message from socket.

Refer to rt_dev_recv() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.25.2.13 ssize_t rtdm_recvfrom (int fd, void * buf, size_t len, int flags, struct sockaddr * from, socklen_t * fromlen)

Receive message from socket.

Refer to rt_dev_recvfrom() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.25.2.14 ssize_t rtdm_recvmsg (int fd, struct msghdr * msg, int flags)

Receive message from socket.

Refer to rt_dev_recvmsg() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.25.2.15 ssize_t rtdm_send (int fd, const void * buf, size_t len, int flags)

Transmit message to socket.

Refer to rt_dev_send() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.25.2.16 ssize_t rtdm_sendmsg (int fd, const struct msghdr * msg, int flags)

Transmit message to socket.

Refer to rt_dev_sendmsg() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.25.2.17 ssize_t rtdm_sendto (int fd, const void * buf, size_t len, int flags, const struct sockaddr * to, socklen_t tolen)

Transmit message to socket.

Refer to rt_dev_sendto() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.25.2.18 int rtdm_setsockopt (int fd, int level, int optname, const void * optval, socklen_t optlen)

Set socket option.

Refer to rt_dev_setsockopt() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

task-unrestricted, might-switch

5.25.2.19 int rtdm_shutdown (int fd, int how)

Shut down parts of a connection.

Refer to rt_dev_shutdown() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

secondary-only, might-switch

5.25.2.20 int rtdm_socket (int protocol_family, int socket_type, int protocol)

Create a socket.

Refer to rt_dev_socket() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

secondary-only, might-switch

5.25.2.21 ssize_t rtdm_write (int fd, const void * buf, size_t nbyte)

Write to device.

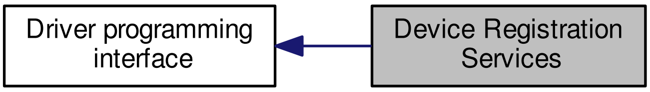
Refer to rt_dev_write() for parameters and return values. Action depends on driver implementation, see Device Profiles.

Tags

mode-unrestricted, might-switch

5.26 Device Registration Services

Collaboration diagram for Device Registration Services:



Functions

- int rtdm_dev_register (struct rtdm_device *device)
  Register a RTDM device.
- int rtdm_dev_unregister (struct rtdm_device *device, unsigned int poll_delay)
  Unregisters a RTDM device.

Device Flags

Static flags describing a RTDM device

- #define RTDM_EXCLUSIVE 0x0001
  If set, only a single instance of the device can be requested by an application.
- #define RTDM_NAMED_DEVICE 0x0010
  If set, the device is addressed via a clear-text name.
- #define RTDM_PROTOCOL_DEVICE 0x0020
  If set, the device is addressed via a combination of protocol ID and socket type.
- #define RTDM_DEVICE_TYPE_MASK 0x00F0
  Mask selecting the device type.

Driver Versioning

Current revisions of RTDM structures, encoding of driver versions. See API Versioning for the interface revision.

- #define RTDM_DEVICE_STRUCT_VER 6
  Version of struct rtdm_device.
- #define RTDM_CONTEXT_STRUCT_VER 4
  Version of struct rtdm_dev_context.
- #define RTDM_SECURE_DEVICE 0x80000000
  Flag indicating a secure variant of RTDM (not supported here)
- #define RTDM_DRIVER_VER(major, minor, patch) (((major & 0xFF) << 16) | ((minor & 0xFF) << 8) | (patch & 0xFF))
  Version code constructor for driver revisions.
- #define RTDM_DRIVER_MAJOR_VER(ver) (((ver) >> 16) & 0xFF)
  Get major version number from driver revision code.

- #define RTDM_DRIVER_MINOR_VER(ver) (((ver) >> 8) & 0xFF)

    Get minor version number from driver revision code.
- #define RTDM_DRIVER_PATCH_VER(ver) ((ver) & 0xFF)

    Get patch version number from driver revision code.

5.26.1 Detailed Description

5.26.2 Macro Definition Documentation

5.26.2.1 #define RTDM_DEVICE_TYPE_MASK 0x00F0

Mask selecting the device type.

Referenced by rtdm_dev_register(), and rtdm_dev_unregister().

5.26.2.2 #define RTDM_EXCLUSIVE 0x0001

If set, only a single instance of the device can be requested by an application.

Referenced by rtdm_dev_register().

5.26.2.3 #define RTDM_NAMED_DEVICE 0x0010

If set, the device is addressed via a clear-text name.

Referenced by rtdm_dev_register(), and rtdm_dev_unregister().

5.26.2.4 #define RTDM_PROTOCOL_DEVICE 0x0020

If set, the device is addressed via a combination of protocol ID and socket type.

Referenced by rtdm_dev_register().

5.26.3 Function Documentation

5.26.3.1 int rtdm_dev_register (struct **rtdm_device** * device)

Register a RTDM device.

Parameters

in	*device*	Pointer to structure describing the new device.

Returns

0 is returned upon success. Otherwise:

- -EINVAL is returned if the device structure contains invalid entries. Check kernel log in this case.
- -ENOMEM is returned if the context for an exclusive device cannot be allocated.
- -EEXIST is returned if the specified device name of protocol ID is already in use.
- -EAGAIN is returned if some /proc entry cannot be created.

Tags

secondary-only

References rtdm_device::context_size, rtdm_device::device_flags, rtdm_device::device_name, rtdm_device::open, rtdm_device::ops, rtdm_device::proc_name, rtdm_device::protocol_family, rtdm_device::reserved, RTDM_DEVICE_STRUCT_VER, RTDM_DEVICE_TYPE_MASK, RTDM_EXCLUSIVE, RTDM_NAMED_DEVICE, RTDM_PROTOCOL_DEVICE, rtdm_device::socket, rtdm_device::socket_type, rtdm_device::struct_version, and xnregistry_enter().

5.26.3.2 int rtdm_dev_unregister (struct **rtdm_device** * device, unsigned int poll_delay)

Unregisters a RTDM device.

Parameters

in	*device*	Pointer to structure describing the device to be unregistered.
in	*poll_delay*	Polling delay in milliseconds to check repeatedly for open instances of *device*, or 0 for non-blocking mode.

Returns

0 is returned upon success. Otherwise:

- -ENODEV is returned if the device was not registered.
- -EAGAIN is returned if the device is busy with open instances and 0 has been passed for *poll_delay*.

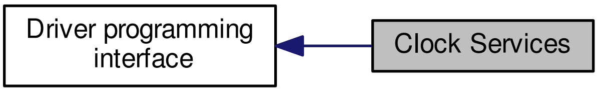
Tags

secondary-only

References rtdm_device::device_flags, rtdm_device::device_name, rtdm_device::protocol_family, rtdm_device::reserved, RTDM_DEVICE_TYPE_MASK, RTDM_NAMED_DEVICE, rtdm_device::socket_type, and xnregistry_remove().

5.27 Clock Services

Collaboration diagram for Clock Services:



Functions

- nanosecs_abs_t rtdm_clock_read (void)
  Get system time.
- nanosecs_abs_t rtdm_clock_read_monotonic (void)
  Get monotonic time.

5.27.1 Detailed Description

5.27.2 Function Documentation

5.27.2.1 **nanosecs_abs_t** rtdm_clock_read (void)

Get system time.

Returns

The system time in nanoseconds is returned

Note

The resolution of this service depends on the system timer. In particular, if the system timer is running in periodic mode, the return value will be limited to multiples of the timer tick period.
The system timer may have to be started to obtain valid results. Whether this happens automatically (as on Xenomai) or is controlled by the application depends on the RTDM host environment.

Tags

unrestricted

Referenced by a4l_get_time(), and rtdm_ratelimit().

5.27.2.2 **nanosecs_abs_t** rtdm_clock_read_monotonic (void)

Get monotonic time.

Returns

The monotonic time in nanoseconds is returned

Note

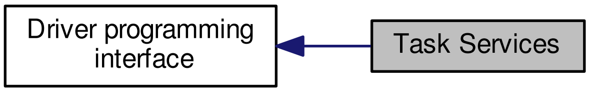
The resolution of this service depends on the system timer. In particular, if the system timer is running in periodic mode, the return value will be limited to multiples of the timer tick period.
The system timer may have to be started to obtain valid results. Whether this happens automatically (as on Xenomai) or is controlled by the application depends on the RTDM host environment.

Tags

unrestricted

5.28 Task Services

Collaboration diagram for Task Services:



Typedefs

- typedef void(* rtdm_task_proc_t)(void *arg)

    Real-time task procedure.

Functions

- int rtdm_task_init (rtdm_task_t *task, const char *name, rtdm_task_proc_t task_proc, void *arg, int priority, nanosecs_rel_t period)

    Initialise and start a real-time task.
- void rtdm_task_destroy (rtdm_task_t *task)

    Destroy a real-time task.
- int rtdm_task_should_stop (void)

    Check for pending termination request.
- void rtdm_task_set_priority (rtdm_task_t *task, int priority)

    Adjust real-time task priority.
- int rtdm_task_set_period (rtdm_task_t *task, nanosecs_rel_t period)

    Adjust real-time task period.
- int rtdm_task_wait_period (void)

    Wait on next real-time task period.
- int rtdm_task_unblock (rtdm_task_t *task)

    Activate a blocked real-time task.
- rtdm_task_t * rtdm_task_current (void)

    Get current real-time task.
- int rtdm_task_sleep (nanosecs_rel_t delay)

    Sleep a specified amount of time.
- int rtdm_task_sleep_until (nanosecs_abs_t wakeup_time)

    Sleep until a specified absolute time.
- int rtdm_task_sleep_abs (nanosecs_abs_t wakeup_time, enum rtdm_timer_mode mode)

    Sleep until a specified absolute time.
- void rtdm_task_join (rtdm_task_t *task)

    Wait on a real-time task to terminate.
- void rtdm_task_busy_sleep (nanosecs_rel_t delay)

    Busy-wait a specified amount of time.

Task Priority Range

Maximum and minimum task priorities

- #define **RTDM_TASK_LOWEST_PRIORITY** 0
- #define **RTDM_TASK_HIGHEST_PRIORITY** 99

Task Priority Modification

Raise or lower task priorities by one level

- #define **RTDM_TASK_RAISE_PRIORITY** (+1)
- #define **RTDM_TASK_LOWER_PRIORITY** (-1)

5.28.1 Detailed Description

5.28.2 Typedef Documentation

5.28.2.1 typedef void(* rtdm_task_proc_t)(void *arg)

Real-time task procedure.

Parameters

in,out	*arg*	argument as passed to rtdm_task_init()

5.28.3 Function Documentation

5.28.3.1 void rtdm_task_busy_sleep (**nanosecs_rel_t** delay)

Busy-wait a specified amount of time.

This service does not schedule out the caller, but rather spins in a tight loop, burning CPU cycles until the timeout elapses.

Parameters

in	*delay*	Delay in nanoseconds. Note that a zero delay does **not** have the meaning of `RTDM_TIMEOUT_INFINITE` here.

Note

The caller must not be migratable to different CPUs while executing this service. Otherwise, the actual delay will be undefined.

Tags

unrestricted

5.28.3.2 rtdm_task_t* rtdm_task_current (void)

Get current real-time task.

Returns

Pointer to task handle

Tags

mode-unrestricted

5.28.3.3 void rtdm_task_destroy (rtdm_task_t * task)

Destroy a real-time task.

This call sends a termination request to *task*, then waits for it to exit. All RTDM task should check for pending termination requests by calling rtdm_task_should_stop() from their work loop.

If *task* is current, rtdm_task_destroy() terminates the current context, and does not return to the caller.

Parameters

`in,out`	*task*	Task handle as returned by rtdm_task_init()

Note

Passing the same task handle to RTDM services after the completion of this function is not allowed.

Tags

secondary-only, might-switch

5.28.3.4 int rtdm_task_init (rtdm_task_t * task, const char * name, **rtdm_task_proc_t** task_proc, void * arg, int priority, **nanosecs_rel_t** period)

Initialise and start a real-time task.

After initialising a task, the task handle remains valid and can be passed to RTDM services until either rtdm_task_destroy() or rtdm_task_join() was invoked.

Parameters

`in,out`	*task*	Task handle
`in`	*name*	Optional task name
`in`	*task_proc*	Procedure to be executed by the task
`in`	*arg*	Custom argument passed to `task_proc()` on entry
`in`	*priority*	Priority of the task, see also Task Priority Range
`in`	*period*	Period in nanoseconds of a cyclic task, 0 for non-cyclic mode

Returns

0 on success, otherwise negative error code

Tags

secondary-only, might-switch

References xnthread_cancel(), xnthread_init(), xnthread_set_periodic(), and xnthread_start().

5.28.3.5 void rtdm_task_join (rtdm_task_t * task)

Wait on a real-time task to terminate.

Parameters

in,out	*task*	Task handle as returned by rtdm_task_init()

Note

Passing the same task handle to RTDM services after the completion of this function is not allowed. This service does not trigger the termination of the targeted task. The user has to take of this, otherwise rtdm_task_join() will never return.

Tags

mode-unrestricted

References xnthread_join().

5.28.3.6 int rtdm_task_set_period (rtdm_task_t * task, **nanosecs_rel_t** period)

Adjust real-time task period.

Parameters

in,out	*task*	Task handle as returned by rtdm_task_init()
in	*period*	New period in nanoseconds of a cyclic task, 0 for non-cyclic mode

Tags

task-unrestricted

5.28.3.7 void rtdm_task_set_priority (rtdm_task_t * task, int priority)

Adjust real-time task priority.

Parameters

in,out	*task*	Task handle as returned by rtdm_task_init()
in	*priority*	New priority of the task, see also Task Priority Range

Tags

task-unrestricted, might-switch

5.28.3.8 int rtdm_task_should_stop (void)

Check for pending termination request.

Check whether a termination request was received by the current RTDM task. Termination requests are sent by calling rtdm_task_destroy().

Returns

Non-zero indicates that a termination request is pending, in which case the caller should wrap up and exit.

Tags

rtdm-task, might-switch

5.28.3.9 int rtdm_task_sleep (**nanosecs_rel_t** delay)

Sleep a specified amount of time.

Parameters

`in`	*delay*	Delay in nanoseconds, see RTDM_TIMEOUT_xxx for special values.

Returns

0 on success, otherwise:

- -EINTR is returned if calling task has been unblock by a signal or explicitly via rtdm_task_unblock().
- -EPERM *may* be returned if an illegal invocation environment is detected.

Tags

primary-only, might-switch

5.28.3.10 int rtdm_task_sleep_abs (**nanosecs_abs_t** wakeup_time, enum **rtdm_timer_mode** mode)

Sleep until a specified absolute time.

Parameters

`in`	*wakeup_time*	Absolute timeout in nanoseconds
`in`	*mode*	Selects the timer mode, see RTDM_TIMERMODE_xxx for details

Returns

0 on success, otherwise:

- -EINTR is returned if calling task has been unblock by a signal or explicitly via rtdm_task_unblock().
- -EPERM *may* be returned if an illegal invocation environment is detected.
- -EINVAL is returned if an invalid parameter was passed.

Tags

primary-only, might-switch

5.28.3.11 int rtdm_task_sleep_until (**nanosecs_abs_t** wakeup_time)

Sleep until a specified absolute time.

Deprecated Use rtdm_task_sleep_abs instead!

Parameters

`in`	*wakeup_time*	Absolute timeout in nanoseconds

Returns

0 on success, otherwise:

- -EINTR is returned if calling task has been unblock by a signal or explicitly via rtdm_task_unblock().
- -EPERM *may* be returned if an illegal invocation environment is detected.

Tags

primary-only, might-switch

5.28.3.12 int rtdm_task_unblock (rtdm_task_t * task)

Activate a blocked real-time task.

Returns

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

Tags

unrestricted, might-switch

5.28.3.13 int rtdm_task_wait_period (void)

Wait on next real-time task period.

Returns

0 on success, otherwise:

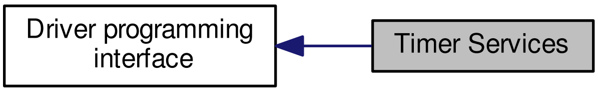
- -EINVAL is returned if calling task is not in periodic mode.
- -ETIMEDOUT is returned if a timer overrun occurred, which indicates that a previous release point has been missed by the calling task.

Tags

primary-only, might-switch

5.29 Timer Services

Collaboration diagram for Timer Services:



Typedefs

- typedef void(* rtdm_timer_handler_t)(rtdm_timer_t *timer)

  Timer handler.

Functions

- int rtdm_timer_init (rtdm_timer_t *timer, rtdm_timer_handler_t handler, const char *name)

  Initialise a timer.
- void rtdm_timer_destroy (rtdm_timer_t *timer)

  Destroy a timer.
- int rtdm_timer_start (rtdm_timer_t *timer, nanosecs_abs_t expiry, nanosecs_rel_t interval, enum rtdm_timer_mode mode)

  Start a timer.
- void rtdm_timer_stop (rtdm_timer_t *timer)

  Stop a timer.
- int rtdm_timer_start_in_handler (rtdm_timer_t *timer, nanosecs_abs_t expiry, nanosecs_rel_t interval, enum rtdm_timer_mode mode)

  Start a timer from inside a timer handler.
- void rtdm_timer_stop_in_handler (rtdm_timer_t *timer)

  Stop a timer from inside a timer handler.

RTDM_TIMERMODE_xxx

Timer operation modes

- enum rtdm_timer_mode { RTDM_TIMERMODE_RELATIVE = XN_RELATIVE, RTDM_TIMERMODE_ABSOLUTE = XN_ABSOLUTE, RTDM_TIMERMODE_REALTIME = XN_REALTIME }

5.29.1 Detailed Description

5.29.2 Typedef Documentation

5.29.2.1 typedef void(* rtdm_timer_handler_t)(rtdm_timer_t *timer)

Timer handler.

Parameters

in	*timer*	Timer handle as returned by rtdm_timer_init()

5.29.3 Enumeration Type Documentation

5.29.3.1 enum **rtdm_timer_mode**

Enumerator

RTDM_TIMERMODE_RELATIVE Monotonic timer with relative timeout.

RTDM_TIMERMODE_ABSOLUTE Monotonic timer with absolute timeout.

RTDM_TIMERMODE_REALTIME Adjustable timer with absolute timeout.

5.29.4 Function Documentation

5.29.4.1 void rtdm_timer_destroy (rtdm_timer_t * timer)

Destroy a timer.

Parameters

in,out	*timer*	Timer handle as returned by rtdm_timer_init()

Tags

task-unrestricted

References xntimer_destroy().

5.29.4.2 int rtdm_timer_init (rtdm_timer_t * timer, **rtdm_timer_handler_t** handler, const char * name)

Initialise a timer.

Parameters

in,out	*timer*	Timer handle
in	*handler*	Handler to be called on timer expiry
in	*name*	Optional timer name

Returns

0 on success, otherwise negative error code

Tags

task-unrestricted

5.29.4.3 int rtdm_timer_start (rtdm_timer_t * timer, **nanosecs_abs_t** expiry, **nanosecs_rel_t** interval, enum **rtdm_timer_mode** mode)

Start a timer.

Parameters

in,out	*timer*	Timer handle as returned by rtdm_timer_init()
in	*expiry*	Firing time of the timer, `mode` defines if relative or absolute
in	*interval*	Relative reload value, > 0 if the timer shall work in periodic mode with the specific interval, 0 for one-shot timers
in	*mode*	Defines the operation mode, see RTDM_TIMERMODE_xxx for possible values

Returns

0 on success, otherwise:

- -ETIMEDOUT is returned if `expiry` describes an absolute date in the past.

Tags

unrestricted

References xntimer_start().

5.29.4.4 int rtdm_timer_start_in_handler (rtdm_timer_t * timer, **nanosecs_abs_t** expiry, **nanosecs_rel_t** interval, enum **rtdm_timer_mode** mode)

Start a timer from inside a timer handler.

Parameters

in,out	*timer*	Timer handle as returned by rtdm_timer_init()
in	*expiry*	Firing time of the timer, `mode` defines if relative or absolute
in	*interval*	Relative reload value, > 0 if the timer shall work in periodic mode with the specific interval, 0 for one-shot timers
in	*mode*	Defines the operation mode, see RTDM_TIMERMODE_xxx for possible values

Returns

0 on success, otherwise:

- -ETIMEDOUT is returned if `expiry` describes an absolute date in the past.

Tags

coreirq-only

5.29.4.5 void rtdm_timer_stop (rtdm_timer_t * timer)

Stop a timer.

Parameters

in,out	*timer*	Timer handle as returned by rtdm_timer_init()

Tags

unrestricted

References xntimer_stop().

5.29.4.6 void rtdm_timer_stop_in_handler (rtdm_timer_t * timer)

Stop a timer from inside a timer handler.

Parameters

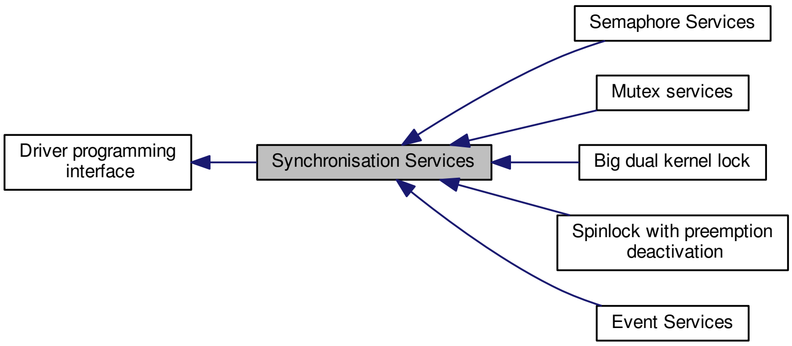
in,out	*timer*	Timer handle as returned by rtdm_timer_init()

Tags

coreirq-only

5.30 Synchronisation Services

Collaboration diagram for Synchronisation Services:



Modules

- Big dual kernel lock
- Spinlock with preemption deactivation
- Event Services
- Semaphore Services
- Mutex services

Functions

- void rtdm_waitqueue_init (struct rtdm_waitqueue *wq)

  Initialize a RTDM wait queue.
- void rtdm_waitqueue_destroy (struct rtdm_waitqueue *wq)

  Deletes a RTDM wait queue.
- rtdm_timedwait_condition_locked (struct rtdm_wait_queue *wq, C_expr condition, nanosecs_rel_t timeout, rtdm_toseq_t *toseq)

  Timed sleep on a locked waitqueue until a condition gets true.
- rtdm_wait_condition_locked (struct rtdm_wait_queue *wq, C_expr condition)

  Sleep on a locked waitqueue until a condition gets true.
- rtdm_timedwait_condition (struct rtdm_wait_queue *wq, C_expr condition, nanosecs_rel_t timeout, rtdm_toseq_t *toseq)

  Timed sleep on a waitqueue until a condition gets true.
- void rtdm_timedwait (struct rtdm_wait_queue *wq, nanosecs_rel_t timeout, rtdm_toseq_t *toseq)

  Timed sleep on a waitqueue unconditionally.
- void rtdm_timedwait_locked (struct rtdm_wait_queue *wq, nanosecs_rel_t timeout, rtdm_toseq_t *toseq)

  Timed sleep on a locked waitqueue unconditionally.
- rtdm_wait_condition (struct rtdm_wait_queue *wq, C_expr condition)

  Sleep on a waitqueue until a condition gets true.
- void rtdm_wait (struct rtdm_wait_queue *wq)

  Sleep on a waitqueue unconditionally.

- void rtdm_wait_locked (struct rtdm_wait_queue *wq)
  Sleep on a locked waitqueue unconditionally.
- void rtdm_waitqueue_lock (struct rtdm_wait_queue *wq, rtdm_lockctx_t context)
  Lock a waitqueue.
- void rtdm_waitqueue_unlock (struct rtdm_wait_queue *wq, rtdm_lockctx_t context)
  Unlock a waitqueue.
- void rtdm_waitqueue_signal (struct rtdm_wait_queue *wq)
  Signal a waitqueue.
- void rtdm_waitqueue_broadcast (struct rtdm_wait_queue *wq)
  Broadcast a waitqueue.
- void rtdm_waitqueue_flush (struct rtdm_wait_queue *wq)
  Flush a waitqueue.
- void rtdm_waitqueue_wakeup (struct rtdm_wait_queue *wq, rtdm_task_t waiter)
  Signal a particular waiter on a waitqueue.
- rtdm_for_each_waiter (rtdm_task_t pos, struct rtdm_wait_queue *wq)
  Simple iterator for waitqueues.
- rtdm_for_each_waiter_safe (rtdm_task_t pos, rtdm_task_t tmp, struct rtdm_wait_queue *wq)
  Safe iterator for waitqueues.

RTDM_SELECTTYPE_xxx

Event types select can bind to

- enum rtdm_selecttype { RTDM_SELECTTYPE_READ = XNSELECT_READ, RTDM_SELECTTYPE_WRITE = XNSELECT_WRITE, RTDM_SELECTTYPE_EXCEPT = XNSELECT_EXCEPT }

Timeout Sequence Management

- void rtdm_toseq_init (rtdm_toseq_t *timeout_seq, nanosecs_rel_t timeout)
  Initialise a timeout sequence.

5.30.1 Detailed Description

5.30.2 Enumeration Type Documentation

5.30.2.1 enum **rtdm_selecttype**

Enumerator

RTDM_SELECTTYPE_READ Select input data availability events.
RTDM_SELECTTYPE_WRITE Select ouput buffer availability events.
RTDM_SELECTTYPE_EXCEPT Select exceptional events.

5.30.3 Function Documentation

5.30.3.1 rtdm_for_each_waiter (rtdm_task_t pos, struct rtdm_wait_queue * wq)

Simple iterator for waitqueues.

This construct traverses the wait list of a given waitqueue *wq*, assigning each RTDM task pointer to the cursor variable *pos*, which must be of type rtdm_task_t.

wq must have been locked by a call to rtdm_waitqueue_lock() prior to traversing its wait list.

Parameters

pos	cursor variable holding a pointer to the RTDM task being fetched.
wq	waitqueue to scan.

Note

The waitqueue should not be signaled, broadcast or flushed during the traversal, unless the loop is aborted immediately after. Should multiple waiters be readied while iterating, the safe form rtdm_for_each_waiter_safe() must be used for traversal instead.

Tags

unrestricted

5.30.3.2 rtdm_for_each_waiter_safe (rtdm_task_t pos, rtdm_task_t tmp, struct rtdm_wait_queue * wq)

Safe iterator for waitqueues.

This construct traverses the wait list of a given waitqueue *wq*, assigning each RTDM task pointer to the cursor variable *pos*, which must be of type rtdm_task_t.

Unlike with rtdm_for_each_waiter(), the waitqueue may be signaled, broadcast or flushed during the traversal.

wq must have been locked by a call to rtdm_waitqueue_lock() prior to traversing its wait list.

Parameters

pos	cursor variable holding a pointer to the RTDM task being fetched.
tmp	temporary cursor variable.
wq	waitqueue to scan.

Tags

unrestricted

5.30.3.3 void rtdm_timedwait (struct rtdm_wait_queue * wq, **nanosecs_rel_t** timeout, rtdm_toseq_t * toseq)

Timed sleep on a waitqueue unconditionally.

The calling task is put to sleep until the waitqueue is signaled by either rtdm_waitqueue_signal() or rtdm_waitqueue_broadcast(), or flushed by a call to rtdm_waitqueue_flush(), or a timeout occurs.

Parameters

	wq	waitqueue to wait on.
	timeout	relative timeout in nanoseconds, see RTDM_TIMEOUT_xxx for special values.
`in,out`	*toseq*	handle of a timeout sequence as returned by rtdm_toseq_init() or NULL.

Returns

0 on success, otherwise:

- -EINTR is returned if the waitqueue has been flushed, or the calling task has received a Linux signal or has been forcibly unblocked by a call to rtdm_task_unblock().

- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.

Note

Passing RTDM_TIMEOUT_NONE to *timeout* makes no sense for such service, and might cause unexpected behavior.

Tags

primary-only, might-switch

5.30.3.4 rtdm_timedwait_condition (struct rtdm_wait_queue * wq, C_expr condition, **nanosecs_rel_t** timeout, rtdm_toseq_t * toseq)

Timed sleep on a waitqueue until a condition gets true.

The calling task is put to sleep until *condition* evaluates to true or a timeout occurs. The condition is checked each time the waitqueue *wq* is signaled.

Parameters

	wq	waitqueue to wait on.
	condition	C expression for the event to wait for.
	timeout	relative timeout in nanoseconds, see RTDM_TIMEOUT_xxx for special values.
`in,out`	*toseq*	handle of a timeout sequence as returned by rtdm_toseq_init() or NULL.

Returns

0 on success, otherwise:

- -EINTR is returned if calling task has received a Linux signal or has been forcibly unblocked by a call to rtdm_task_unblock().
- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.

Note

rtdm_waitqueue_signal() has to be called after changing any variable that could change the result of the wait condition.
Passing RTDM_TIMEOUT_NONE to *timeout* makes no sense for such service, and might cause unexpected behavior.

Tags

primary-only, might-switch

5.30.3.5 rtdm_timedwait_condition_locked (struct rtdm_wait_queue * wq, C_expr condition, **nanosecs_rel_t** timeout, rtdm_toseq_t * toseq)

Timed sleep on a locked waitqueue until a condition gets true.

The calling task is put to sleep until *condition* evaluates to true or a timeout occurs. The condition is checked each time the waitqueue *wq* is signaled.

The waitqueue must have been locked by a call to rtdm_waitqueue_lock() prior to calling this service.

Parameters

	wq	locked waitqueue to wait on. The waitqueue lock is dropped when sleeping, then reacquired before this service returns to the caller.
	condition	C expression for the event to wait for.
	timeout	relative timeout in nanoseconds, see RTDM_TIMEOUT_xxx for special values.
`in,out`	*toseq*	handle of a timeout sequence as returned by rtdm_toseq_init() or NULL.

Returns

0 on success, otherwise:

- -EINTR is returned if calling task has received a Linux signal or has been forcibly unblocked by a call to rtdm_task_unblock().
- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.

Note

rtdm_waitqueue_signal() has to be called after changing any variable that could change the result of the wait condition.
Passing RTDM_TIMEOUT_NONE to *timeout* makes no sense for such service, and might cause unexpected behavior.

Tags

primary-only, might-switch

5.30.3.6 void rtdm_timedwait_locked (struct rtdm_wait_queue * wq, **nanosecs_rel_t** timeout, rtdm_toseq_t * toseq)

Timed sleep on a locked waitqueue unconditionally.

The calling task is put to sleep until the waitqueue is signaled by either rtdm_waitqueue_signal() or rtdm_waitqueue_broadcast(), or flushed by a call to rtdm_waitqueue_flush(), or a timeout occurs.

The waitqueue must have been locked by a call to rtdm_waitqueue_lock() prior to calling this service.

Parameters

	wq	locked waitqueue to wait on. The waitqueue lock is dropped when sleeping, then reacquired before this service returns to the caller.
	timeout	relative timeout in nanoseconds, see RTDM_TIMEOUT_xxx for special values.
`in,out`	*toseq*	handle of a timeout sequence as returned by rtdm_toseq_init() or NULL.

Returns

0 on success, otherwise:

- -EINTR is returned if the waitqueue has been flushed, or the calling task has received a Linux signal or has been forcibly unblocked by a call to rtdm_task_unblock().
- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.

Note

Passing RTDM_TIMEOUT_NONE to *timeout* makes no sense for such service, and might cause unexpected behavior.

Tags

primary-only, might-switch

5.30.3.7 void rtdm_toseq_init (rtdm_toseq_t * timeout_seq, **nanosecs_rel_t** timeout)

Initialise a timeout sequence.

This service initialises a timeout sequence handle according to the given timeout value. Timeout sequences allow to maintain a continuous *timeout* across multiple calls of blocking synchronisation services. A typical application scenario is given below.

Parameters

`in,out`	*timeout_seq*	Timeout sequence handle
`in`	*timeout*	Relative timeout in nanoseconds, see RTDM_TIMEOUT_xxx for special values

Application Scenario:

```
int device_service_routine(...)
{
        rtdm_toseq_t timeout_seq;
        ...

        rtdm_toseq_init(&timeout_seq, timeout);
        ...
        while (received < requested) {
                ret = rtdm_event_timedwait(&data_available, timeout, &timeout_seq);
                if (ret < 0) // including -ETIMEDOUT
                        break;

                // receive some data
                ...
        }
        ...
}
```

Using a timeout sequence in such a scenario avoids that the user-provided relative `timeout` is restarted on every call to rtdm_event_timedwait(), potentially causing an overall delay that is larger than specified by `timeout`. Moreover, all functions supporting timeout sequences also interpret special timeout values (infinite and non-blocking), disburdening the driver developer from handling them separately.

Tags

task-unrestricted

5.30.3.8 void rtdm_wait (struct rtdm_wait_queue * wq)

Sleep on a waitqueue unconditionally.

The calling task is put to sleep until the waitqueue is signaled by either rtdm_waitqueue_signal() or rtdm_waitqueue_broadcast(), or flushed by a call to rtdm_waitqueue_flush().

Parameters

wq	waitqueue to wait on.

Returns

0 on success, otherwise:

- -EINTR is returned if the waitqueue has been flushed, or the calling task has received a Linux signal or has been forcibly unblocked by a call to rtdm_task_unblock().

Tags

primary-only, might-switch

5.30.3.9 rtdm_wait_condition (struct rtdm_wait_queue * wq, C_expr condition)

Sleep on a waitqueue until a condition gets true.

The calling task is put to sleep until *condition* evaluates to true. The condition is checked each time the waitqueue *wq* is signaled.

Parameters

wq	waitqueue to wait on
condition	C expression for the event to wait for.

Returns

0 on success, otherwise:

- -EINTR is returned if calling task has received a Linux signal or has been forcibly unblocked by a call to rtdm_task_unblock().

Note

rtdm_waitqueue_signal() has to be called after changing any variable that could change the result of the wait condition.

Tags

primary-only, might-switch

5.30.3.10 rtdm_wait_condition_locked (struct rtdm_wait_queue * wq, C_expr condition)

Sleep on a locked waitqueue until a condition gets true.

The calling task is put to sleep until *condition* evaluates to true. The condition is checked each time the waitqueue *wq* is signaled.

The waitqueue must have been locked by a call to rtdm_waitqueue_lock() prior to calling this service.

Parameters

wq	locked waitqueue to wait on. The waitqueue lock is dropped when sleeping, then reacquired before this service returns to the caller.
condition	C expression for the event to wait for.

Returns

0 on success, otherwise:

- -EINTR is returned if calling task has received a Linux signal or has been forcibly unblocked by a call to rtdm_task_unblock().

Note

rtdm_waitqueue_signal() has to be called after changing any variable that could change the result of the wait condition.

Tags

primary-only, might-switch

5.30.3.11 void rtdm_wait_locked (struct rtdm_wait_queue * wq)

Sleep on a locked waitqueue unconditionally.

The calling task is put to sleep until the waitqueue is signaled by either rtdm_waitqueue_signal() or rtdm_waitqueue_broadcast(), or flushed by a call to rtdm_waitqueue_flush().

The waitqueue must have been locked by a call to rtdm_waitqueue_lock() prior to calling this service.

Parameters

wq	locked waitqueue to wait on. The waitqueue lock is dropped when sleeping, then reacquired before this service returns to the caller.

Returns

0 on success, otherwise:

- -EINTR is returned if the waitqueue has been flushed, or the calling task has received a Linux signal or has been forcibly unblocked by a call to rtdm_task_unblock().

Tags

primary-only, might-switch

5.30.3.12 void rtdm_waitqueue_broadcast (struct rtdm_wait_queue * wq)

Broadcast a waitqueue.

Broadcast the waitqueue *wq*, waking up all waiters. Each readied task may assume to have received the wake up event.

Parameters

wq	waitqueue to broadcast.

Returns

non-zero if at least one task has been readied as a result of this call, zero otherwise.

Tags

unrestricted, might-switch

5.30.3.13 void rtdm_waitqueue_destroy (struct rtdm_waitqueue * wq)

Deletes a RTDM wait queue.

Dismantles a wait queue structure, releasing all resources attached to it.

Parameters

wq	waitqueue to delete.

Tags

task-unrestricted

5.30.3.14 void rtdm_waitqueue_flush (struct rtdm_wait_queue * wq)

Flush a waitqueue.

Flushes the waitqueue *wq*, unblocking all waiters with an error status (-EINTR).

Parameters

wq	waitqueue to flush.

Returns

non-zero if at least one task has been readied as a result of this call, zero otherwise.

Tags

unrestricted, might-switch

5.30.3.15 void rtdm_waitqueue_init (struct rtdm_waitqueue * wq)

Initialize a RTDM wait queue.

Sets up a wait queue structure for further use.

Parameters

wq	waitqueue to initialize.

Tags

task-unrestricted

5.30.3.16 void rtdm_waitqueue_lock (struct rtdm_wait_queue * wq, **rtdm_lockctx_t** context)

Lock a waitqueue.

Acquires the lock on the waitqueue *wq*.

Parameters

wq	waitqueue to lock.
context	name of local variable to store the context in.

Note

Recursive locking might lead to unexpected behavior, including lock up.

Tags

unrestricted

5.30.3.17 void rtdm_waitqueue_signal (struct rtdm_wait_queue * wq)

Signal a waitqueue.

Signals the waitqueue *wq*, waking up a single waiter (if any).

Parameters

wq	waitqueue to signal.

Returns

non-zero if a task has been readied as a result of this call, zero otherwise.

Tags

unrestricted, might-switch

5.30.3.18 void rtdm_waitqueue_unlock (struct rtdm_wait_queue * wq, **rtdm_lockctx_t** context)

Unlock a waitqueue.

Releases the lock on the waitqueue *wq*.

Parameters

wq	waitqueue to unlock.
context	name of local variable to retrieve the context from.

Tags

unrestricted

5.30.3.19 void rtdm_waitqueue_wakeup (struct rtdm_wait_queue * wq, rtdm_task_t waiter)

Signal a particular waiter on a waitqueue.

Signals the waitqueue *wq*, waking up waiter *waiter* only, which must be currently sleeping on the wait-queue.

Parameters

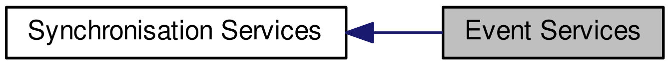
wq	waitqueue to signal.
waiter	RTDM task to wake up.

Tags

unrestricted, might-switch

5.31 Event Services

Collaboration diagram for Event Services:



Functions

- void rtdm_event_init (rtdm_event_t *event, unsigned long pending)
  Initialise an event.
- void rtdm_event_destroy (rtdm_event_t *event)
  Destroy an event.
- void rtdm_event_pulse (rtdm_event_t *event)
  Signal an event occurrence to currently listening waiters.
- void rtdm_event_signal (rtdm_event_t *event)
  Signal an event occurrence.
- int rtdm_event_wait (rtdm_event_t *event)
  Wait on event occurrence.
- int rtdm_event_timedwait (rtdm_event_t *event, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
  Wait on event occurrence with timeout.
- void rtdm_event_clear (rtdm_event_t *event)
  Clear event state.
- int rtdm_event_select_bind (rtdm_event_t *event, rtdm_selector_t *selector, enum rtdm_selecttype type, unsigned int fd_index)
  Bind a selector to an event.

5.31.1 Detailed Description

5.31.2 Function Documentation

5.31.2.1 void rtdm_event_clear (rtdm_event_t * event)

Clear event state.

Parameters

`in,out`	*event*	Event handle as returned by rtdm_event_init()

Tags

unrestricted

References xnselect_signal().

5.31.2.2 void rtdm_event_destroy (rtdm_event_t * event)

Destroy an event.

Parameters

in,out	*event*	Event handle as returned by rtdm_event_init()

Tags

task-unrestricted, might-switch

References XNRMID, and xnselect_destroy().

5.31.2.3 void rtdm_event_init (rtdm_event_t * event, unsigned long pending)

Initialise an event.

Parameters

in,out	*event*	Event handle
in	*pending*	Non-zero if event shall be initialised as set, 0 otherwise

Tags

task-unrestricted

References xnselect_init(), and xnsynch_init().

5.31.2.4 void rtdm_event_pulse (rtdm_event_t * event)

Signal an event occurrence to currently listening waiters.

This function wakes up all current waiters of the given event, but it does not change the event state. Subsequently callers of rtdm_event_wait() or rtdm_event_timedwait() will therefore be blocked first.

Parameters

in,out	*event*	Event handle as returned by rtdm_event_init()

Tags

unrestricted, might-switch

5.31.2.5 int rtdm_event_select_bind (rtdm_event_t * event, rtdm_selector_t * selector, enum **rtdm_selecttype** type, unsigned int fd_index)

Bind a selector to an event.

This functions binds the given selector to an event so that the former is notified when the event state changes. Typically the select binding handler will invoke this service.

Parameters

in,out	*event*	Event handle as returned by rtdm_event_init()
in,out	*selector*	Selector as passed to the select binding handler
in	*type*	Type of the bound event as passed to the select binding handler

in	*fd_index*	File descriptor index as passed to the select binding handler

Returns

0 on success, otherwise:

- -ENOMEM is returned if there is insufficient memory to establish the dynamic binding.
- -EINVAL is returned if *type* or *fd_index* are invalid.

Tags

task-unrestricted

References xnselect_bind().

5.31.2.6 void rtdm_event_signal (rtdm_event_t * event)

Signal an event occurrence.

This function sets the given event and wakes up all current waiters. If no waiter is presently registered, the next call to rtdm_event_wait() or rtdm_event_timedwait() will return immediately.

Parameters

in,out	*event*	Event handle as returned by rtdm_event_init()

Tags

unrestricted, might-switch

References xnsched_run(), xnselect_signal(), and xnsynch_flush().

5.31.2.7 int rtdm_event_timedwait (rtdm_event_t * event, **nanosecs_rel_t** timeout, rtdm_toseq_t * timeout_seq)

Wait on event occurrence with timeout.

This function waits or tests for the occurence of the given event, taking the provided timeout into account. On successful return, the event is reset.

Parameters

in,out	*event*	Event handle as returned by rtdm_event_init()
in	*timeout*	Relative timeout in nanoseconds, see RTDM_TIMEOUT_xxx for special values
in,out	*timeout_seq*	Handle of a timeout sequence as returned by rtdm_toseq_init() or NULL

Returns

0 on success, otherwise:

- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.
- -EINTR is returned if calling task has been unblock by a signal or explicitly via rtdm_task_unblock().
- -EIDRM is returned if *event* has been destroyed.

- -EPERM *may* be returned if an illegal invocation environment is detected.
- -EWOULDBLOCK is returned if a negative *timeout* (i.e., non-blocking operation) has been specified.

Tags

primary-only, might-switch

References XNBREAK, XNRMID, xnselect_signal(), xnsynch_sleep_on(), and XNTIMEO.

Referenced by rtdm_event_wait().

5.31.2.8 int rtdm_event_wait (rtdm_event_t * event)

Wait on event occurrence.

This is the light-weight version of rtdm_event_timedwait(), implying an infinite timeout.

Parameters

`in,out`	*event*	Event handle as returned by rtdm_event_init()

Returns

0 on success, otherwise:

- -EINTR is returned if calling task has been unblock by a signal or explicitly via rtdm_task_unblock().
- -EIDRM is returned if *event* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

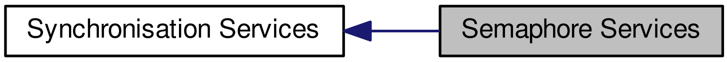
Tags

primary-only, might-switch

References rtdm_event_timedwait().

5.32 Semaphore Services

Collaboration diagram for Semaphore Services:



Functions

- void rtdm_sem_init (rtdm_sem_t *sem, unsigned long value)

  Initialise a semaphore.
- void rtdm_sem_destroy (rtdm_sem_t *sem)

  Destroy a semaphore.
- int rtdm_sem_down (rtdm_sem_t *sem)

  Decrement a semaphore.
- int rtdm_sem_timeddown (rtdm_sem_t *sem, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)

  Decrement a semaphore with timeout.
- void rtdm_sem_up (rtdm_sem_t *sem)

  Increment a semaphore.
- int rtdm_sem_select_bind (rtdm_sem_t *sem, rtdm_selector_t *selector, enum rtdm_selecttype type, unsigned int fd_index)

  Bind a selector to a semaphore.

5.32.1 Detailed Description

5.32.2 Function Documentation

5.32.2.1 void rtdm_sem_destroy (rtdm_sem_t * sem)

Destroy a semaphore.

Parameters

in,out	*sem*	Semaphore handle as returned by rtdm_sem_init()

Tags

task-unrestricted, might-switch

References XNRMID, and xnselect_destroy().

5.32.2.2 int rtdm_sem_down (rtdm_sem_t * sem)

Decrement a semaphore.

This is the light-weight version of rtdm_sem_timeddown(), implying an infinite timeout.

Parameters

in,out	*sem*	Semaphore handle as returned by rtdm_sem_init()

Returns

0 on success, otherwise:

- -EINTR is returned if calling task has been unblock by a signal or explicitly via rtdm_task_unblock().
- -EIDRM is returned if *sem* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Tags

primary-only, might-switch

References rtdm_sem_timeddown().

5.32.2.3 void rtdm_sem_init (rtdm_sem_t * sem, unsigned long value)

Initialise a semaphore.

Parameters

in,out	*sem*	Semaphore handle
in	*value*	Initial value of the semaphore

Tags

task-unrestricted

References xnselect_init(), and xnsynch_init().

5.32.2.4 int rtdm_sem_select_bind (rtdm_sem_t * sem, rtdm_selector_t * selector, enum **rtdm_selecttype** type, unsigned int fd_index)

Bind a selector to a semaphore.

This functions binds the given selector to the semaphore so that the former is notified when the semaphore state changes. Typically the select binding handler will invoke this service.

Parameters

in,out	*sem*	Semaphore handle as returned by rtdm_sem_init()
in,out	*selector*	Selector as passed to the select binding handler
in	*type*	Type of the bound event as passed to the select binding handler
in	*fd_index*	File descriptor index as passed to the select binding handler

Returns

0 on success, otherwise:

- -ENOMEM is returned if there is insufficient memory to establish the dynamic binding.
- -EINVAL is returned if *type* or *fd_index* are invalid.

Tags

task-unrestricted

References xnselect_bind().

5.32.2.5 int rtdm_sem_timeddown (rtdm_sem_t * sem, **nanosecs_rel_t** timeout, rtdm_toseq_t * timeout_seq)

Decrement a semaphore with timeout.

This function tries to decrement the given semphore's value if it is positive on entry. If not, the caller is blocked unless non-blocking operation was selected.

Parameters

in,out	*sem*	Semaphore handle as returned by rtdm_sem_init()
in	*timeout*	Relative timeout in nanoseconds, see RTDM_TIMEOUT_xxx for special values
in,out	*timeout_seq*	Handle of a timeout sequence as returned by rtdm_toseq_init() or NULL

Returns

0 on success, otherwise:

- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.
- -EWOULDBLOCK is returned if *timeout* is negative and the semaphore value is currently not positive.
- -EINTR is returned if calling task has been unblock by a signal or explicitly via rtdm_task_unblock().
- -EIDRM is returned if *sem* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Tags

primary-only, might-switch

References XNBREAK, XNRMID, xnselect_signal(), xnsynch_sleep_on(), and XNTIMEO.

Referenced by rtdm_sem_down().

5.32.2.6 void rtdm_sem_up (rtdm_sem_t * sem)

Increment a semaphore.

This function increments the given semphore's value, waking up a potential waiter which was blocked upon rtdm_sem_down().

Parameters

in,out	*sem*	Semaphore handle as returned by rtdm_sem_init()

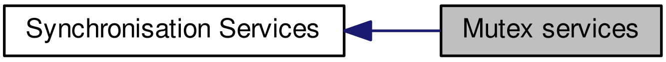
Tags

unrestricted, might-switch

References xnsched_run(), xnselect_signal(), and xnsynch_wakeup_one_sleeper().

5.33 Mutex services

Collaboration diagram for Mutex services:



Functions

- void rtdm_mutex_init (rtdm_mutex_t *mutex)
  Initialise a mutex.
- void rtdm_mutex_destroy (rtdm_mutex_t *mutex)
  Destroy a mutex.
- void rtdm_mutex_unlock (rtdm_mutex_t *mutex)
  Release a mutex.
- int rtdm_mutex_lock (rtdm_mutex_t *mutex)
  Request a mutex.
- int rtdm_mutex_timedlock (rtdm_mutex_t *mutex, nanosecs_rel_t timeout, rtdm_toseq_t *timeout-_seq)
  Request a mutex with timeout.

5.33.1 Detailed Description

5.33.2 Function Documentation

5.33.2.1 void rtdm_mutex_destroy (rtdm_mutex_t * mutex)

Destroy a mutex.

Parameters

`in,out`	*mutex*	Mutex handle as returned by rtdm_mutex_init()

Tags

task-unrestricted, might-switch

References XNRMID.

5.33.2.2 void rtdm_mutex_init (rtdm_mutex_t * mutex)

Initialise a mutex.

This function initalises a basic mutex with priority inversion protection. "Basic", as it does not allow a mutex owner to recursively lock the same mutex again.

Parameters

in,out	*mutex*	Mutex handle

Tags

task-unrestricted

References xnsynch_init().

5.33.2.3 int rtdm_mutex_lock (rtdm_mutex_t * mutex)

Request a mutex.

This is the light-weight version of rtdm_mutex_timedlock(), implying an infinite timeout.

Parameters

in,out	*mutex*	Mutex handle as returned by rtdm_mutex_init()

Returns

0 on success, otherwise:

- -EIDRM is returned if *mutex* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Tags

primary-only, might-switch

References rtdm_mutex_timedlock().

5.33.2.4 int rtdm_mutex_timedlock (rtdm_mutex_t * mutex, **nanosecs_rel_t** timeout, rtdm_toseq_t * timeout_seq)

Request a mutex with timeout.

This function tries to acquire the given mutex. If it is not available, the caller is blocked unless non-blocking operation was selected.

Parameters

in,out	*mutex*	Mutex handle as returned by rtdm_mutex_init()
in	*timeout*	Relative timeout in nanoseconds, see RTDM_TIMEOUT_xxx for special values
in,out	*timeout_seq*	Handle of a timeout sequence as returned by rtdm_toseq_init() or NULL

Returns

0 on success, otherwise:

- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.
- -EWOULDBLOCK is returned if *timeout* is negative and the semaphore value is currently not positive.

- -EIDRM is returned if *mutex* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Tags

primary-only, might-switch

References XNBREAK, XNRMID, xnsynch_acquire(), and XNTIMEO.

Referenced by rtdm_mutex_lock().

5.33.2.5 void rtdm_mutex_unlock (rtdm_mutex_t * mutex)

Release a mutex.

This function releases the given mutex, waking up a potential waiter which was blocked upon rtdm_mutex_lock() or rtdm_mutex_timedlock().

Parameters

in,out	*mutex*	Mutex handle as returned by rtdm_mutex_init()

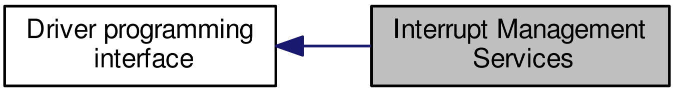
Tags

primary-only, might-switch

References xnsched_run(), and xnsynch_release().

5.34 Interrupt Management Services

Collaboration diagram for Interrupt Management Services:



Macros

- #define rtdm_irq_get_arg(irq_handle, type) ((type *)irq_handle->cookie)

  Retrieve IRQ handler argument.

Typedefs

- typedef int(* rtdm_irq_handler_t)(rtdm_irq_t *irq_handle)

  Interrupt handler.

Functions

- int rtdm_irq_request (rtdm_irq_t *irq_handle, unsigned int irq_no, rtdm_irq_handler_t handler, unsigned long flags, const char *device_name, void *arg)

  Register an interrupt handler.
- int rtdm_irq_free (rtdm_irq_t *irq_handle)

  Release an interrupt handler.
- int rtdm_irq_enable (rtdm_irq_t *irq_handle)

  Enable interrupt line.
- int rtdm_irq_disable (rtdm_irq_t *irq_handle)

  Disable interrupt line.

RTDM_IRQTYPE_xxx

Interrupt registrations flags

- #define RTDM_IRQTYPE_SHARED XN_ISR_SHARED

  Enable IRQ-sharing with other real-time drivers.
- #define RTDM_IRQTYPE_EDGE XN_ISR_EDGE

  Mark IRQ as edge-triggered, relevant for correct handling of shared edge-triggered IRQs.

RTDM_IRQ_xxx

Return flags of interrupt handlers

- #define RTDM_IRQ_NONE XN_ISR_NONE

  Unhandled interrupt.
- #define RTDM_IRQ_HANDLED XN_ISR_HANDLED

  Denote handled interrupt.

5.34.1 Detailed Description

5.34.2 Macro Definition Documentation

5.34.2.1 #define rtdm_irq_get_arg(irq_handle, type) ((type *)irq_handle->cookie)

Retrieve IRQ handler argument.

Parameters

irq_handle	IRQ handle
type	Type of the pointer to return

Returns

The argument pointer registered on rtdm_irq_request() is returned, type-casted to the specified *type*.

Tags

unrestricted

5.34.3 Typedef Documentation

5.34.3.1 typedef int(* rtdm_irq_handler_t)(rtdm_irq_t *irq_handle)

Interrupt handler.

Parameters

in	*irq_handle*	IRQ handle as returned by rtdm_irq_request()

Returns

0 or a combination of RTDM_IRQ_xxx flags

5.34.4 Function Documentation

5.34.4.1 int rtdm_irq_disable (rtdm_irq_t * irq_handle)

Disable interrupt line.

Parameters

in,out	*irq_handle*	IRQ handle as returned by rtdm_irq_request()

Returns

0 on success, otherwise negative error code

Note

This service is for exceptional use only. Drivers should always prefer interrupt masking at device level (via corresponding control registers etc.) over masking at line level. Keep in mind that the latter is incompatible with IRQ line sharing and can also be more costly as interrupt controller access requires broader synchronization. Also, certain IRQ types may not allow the invocation over RT and interrupt contexts. The caller is responsible for excluding such conflicts.

Tags

secondary-only

5.34.4.2 int rtdm_irq_enable (rtdm_irq_t * irq_handle)

Enable interrupt line.

Parameters

in,out	*irq_handle*	IRQ handle as returned by rtdm_irq_request()

Returns

0 on success, otherwise negative error code

Note

This service is for exceptional use only. Drivers should always prefer interrupt masking at device level (via corresponding control registers etc.) over masking at line level. Keep in mind that the latter is incompatible with IRQ line sharing and can also be more costly as interrupt controller access requires broader synchronization. Also, certain IRQ types may not allow the invocation over RT and interrupt contexts. The caller is responsible for excluding such conflicts.

Tags

secondary-only

5.34.4.3 int rtdm_irq_free (rtdm_irq_t * irq_handle)

Release an interrupt handler.

Parameters

in,out	*irq_handle*	IRQ handle as returned by rtdm_irq_request()

Returns

0 on success, otherwise negative error code

Note

The caller is responsible for shutting down the IRQ source at device level before invoking this service. In turn, rtdm_irq_free ensures that any pending event on the given IRQ line is fully processed on return from this service.

Tags

secondary-only

5.34.4.4 int rtdm_irq_request (rtdm_irq_t * irq_handle, unsigned int irq_no, **rtdm_irq_handler_t** handler, unsigned long flags, const char * device_name, void * arg)

Register an interrupt handler.

This function registers the provided handler with an IRQ line and enables the line.

Parameters

in,out	*irq_handle*	IRQ handle
in	*irq_no*	Line number of the addressed IRQ
in	*handler*	Interrupt handler
in	*flags*	Registration flags, see RTDM_IRQTYPE_xxx for details
in	*device_name*	Device name to show up in real-time IRQ lists
in	*arg*	Pointer to be passed to the interrupt handler on invocation

Returns

0 on success, otherwise:

- -EINVAL is returned if an invalid parameter was passed.
- -EBUSY is returned if the specified IRQ line is already in use.

Tags

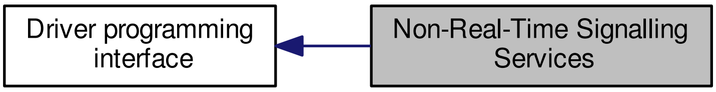
secondary-only

References xnintr_attach(), xnintr_enable(), and xnintr_init().

5.35 Non-Real-Time Signalling Services

These services provide a mechanism to request the execution of a specified handler in non-real-time context.

Collaboration diagram for Non-Real-Time Signalling Services:



Typedefs

- typedef void(* rtdm_nrtsig_handler_t)(rtdm_nrtsig_t nrt_sig, void *arg)

  Non-real-time signal handler.

Functions

- int rtdm_nrtsig_init (rtdm_nrtsig_t *nrt_sig, rtdm_nrtsig_handler_t handler, void *arg)

  Register a non-real-time signal handler.
- void rtdm_nrtsig_destroy (rtdm_nrtsig_t *nrt_sig)

  Release a non-realtime signal handler.
- void rtdm_nrtsig_pend (rtdm_nrtsig_t *nrt_sig)

  Trigger non-real-time signal.

5.35.1 Detailed Description

These services provide a mechanism to request the execution of a specified handler in non-real-time context. The triggering can safely be performed in real-time context without suffering from unknown delays. The handler execution will be deferred until the next time the real-time subsystem releases the CPU to the non-real-time part.

5.35.2 Typedef Documentation

5.35.2.1 typedef void(* rtdm_nrtsig_handler_t)(rtdm_nrtsig_t nrt_sig, void *arg)

Non-real-time signal handler.

Parameters

in	*nrt_sig*	Signal handle as returned by rtdm_nrtsig_init()
in	*arg*	Argument as passed to rtdm_nrtsig_init()

Note

The signal handler will run in soft-IRQ context of the non-real-time subsystem. Note the implications of this context, e.g. no invocation of blocking operations.

5.35.3 Function Documentation

5.35.3.1 void rtdm_nrtsig_destroy (rtdm_nrtsig_t * nrt_sig)

Release a non-realtime signal handler.

Parameters

in,out	*nrt_sig*	Signal handle

Tags

task-unrestricted

5.35.3.2 int rtdm_nrtsig_init (rtdm_nrtsig_t * nrt_sig, **rtdm_nrtsig_handler_t** handler, void * arg)

Register a non-real-time signal handler.

Parameters

in,out	*nrt_sig*	Signal handle
in	*handler*	Non-real-time signal handler
in	*arg*	Custom argument passed to `handler()` on each invocation

Returns

0 on success, otherwise:

- -EAGAIN is returned if no free signal slot is available.

Tags

task-unrestricted

5.35.3.3 void rtdm_nrtsig_pend (rtdm_nrtsig_t * nrt_sig)

Trigger non-real-time signal.

Parameters

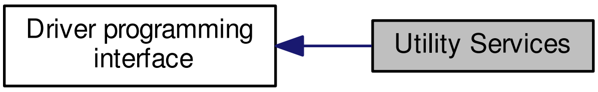
in,out	*nrt_sig*	Signal handle

Tags

unrestricted

5.36 Utility Services

Collaboration diagram for Utility Services:



Functions

- int rtdm_mmap_to_user (struct rtdm_fd *fd, void *src_addr, size_t len, int prot, void **pptr, struct vm_operations_struct *vm_ops, void *vm_private_data)

  Map a kernel memory range into the address space of the user.
- int rtdm_iomap_to_user (struct rtdm_fd *fd, phys_addr_t src_addr, size_t len, int prot, void **pptr, struct vm_operations_struct *vm_ops, void *vm_private_data)

  Map an I/O memory range into the address space of the user.
- int rtdm_munmap (struct rtdm_fd *fd, void *ptr, size_t len)

  Unmap a user memory range.
- int rtdm_ratelimit (struct rtdm_ratelimit_state *rs, const char *func)

  Enforces a rate limit.
- void rtdm_printk_ratelimited (const char *format,...)

  Real-time safe rate-limited message printing on kernel console.
- void rtdm_printk (const char *format,...)

  Real-time safe message printing on kernel console.
- void * rtdm_malloc (size_t size)

  Allocate memory block.
- void rtdm_free (void *ptr)

  Release real-time memory block.
- int rtdm_read_user_ok (struct rtdm_fd *fd, const void __user *ptr, size_t size)

  Check if read access to user-space memory block is safe.
- int rtdm_rw_user_ok (struct rtdm_fd *fd, const void __user *ptr, size_t size)

  Check if read/write access to user-space memory block is safe.
- int rtdm_copy_from_user (struct rtdm_fd *fd, void *dst, const void __user *src, size_t size)

  Copy user-space memory block to specified buffer.
- int rtdm_safe_copy_from_user (struct rtdm_fd *fd, void *dst, const void __user *src, size_t size)

  Check if read access to user-space memory block and copy it to specified buffer.
- int rtdm_copy_to_user (struct rtdm_fd *fd, void __user *dst, const void *src, size_t size)

  Copy specified buffer to user-space memory block.
- int rtdm_safe_copy_to_user (struct rtdm_fd *fd, void __user *dst, const void *src, size_t size)

  Check if read/write access to user-space memory block is safe and copy specified buffer to it.
- int rtdm_strncpy_from_user (struct rtdm_fd *fd, char *dst, const char __user *src, size_t count)

  Copy user-space string to specified buffer.
- int rtdm_in_rt_context (void)

  Test if running in a real-time task.
- int rtdm_rt_capable (struct rtdm_fd *fd)

  Test if the caller is capable of running in real-time context.

5.36.1 Detailed Description

5.36.2 Function Documentation

5.36.2.1 int rtdm_copy_from_user (struct rtdm_fd * fd, void * dst, const void __user * src, size_t size)

Copy user-space memory block to specified buffer.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler
in	*dst*	Destination buffer address
in	*src*	Address of the user-space memory block
in	*size*	Size of the memory block

Returns

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

Before invoking this service, verify via rtdm_read_user_ok() that the provided user-space address can securely be accessed.

Tags

task-unrestricted

5.36.2.2 int rtdm_copy_to_user (struct rtdm_fd * fd, void __user * dst, const void * src, size_t size)

Copy specified buffer to user-space memory block.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler
in	*dst*	Address of the user-space memory block
in	*src*	Source buffer address
in	*size*	Size of the memory block

Returns

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

Before invoking this service, verify via rtdm_rw_user_ok() that the provided user-space address can securely be accessed.

Tags

task-unrestricted

5.36.2.3 void rtdm_free (void * ptr)

Release real-time memory block.

Parameters

in	*ptr*	Pointer to memory block as returned by rtdm_malloc()

Tags

unrestricted

5.36.2.4 int rtdm_in_rt_context (void)

Test if running in a real-time task.

Returns

Non-zero is returned if the caller resides in real-time context, 0 otherwise.

Tags

task-unrestricted

5.36.2.5 int rtdm_iomap_to_user (struct rtdm_fd * fd, phys_addr_t src_addr, size_t len, int prot, void ** pptr, struct vm_operations_struct * vm_ops, void * vm_private_data)

Map an I/O memory range into the address space of the user.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler
in	*src_addr*	physical I/O address to be mapped
in	*len*	Length of the memory range
in	*prot*	Protection flags for the user's memory range, typically either PROT_READ or PROT_READ|PROT_WRITE
in,out	*pptr*	Address of a pointer containing the desired user address or NULL on entry and the finally assigned address on return
in	*vm_ops*	vm_operations to be executed on the vma_area of the user memory range or NULL
in	*vm_private_data*	Private data to be stored in the vma_area, primarily useful for vm_operation handlers

Returns

0 on success, otherwise (most common values):

- -EINVAL is returned if an invalid start address, size, or destination address was passed.
- -ENOMEM is returned if there is insufficient free memory or the limit of memory mapping for the user process was reached.
- -EAGAIN is returned if too much memory has been already locked by the user process.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Note

RTDM supports two models for unmapping the user memory range again. One is explicit unmapping via rtdm_munmap(), either performed when the user requests it via an IOCTL etc. or when the related device is closed. The other is automatic unmapping, triggered by the user invoking standard munmap() or by the termination of the related process. To track release of the mapping and therefore relinquishment of the referenced physical memory, the caller of rtdm_iomap_to_user() can pass a vm_operations_struct on invocation, defining a close handler for the vm_area. See Linux documentaion (e.g. Linux Device Drivers book) on virtual memory management for details.

Tags

secondary-only

5.36.2.6 void* rtdm_malloc (size_t size)

Allocate memory block.

Parameters

in	*size*	Requested size of the memory block

Returns

The pointer to the allocated block is returned on success, NULL otherwise.

Tags

unrestricted

Referenced by a4l_alloc_subd().

5.36.2.7 int rtdm_mmap_to_user (struct rtdm_fd * fd, void * src_addr, size_t len, int prot, void ** pptr, struct vm_operations_struct * vm_ops, void * vm_private_data)

Map a kernel memory range into the address space of the user.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler
in	*src_addr*	Kernel virtual address to be mapped
in	*len*	Length of the memory range
in	*prot*	Protection flags for the user's memory range, typically either PROT_-READ or PROT_READ|PROT_WRITE
in,out	*pptr*	Address of a pointer containing the desired user address or NULL on entry and the finally assigned address on return
in	*vm_ops*	vm_operations to be executed on the vma_area of the user memory range or NULL
in	*vm_private_-data*	Private data to be stored in the vma_area, primarily useful for vm_-operation handlers

Returns

0 on success, otherwise (most common values):

- -EINVAL is returned if an invalid start address, size, or destination address was passed.

- -ENOMEM is returned if there is insufficient free memory or the limit of memory mapping for the user process was reached.
- -EAGAIN is returned if too much memory has been already locked by the user process.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Note

This service only works on memory regions allocated via kmalloc() or vmalloc(). To map physical I/O memory to user-space use rtdm_iomap_to_user() instead.
RTDM supports two models for unmapping the user memory range again. One is explicit unmapping via rtdm_munmap(), either performed when the user requests it via an IOCTL etc. or when the related device is closed. The other is automatic unmapping, triggered by the user invoking standard munmap() or by the termination of the related process. To track release of the mapping and therefore relinquishment of the referenced physical memory, the caller of rtdm_mmap_to_user() can pass a vm_operations_struct on invocation, defining a close handler for the vm_area. See Linux documentaion (e.g. Linux Device Drivers book) on virtual memory management for details.

Tags

secondary-only

5.36.2.8 int rtdm_munmap (struct rtdm_fd * fd, void * ptr, size_t len)

Unmap a user memory range.

Parameters

in	*fd*	RTDM file descriptor as passed to rtdm_mmap_to_user() when requesting to map the memory range
in	*ptr*	User address or the memory range
in	*len*	Length of the memory range

Returns

0 on success, otherwise:

- -EINVAL is returned if an invalid address or size was passed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Tags

secondary-only

5.36.2.9 void rtdm_printk (const char * format, ...)

Real-time safe message printing on kernel console.

Parameters

in	*format*	Format string (conforming standard `printf()`)

	...	Arguments referred by *format*

Returns

On success, this service returns the number of characters printed. Otherwise, a negative error code is returned.

Tags

unrestricted

5.36.2.10 void rtdm_printk_ratelimited (const char * format, ...)

Real-time safe rate-limited message printing on kernel console.

Parameters

in	*format*	Format string (conforming standard `printf()`)
	...	Arguments referred by *format*

Returns

On success, this service returns the number of characters printed. Otherwise, a negative error code is returned.

Tags

unrestricted

5.36.2.11 int rtdm_ratelimit (struct rtdm_ratelimit_state * rs, const char * func)

Enforces a rate limit.

This function enforces a rate limit: not more than *rs->burst* callbacks in every *rs->interval*.

Parameters

in,out	*rs*	rtdm_ratelimit_state data
in	*func*	name of calling function

Returns

0 means callback will be suppressed and 1 means go ahead and do it

Tags

unrestricted

References rtdm_clock_read(), and rtdm_lock_put_irqrestore().

5.36.2.12 int rtdm_read_user_ok (struct rtdm_fd * fd, const void __user * ptr, size_t size)

Check if read access to user-space memory block is safe.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler
in	*ptr*	Address of the user-provided memory block
in	*size*	Size of the memory block

Returns

Non-zero is return when it is safe to read from the specified memory block, 0 otherwise.

Tags

task-unrestricted

5.36.2.13 int rtdm_rt_capable (struct rtdm_fd * fd)

Test if the caller is capable of running in real-time context.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler

Returns

Non-zero is returned if the caller is able to execute in real-time context (independent of its current execution mode), 0 otherwise.

Note

This function can be used by drivers that provide different implementations for the same service depending on the execution mode of the caller. If a caller requests such a service in non-real-time context but is capable of running in real-time as well, it might be appropriate for the driver to reject the request via -ENOSYS so that RTDM can switch the caller and restart the request in real-time context.

Tags

task-unrestricted

5.36.2.14 int rtdm_rw_user_ok (struct rtdm_fd * fd, const void __user * ptr, size_t size)

Check if read/write access to user-space memory block is safe.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler
in	*ptr*	Address of the user-provided memory block
in	*size*	Size of the memory block

Returns

Non-zero is return when it is safe to read from or write to the specified memory block, 0 otherwise.

Tags

task-unrestricted

5.36.2.15 int rtdm_safe_copy_from_user (struct rtdm_fd * fd, void * dst, const void __user * src, size_t size)

Check if read access to user-space memory block and copy it to specified buffer.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler
in	*dst*	Destination buffer address
in	*src*	Address of the user-space memory block
in	*size*	Size of the memory block

Returns

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

This service is a combination of rtdm_read_user_ok and rtdm_copy_from_user.

Tags

task-unrestricted

5.36.2.16 int rtdm_safe_copy_to_user (struct rtdm_fd * fd, void __user * dst, const void * src, size_t size)

Check if read/write access to user-space memory block is safe and copy specified buffer to it.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler
in	*dst*	Address of the user-space memory block
in	*src*	Source buffer address
in	*size*	Size of the memory block

Returns

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

This service is a combination of rtdm_rw_user_ok and rtdm_copy_to_user.

Tags

task-unrestricted

5.36.2.17 int rtdm_strncpy_from_user (struct rtdm_fd * fd, char * dst, const char __user * src, size_t count)

Copy user-space string to specified buffer.

Parameters

in	*fd*	RTDM file descriptor as passed to the invoked device operation handler
in	*dst*	Destination buffer address
in	*src*	Address of the user-space string
in	*count*	Maximum number of bytes to copy, including the trailing '0'

Returns

Length of the string on success (not including the trailing '0'), otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

This services already includes a check of the source address, calling rtdm_read_user_ok() for *src* explicitly is not required.

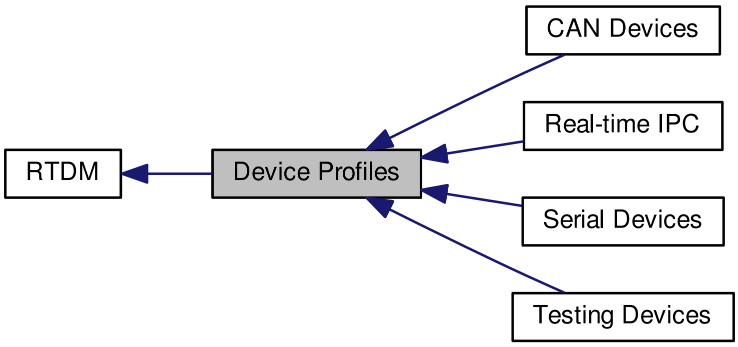
Tags

task-unrestricted

5.37 Device Profiles

Pre-defined classes of real-time devices.

Collaboration diagram for Device Profiles:



Modules

- CAN Devices

  This is the common interface a RTDM-compliant CAN device has to provide.
- Serial Devices

  This is the common interface a RTDM-compliant serial device has to provide.
- Testing Devices

  This group of devices is intended to provide in-kernel testing results.
- Real-time IPC

  ***Profile Revision:** 1*

Data Structures

- struct rtdm_device_info

  Device information.

Typedefs

- typedef struct rtdm_device_info rtdm_device_info_t

  Device information.

RTDM_CLASS_xxx

Device classes

- #define **RTDM_CLASS_PARPORT** 1
- #define **RTDM_CLASS_SERIAL** 2

- #define **RTDM_CLASS_CAN** 3
- #define **RTDM_CLASS_NETWORK** 4
- #define **RTDM_CLASS_RTMAC** 5
- #define **RTDM_CLASS_TESTING** 6
- #define **RTDM_CLASS_RTIPC** 7
- #define **RTDM_CLASS_COBALT** 8
- #define **RTDM_CLASS_EXPERIMENTAL** 224
- #define **RTDM_CLASS_MAX** 255

Device Naming

Maximum length of device names (excluding the final null character)

- #define **RTDM_MAX_DEVNAME_LEN** 31

RTDM_PURGE_xxx_BUFFER

Flags selecting buffers to be purged

- #define **RTDM_PURGE_RX_BUFFER** 0x0001
- #define **RTDM_PURGE_TX_BUFFER** 0x0002

Common IOCTLs

The following IOCTLs are common to all device rtdm_profiles.

- #define RTIOC_DEVICE_INFO _IOR(RTIOC_TYPE_COMMON, 0x00, struct rtdm_device_info)

  Retrieve information about a device or socket.
- #define RTIOC_PURGE _IOW(RTIOC_TYPE_COMMON, 0x10, int)

  Purge internal device or socket buffers.

5.37.1 Detailed Description

Pre-defined classes of real-time devices. Device profiles define which operation handlers a driver of a certain class has to implement, which name or protocol it has to register, which IOCTLs it has to provide, and further details. Sub-classes can be defined in order to extend a device profile with more hardware-specific functions.

5.37.2 Macro Definition Documentation

5.37.2.1 #define RTIOC_DEVICE_INFO _IOR(RTIOC_TYPE_COMMON, 0x00, struct rtdm_device_info)

Retrieve information about a device or socket.

Parameters

out	*arg*	Pointer to information buffer (struct rtdm_device_info)

5.37.2.2 #define RTIOC_PURGE _IOW(RTIOC_TYPE_COMMON, 0x10, int)

Purge internal device or socket buffers.

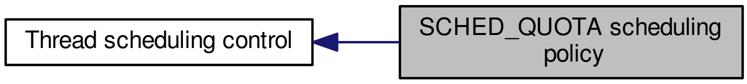
Parameters

in	*arg*	Purge mask, see RTDM_PURGE_xxx_BUFFER

5.38 SCHED_QUOTA scheduling policy

The SCHED_QUOTA policy enforces a limitation on the CPU consumption of threads over a globally defined period, known as the quota interval.

Collaboration diagram for SCHED_QUOTA scheduling policy:



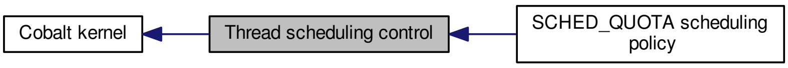
5.38.1 Detailed Description

The SCHED_QUOTA policy enforces a limitation on the CPU consumption of threads over a globally defined period, known as the quota interval. This is done by pooling threads with common requirements in groups, and giving each group a share of the global period (CONFIG_XENO_OPT_SCHED_QUOT-A_PERIOD).

When threads have entirely consumed the quota allotted to the group they belong to, the latter is suspended as a whole, until the next quota interval starts. At this point, a new runtime budget is given to each group, in accordance with its share.

5.39 Thread scheduling control

Collaboration diagram for Thread scheduling control:



Modules

- SCHED_QUOTA scheduling policy

  The SCHED_QUOTA policy enforces a limitation on the CPU consumption of threads over a globally defined period, known as the quota interval.

Data Structures

- struct xnsched

  Scheduling information structure.

Functions

- static int xnsched_run (void)

  The rescheduling procedure.
- static void xnsched_rotate (struct xnsched *sched, struct xnsched_class *sched_class, const union xnsched_policy_param *sched_param)

  Rotate a scheduler runqueue.

5.39.1 Detailed Description

5.39.2 Function Documentation

5.39.2.1 void xnsched_rotate (struct **xnsched** * sched, struct xnsched_class * sched_class, const union xnsched_policy_param * sched_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.

Tags

unrestricted, atomic-entry

5.39.2.2 int xnsched_run (void) `[inline]`, `[static]`

The rescheduling procedure.

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 performs context switches as needed. xnsched_run() schedules out the current thread if:

- the current thread is about to block.
- 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 (i.e. round-robin).

The Cobalt core 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. When all changes have been applied, xnsched_run() should be called for considering those changes, and possibly switching context.

As a notable exception to the previous principle however, every action which ends up suspending the current thread begets an implicit call to the rescheduling procedure on behalf of the blocking service.

Typically, self-suspension or sleeping on a synchronization object automatically leads to a call to the rescheduling procedure, therefore the caller does not need to explicitly issue xnsched_run() after such operations.

The rescheduling procedure always leads to a null-effect if it is called on behalf of an interrupt service routine. 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.

Returns

Non-zero is returned if a context switch actually happened, otherwise zero if the current thread was left running.

Tags

unrestricted

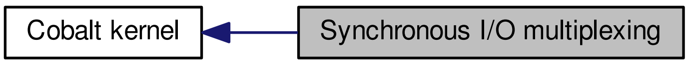
References xnsched::lflags, and xnsched::status.

Referenced by rtdm_event_signal(), rtdm_mutex_unlock(), rtdm_sem_up(), xnregistry_enter(), xnselect-_bind(), xnselect_destroy(), xnthread_cancel(), xnthread_migrate(), xnthread_start(), and xnthread_-suspend().

5.40 Synchronous I/O multiplexing

This module implements the services needed for implementing the POSIX select() service, or any other event multiplexing services.

Collaboration diagram for Synchronous I/O multiplexing:



Functions

- void xnselect_init (struct xnselect *select_block)

  Initialize a struct xnselect structure.
- static int xnselect_signal (struct xnselect *select_block, unsigned int state)

  Signal a file descriptor state change.
- 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.
- 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.

5.40.1 Detailed Description

This module implements the services needed for implementing the POSIX select() service, or any other event 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.

5.40.2 Function Documentation

5.40.2.1 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.

Tags

primary-only, might-switch

References XNBREAK, xnsynch_sleep_on(), and XNTIMEO.

5.40.2.2 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 *XNSELECT_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.

Tags

task-unrestricted, might-switch, atomic-entry

References xnsched_run().

Referenced by rtdm_event_select_bind(), and rtdm_sem_select_bind().

5.40.2.3 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

Tags

task-unrestricted, might-switch

References xnsched_run().

Referenced by rtdm_event_destroy(), and rtdm_sem_destroy().

5.40.2.4 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

Tags

task-unrestricted

Referenced by rtdm_event_init(), and rtdm_sem_init().

5.40.2.5 static int xnselect_signal (struct **xnselect** * select_block, unsigned int state) `[inline]`, `[static]`

Signal a file descriptor state change.

Parameters

select_block	pointer to an *xnselect* structure representing the file descriptor whose state changed;
state	new value of the state.

Return values

1	if rescheduling is needed;
0	otherwise.

Referenced by rtdm_event_clear(), rtdm_event_signal(), rtdm_event_timedwait(), rtdm_sem_timeddown(), and rtdm_sem_up().

5.40.2.6 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

Tags

task-unrestricted

5.40.2.7 int xnselector_init (struct xnselector * selector)

Initialize a selector structure.

Parameters

selector	The selector structure to be initialized.

Return values

0	

Tags

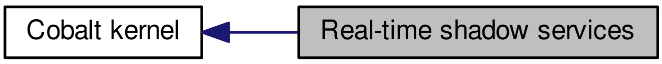
task-unrestricted

References xnsynch_init().

5.41 Real-time shadow services

Real-time shadow services.

Collaboration diagram for Real-time shadow services:



Functions

- int xnshadow_map_user (struct xnthread *thread, unsigned long __user *u_window_offset)

  Create a shadow thread context over a user task.
- int xnshadow_map_kernel (struct xnthread *thread, struct completion *done)

  Create a shadow thread context over a kernel task.
- 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_register_personality (struct xnpersonality *personality)

  Register a new interface personality.
- struct xnpersonality * xnshadow_push_personality (int muxid)

  Stack a new personality over the current thread.
- void xnshadow_pop_personality (struct xnpersonality *prev)

  Pop the topmost personality from the current thread.
- void * xnshadow_get_context (unsigned int muxid)

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

5.41.1 Detailed Description

Real-time shadow services.

5.41.2 Function Documentation

5.41.2.1 void* xnshadow_get_context (unsigned int 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 personality whose muxid is *muxid*. It must be called with nklock locked, irqs off.

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

Parameters

muxid	the personality muxid.

Returns

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

Tags

task-unrestricted, atomic-entry

5.41.2.2 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. The shadow will resume in the Xenomai domain as returning from schedule().

Tags

secondary-only, might-switch

References XNDEBUG, XNRELAX, xnshadow_relax(), and xnthread_test_cancel().

Referenced by xnshadow_map_kernel().

5.41.2.3 int xnshadow_map_kernel (struct xnthread * thread, struct completion * done)

Create a shadow thread context over a kernel task.

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

This call immediately moves the calling kernel thread to the Xenomai domain.

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 xnthread_init().
done	A completion object to be signaled when *thread* is fully mapped over the current Linux context, waiting for xnthread_start().

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

Tags

secondary-only, might-switch

References XNDORMANT, XNMAPPED, XNRELAX, xnshadow_harden(), xnthread_resume(), xnthread_suspend(), xnthread_test_cancel(), and XNUSER.

5.41.2.4 int xnshadow_map_user (struct xnthread * thread, unsigned long __user * u_window_offset)

Create a shadow thread context over a user task.

This call maps a nucleus thread to the "current" Linux task running in userland. 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 xnthread_init().
u_window_offset	will receive the offset of the per-thread "u_window" structure in the process shared heap associated to *thread*. This structure reflects thread state information visible from userland through a shared memory window.

Returns

0 is returned on success. Otherwise:

- -EINVAL is returned if the thread control block does not bear the XNUSER bit.
- -EBUSY is returned if either the current Linux task or the associated shadow thread is already involved in a shadow mapping.

Tags

secondary-only

References xnheap_alloc(), XNMAPPED, XNRELAX, xnthread_start(), xnthread_suspend(), and XNUSER.

5.41.2.5 void xnshadow_pop_personality (struct xnpersonality * prev)

Pop the topmost personality from the current thread.

This service pops the topmost personality off the current thread.

Parameters

prev	the previous personality which was returned by the latest call to xnshadow_push_personality() for the current thread.

Tags

secondary-only

5.41.2.6 struct xnpersonality * xnshadow_push_personality (int muxid)

Stack a new personality over the current thread.

This service registers the current thread as a member of the additional personality identified by *muxid*. If the current thread is already assigned this personality, the call returns successfully with no effect.

Parameters

muxid	the identifier of the additional personality.

Returns

A handle to the previous personality. The caller should save this handle for unstacking *muxid* when applicable via a call to xnshadow_pop_personality().

Tags

secondary-only

5.41.2.7 int xnshadow_register_personality (struct xnpersonality * personality)

Register a new interface personality.

- personality->ops.attach_process() is called when a user-space process binds to the personality, on behalf of one of its threads. The attach_process() handler may return:

  . an opaque pointer, representing the context of the calling process for this personality;

  . a NULL pointer, meaning that no per-process structure should be attached to this process for this personality;

  . ERR_PTR(negative value) indicating an error, the binding process will then abort.

- personality->ops.detach() is called on behalf of an exiting user-space process which has previously attached to the personality. This handler is passed a pointer to the per-process data received earlier from the ops->attach_process() handler.

Tags

secondary-only

5.41.2.8 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 xnthread_suspend() 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.

Tags

primary-only, might-switch

Note

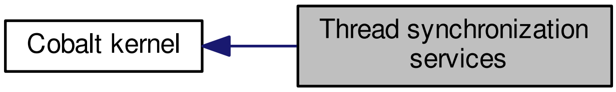
"current" is valid here since the shadow runs with the properties of the Linux task.

References splmax, splnone, XNMOVED, XNRELAX, xnthread_suspend(), XNTRAPSW, and XNUSER.

Referenced by xnshadow_harden().

5.42 Thread synchronization services

Collaboration diagram for Thread synchronization services:



Functions

- void xnsynch_init (struct xnsynch *synch, int flags, atomic_long_t *fastlock)
  Initialize a synchronization object.
- int 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)
  Unblock the heading thread from wait.
- void xnsynch_wakeup_this_sleeper (struct xnsynch *synch, struct xnthread *sleeper)
  Unblock a particular thread from wait.
- int xnsynch_acquire (struct xnsynch *synch, xnticks_t timeout, xntmode_t timeout_mode)
  Acquire the ownership of a synchronization object.
- struct xnthread * xnsynch_release (struct xnsynch *synch, struct xnthread *thread)
  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, int reason)
  Unblock all waiters pending on a resource.

5.42.1 Detailed Description

5.42.2 Function Documentation

5.42.2.1 int 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 another 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 as a count of nanoseconds. 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.

Tags

primary-only, might-switch

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

Referenced by rtdm_mutex_timedlock().

5.42.2.2 int xnsynch_flush (struct xnsynch * synch, int 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 xnthread_resume()).
- XNBREAK should be set to indicate that the wait has been forcibly interrupted (see xnthread_unblock()).

Returns

XNSYNCH_RESCHED is returned if at least one thread is unblocked, which means the caller should invoke xnsched_run() 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.

Tags

unrestricted

References XNPEND, and xnthread_resume().

Referenced by rtdm_event_signal().

5.42.2.3 void xnsynch_init (struct xnsynch * synch, int flags, **atomic_long_t** * fastlock)

Initialize a synchronization object.

Initializes a synchronization object. Xenomai threads can wait on and signal such objects for serializing access to resources. 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 the resource ownership, allowing a single owner at most at any point in time. Note that setting this flag implies the use of xnsynch_acquire() and xnsynch_release() instead of xnsynch_sleep_on() and xnsynch_wakeup_-*().
- XNSYNCH_PIP enables priority inheritance when a priority inversion is detected among threads using this object. XNSYNCH_PIP enables XNSYNCH_OWNER and XNSYNCH_PRIO implicitly.
- 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 xnthread_set_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 a synchronization object with ownership tracking. Therefore, a valid fast-lock address is required if XNSYNCH_-OWNER is set in *flags*.

Tags

task-unrestricted

Referenced by rtdm_event_init(), rtdm_mutex_init(), rtdm_sem_init(), and xnselector_init().

5.42.2.4 struct xnthread * xnsynch_peek_pendq (struct xnsynch * synch)

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.

Tags

unrestricted

5.42.2.5 struct xnthread * xnsynch_release (struct xnsynch * synch, struct xnthread * thread)

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.
thread	The descriptor address of the current owner.

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.

Tags

primary-only, might-switch

References XNWEAK.

Referenced by rtdm_mutex_unlock().

5.42.2.6 int 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 as a count of nanoseconds. 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.

Tags

primary-only, might-switch

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

Referenced by rtdm_event_timedwait(), rtdm_sem_timeddown(), xnregistry_bind(), xnselect(), and xnthread_join().

5.42.2.7 struct xnthread * xnsynch_wakeup_one_sleeper (struct xnsynch * synch)

Unblock the heading thread from wait.

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.

Tags

unrestricted

References XNPEND, and xnthread_resume().

Referenced by rtdm_sem_up().

5.42.2.8 void xnsynch_wakeup_this_sleeper (struct xnsynch * synch, struct xnthread * sleeper)

Unblock a particular thread from wait.

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.
sleeper	The thread to unblock which MUST be currently linked to the synchronization object's pending queue (i.e. synch->pendq).

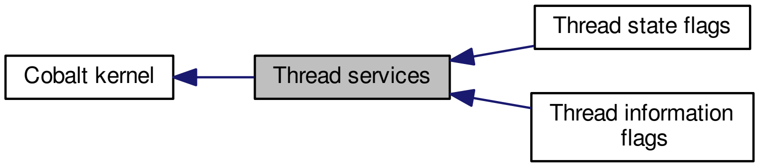
Tags

unrestricted

References XNPEND, and xnthread_resume().

5.43 Thread services

Collaboration diagram for Thread services:



Modules

- Thread state flags

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

  Bits reporting events notified to threads.

Functions

- static void xnthread_test_cancel (void)

  Introduce a thread cancellation point.
- int xnthread_init (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 xnthread_start (struct xnthread *thread, const struct xnthread_start_attr *attr)

  Start a newly created thread.
- int xnthread_set_mode (struct xnthread *thread, int clrmask, int setmask)

  Change a thread's control mode.
- void xnthread_suspend (struct xnthread *thread, int mask, xnticks_t timeout, xntmode_t timeout_-mode, struct xnsynch *wchan)

  Suspend a thread.
- void xnthread_resume (struct xnthread *thread, int mask)

  Resume a thread.
- int xnthread_unblock (struct xnthread *thread)

  Unblock a thread.
- int xnthread_set_periodic (struct xnthread *thread, xnticks_t idate, xntmode_t timeout_mode, xnticks_t period)

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

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

  Set thread time-slicing information.
- void xnthread_cancel (struct xnthread *thread)

  Cancel a thread.
- int xnthread_join (struct xnthread *thread, bool uninterruptible)

Join with a terminated thread.

- int xnthread_migrate (int cpu)

  Migrate the current thread.

- int xnthread_set_schedparam (struct xnthread *thread, struct xnsched_class *sched_class, const union xnsched_policy_param *sched_param)

  Change the base scheduling parameters of a thread.

5.43.1 Detailed Description

5.43.2 Function Documentation

5.43.2.1 void xnthread_cancel (struct xnthread * thread)

Cancel a thread.

Request cancellation of a thread. This service forces *thread* to exit from any blocking call. *thread* will terminate as soon as it reaches a cancellation point. Cancellation points are defined for the following situations:

- *thread* self-cancels by a call to xnthread_cancel().
- *thread* invokes a Linux syscall (user-space shadow only).
- *thread* receives a Linux signal (user-space shadow only).
- *thread* explicitly calls xnthread_test_cancel().

Parameters

thread	The descriptor address of the thread to terminate.

Tags

task-unrestricted, might-switch

References XNCANCELD, XNDORMANT, XNKICKED, xnsched_run(), xnthread_resume(), and xnthread_test_cancel().

Referenced by rtdm_task_init().

5.43.2.2 int xnthread_init (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. The thread is left dormant until it is actually started by xnthread_start().

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. NULL is fine though and means "anonymous".
- 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 shall be explicitly resumed using the xnthread_resume() service for its execution to actually begin, additionally to issuing xnthread_start() for it. This flag can also be specified when invoking xnthread_-start() as a starting mode.
- XNUSER shall be set if *thread* will be mapped over an existing user-space task. Otherwise, a new kernel host task is created, then paired with the new Xenomai thread.
- XNFPU (enable FPU) tells the nucleus that the new thread may use the floating-point unit. XNFPU is implicitly assumed for user-space threads even if not set in *flags*.
- affinity: The processor affinity of this thread. Passing CPU_MASK_ALL means "any cpu" from the allowed core affinity mask (nkaffinity). Passing an empty set is invalid.

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, the following error code indicates the cause of the failure:

- -EINVAL is returned if *attr->flags* has invalid bits set, or *attr->affinity* is invalid (e.g. empty).

Tags

secondary-only

References XNFPU, XNSUSP, and XNUSER.

Referenced by rtdm_task_init().

5.43.2.3 int xnthread_join (struct xnthread * thread, bool uninterruptible)

Join with a terminated thread.

This service waits for *thread* to terminate after a call to xnthread_cancel(). If that thread has already terminated or is dormant at the time of the call, then xnthread_join() returns immediately.

xnthread_join() adapts to the calling context (primary or secondary).

Parameters

thread	The descriptor address of the thread to join with.
uninterruptible	Boolean telling whether the service should wait for completion uninterruptible if called from secondary mode.

Returns

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

- -EDEADLK is returned if the current thread attempts to join itself.
- -EINTR is returned if the current thread was unblocked while waiting for *thread* to terminate.
- -EBUSY indicates that another thread is already waiting for *thread* to terminate.

Tags

task-unrestricted, might-switch

References XNBREAK, XNDORMANT, XNJOINED, XNRMID, and xnsynch_sleep_on().

Referenced by rtdm_task_join().

5.43.2.4 int xnthread_migrate (int cpu)

Migrate the current thread.

This call makes the current thread migrate to another (real-time) CPU if its affinity allows it. This call is available from primary mode only.

Parameters

cpu	The destination CPU.

Return values

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

Tags

primary-only, might-switch

References __xntimer_migrate(), XNMOVED, and xnsched_run().

5.43.2.5 void xnthread_resume (struct xnthread * thread, int mask)

Resume a thread.

Resumes the execution of a thread previously suspended by one or more calls to xnthread_suspend(). 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 xnthread_resume(), the caller of xnthread_suspend() 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 xnthread_unblock().

Tags

unrestricted, might-switch

References XNDELAY, XNHELD, XNPEND, XNREADY, and xntimer_stop().

Referenced by xnshadow_map_kernel(), xnsynch_flush(), xnsynch_wakeup_one_sleeper(), xnsynch_-wakeup_this_sleeper(), xnthread_cancel(), xnthread_start(), and xnthread_unblock().

5.43.2.6 int xnthread_set_mode (struct xnthread * thread, int clrmask, int 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 may be set in this bitmask:

- XNLOCK makes *thread* non-preemptible by other threads when running on a CPU. A non-preemptible thread may still block, in which case, the lock is reasserted when the thread is scheduled back in. If *thread* is current, the scheduler is immediately locked, otherwise such lock will take effect next time *thread* resumes on a CPU.
- XNTRAPSW causes the thread to receive a SIGDEBUG signal when it switches to secondary mode. This is a debugging aid for detecting spurious relaxes.

- XNTRAPLB disallows breaking the scheduler lock. In the default case, a thread which holds the scheduler lock is allowed to drop it temporarily for sleeping. If this mode bit is set, such thread would return immediately with XNBREAK set from xnthread_suspend().

Tags

task-unrestricted, might-switch

Note

Setting *clrmask* and *setmask* to zero leads to a nop, only returning the previous mode if *mode_r* is a valid address.

References XNLOCK.

5.43.2.7 int xnthread_set_periodic (struct xnthread * thread, xnticks_t idate, xntmode_t timeout_mode, 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 xnthread_wait_period() will delay the thread until the next periodic release point in the processor timeline is reached.

Parameters

thread	The core thread to make periodic.
idate	The initial (absolute) date of the first release point, expressed in nanoseconds. The affected thread will be delayed by the first call to xnthread_wait_period() until this point is reached. If *idate* is equal to XN_INFINITE, the current system date is used, and no initial delay takes place. In the latter case, *timeout_mode* is not considered and can have any valid value.
timeout_mode	The mode of the *idate* parameter. It can either be set to XN_ABSOLUTE or XN_REALTIME with *idate* different from XN_INFINITE (see also xntimer_start()).
period	The period of the thread, expressed in nanoseconds. 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.
- -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. -EINVAL is also returned if *timeout_mode* is not compatible with *idate*, such as XN_RELATIVE with *idate* different from XN_INFINITE.

Tags

task-unrestricted

References xntimer_start(), and xntimer_stop().

Referenced by rtdm_task_init().

5.43.2.8 int xnthread_set_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. See note.
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.

Tags

task-unregistred

Note

The changes only apply to the Xenomai scheduling parameters for *thread*. There is no propagation/translation of such changes to the Linux scheduler for the task mated to the Xenomai target thread.

5.43.2.9 int xnthread_set_slice (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 xnthread_init().

Parameters

thread	The descriptor address of the affected thread.
quantum	The time quantum assigned to the thread expressed in nanoseconds. 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 *quantum* is not XN_INFINITE and:

- the base scheduling class of the target thread does not support time-slicing,
- *quantum* is smaller than the master clock gravity, which denotes a spurious value.

Tags

task-unrestricted

References xnsched::curr, xnsched::rrbtimer, XNRRB, xntimer_start(), and xntimer_stop().

5.43.2.10 int xnthread_start (struct xnthread * thread, const struct xnthread_start_attr * attr)

Start 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 for the new thread.

Parameters

thread	The descriptor address of the started thread which must have been previously initialized by a call to xnthread_init().
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 xnsched_unlock() 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.
  - XNSUSP makes the thread start in a suspended state. In such a case, the thread will have to be explicitly resumed using the xnthread_resume() service for its execution to actually begin.
- 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.

Return values

0	if *thread* could be started ;
-EBUSY	if *thread* was not dormant or stopped ;

Tags

task-unrestricted, might-switch

References XNDORMANT, xnsched_run(), XNSUSP, and xnthread_resume().

Referenced by rtdm_task_init(), and xnshadow_map_user().

5.43.2.11 void xnthread_suspend (struct xnthread * thread, int 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 xnthread_resume().

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 xnthread_resume() 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 duration 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 nanoseconds. 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 xnthread_suspend() has completed, then the target thread will not be suspended, and this routine leads to a null effect.

Parameters

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

Tags

unrestricted, might-switch

References xnsched::curr, xnsched::lflags, splmax, XNBREAK, XNDELAY, XNHELD, XNKICKED, XNLOCK, XNREADY, XNRELAX, XNRMID, XNROBBED, xnsched_run(), XNSUSP, XNTIMEO, xntimer_start(), XNTRAPLB, XNUSER, and XNWAKEN.

Referenced by xnshadow_map_kernel(), xnshadow_map_user(), xnshadow_relax(), xnsynch_acquire(), xnsynch_sleep_on(), and xnthread_wait_period().

5.43.2.12 void xnthread_test_cancel (void) [inline], [static]

Introduce a thread cancellation point.

Terminates the current thread if a cancellation request is pending for it, i.e. if xnthread_cancel() was called.

Calling context: This service may be called from all runtime modes of kernel or user-space threads.

References XNCANCELD.

Referenced by xnshadow_harden(), xnshadow_map_kernel(), and xnthread_cancel().

5.43.2.13 int xnthread_unblock (struct xnthread * 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 xnthread_suspend() 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.

Tags

unrestricted, might-switch

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

5.43.2.14 int xnthread_wait_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 xnthread_wait_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 xnthread_set_periodic() has not previously been called for the calling thread.

- -EINTR is returned if xnthread_unblock() 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.

Tags

primary-only, might-switch

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

5.44 Timer services

The Xenomai timer facility depends on a clock source (xnclock) for scheduling the next activation times.

Collaboration diagram for Timer services:

Functions

- void xntimer_destroy (struct xntimer *timer)

  Release a timer object.
- static xnticks_t xntimer_interval (struct xntimer *timer)

  Return the timer interval value.
- int xntimer_start (struct xntimer *timer, xnticks_t value, xnticks_t interval, xntmode_t mode)

  Arm a timer.
- xnticks_t xntimer_get_date (struct xntimer *timer)

  Return the absolute expiration date.
- xnticks_t xntimer_get_timeout (struct xntimer *timer)

  Return the relative expiration date.
- static void xntimer_stop (struct xntimer *timer)

  Disarm a timer.
- void xntimer_init (struct xntimer *timer, struct xnclock *clock, void(*handler)(struct xntimer *timer), struct xnthread *thread)

  Initialize a timer object.
- void __xntimer_migrate (struct xntimer *timer, struct xnsched *sched)

  Migrate a timer.
- unsigned long long xntimer_get_overruns (struct xntimer *timer, xnticks_t now)

  Get the count of overruns for the last tick.
- static int program_htick_shot (unsigned long delay, struct clock_event_device *cdev)

  Program next host tick as a Xenomai timer event.
- static void switch_htick_mode (enum clock_event_mode mode, struct clock_event_device *cdev)

  Tick mode switch emulation callback.
- int xntimer_grab_hardware (int cpu)

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

  Release the hardware timer.

5.44.1 Detailed Description

The Xenomai timer facility depends on a clock source (xnclock) for scheduling the next activation times. The core provides and depends on a monotonic clock source (nkclock) with nanosecond resolution, driving the platform timer hardware exposed by the interrupt pipeline.

5.44.2 Function Documentation

5.44.2.1 void __xntimer_migrate (struct xntimer * timer, struct **xnsched** * sched)

Migrate a timer.

This call migrates a timer to another cpu. In order to avoid pathological cases, it must be called from the CPU to which *timer* is currently attached.

Parameters

timer	The address of the timer object to be migrated.
sched	The address of the destination per-CPU scheduler slot.

Tags

unrestricted, atomic-entry

References xntimer_stop().

Referenced by xnthread_migrate().

5.44.2.2 static int program_htick_shot (unsigned long delay, struct clock_event_device * cdev) [static]

Program next host tick as a Xenomai timer event.

Program the next shot for the host tick on the current CPU. Emulation is done using a nucleus timer attached to the master timebase.

Parameters

delay	The time delta from the current date to the next tick, expressed as a count of nanoseconds.
cdev	An pointer to the clock device which notifies us.

Tags

unrestricted

References xnsched::htimer, and xntimer_start().

Referenced by xntimer_grab_hardware().

5.44.2.3 void switch_htick_mode (enum clock_event_mode mode, struct clock_event_device * cdev) [static]

Tick mode switch emulation callback.

Changes the host tick mode for the tick device of the current CPU.

Parameters

mode	The new mode to switch to. The possible values are:

- CLOCK_EVT_MODE_ONESHOT, for a switch to oneshot mode.
- CLOCK_EVT_MODE_PERIODIC, for a switch to periodic mode. The current implementation for the generic clockevent layer Linux exhibits should never downgrade from a oneshot to a periodic tick mode, so this mode should not be encountered. This said, the associated code is provided, basically for illustration purposes.

- CLOCK_EVT_MODE_SHUTDOWN, indicates the removal of the current tick device. Normally, the nucleus only interposes on tick devices which should never be shut down, so this mode should not be encountered.

Parameters

cdev	An opaque pointer to the clock device which notifies us.

Tags

unrestricted

Note

GENERIC_CLOCKEVENTS is required from the host kernel.

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

Referenced by xntimer_grab_hardware().

5.44.2.4 void xntimer_destroy (struct xntimer * 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.

Tags

unrestricted

References xntimer_stop().

Referenced by rtdm_timer_destroy().

5.44.2.5 xnticks_t xntimer_get_date (struct xntimer * timer)

Return the absolute expiration date.

Return the next expiration date of a timer as an absolute count of nanoseconds.

Parameters

timer	The address of a valid timer descriptor.

Returns

The expiration date in nanoseconds. The special value XN_INFINITE is returned if *timer* is currently disabled.

Tags

unrestricted, atomic-entry

5.44.2.6 unsigned long long xntimer_get_overruns (struct xntimer * 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 (as xnclock_read_raw(xntimer_clock(timer)))

Returns

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

Tags

unrestricted, atomic-entry

Referenced by xnthread_wait_period().

5.44.2.7 xnticks_t xntimer_get_timeout (struct xntimer * timer)

Return the relative expiration date.

This call returns the count of nanoseconds remaining until the timer expires.

Parameters

timer	The address of a valid timer descriptor.

Returns

The count of nanoseconds until expiry. The special value XN_INFINITE is returned if *timer* is currently disabled. It might happen that the timer expires when this service runs (even if the associated handler has not been fired yet); in such a case, 1 is returned.

Tags

unrestricted, atomic-entry

5.44.2.8 int xntimer_grab_hardware (int cpu)

Grab the hardware timer.

xntimer_grab_hardware() grabs and tunes the hardware timer in oneshot mode in order to clock the master time base. GENERIC_CLOCKEVENTS is required from the host kernel.

Host tick emulation is performed for sharing 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

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. xntimer_release_hardware() must be issued before xntimer_grab_hardware() 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.

Tags

secondary-only

References program_htick_shot(), and switch_htick_mode().

5.44.2.9 void xntimer_init (struct xntimer * timer, struct xnclock * clock, void(*)(struct xntimer *timer) handler, struct xnthread * thread)

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.
clock	The clock the timer relates to. Xenomai defines a monotonic system clock, with nanosecond resolution, named nkclock. In addition, external clocks driven by other tick sources may be created dynamically if CONFIG_XENO_OPT_EXTCLOCK is defined.
handler	The routine to call upon expiration of the timer.
thread	The optional thread object the new timer is affine to. If non-NULL, the timer will fire on the same CPU *thread* currently runs on by default. A call to xntimer_set_sched() may change this setting.

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

Tags

unrestricted

5.44.2.10 xnticks_t xntimer_interval (struct xntimer * timer) [inline], [static]

Return the timer interval value.

Return the timer interval value in nanoseconds.

Parameters

timer	The address of a valid timer descriptor.

Returns

The duration of a period in nanoseconds. The special value XN_INFINITE is returned if *timer* is currently disabled or one shot.

Tags

unrestricted, atomic-entry

5.44.2.11 void xntimer_release_hardware (int cpu)

Release the hardware timer.

Releases the hardware timer, thus reverting the effect of a previous call to xntimer_grab_hardware(). In case the timer hardware is shared with Linux, a periodic setup suitable for the Linux kernel is reset.

Parameters

cpu	The CPU number the timer was grabbed from.

Tags

secondary-only

5.44.2.12 int xntimer_start (struct xntimer * timer, xnticks_t value, xnticks_t interval, xntmode_t mode)

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 one-shot, depending on the reload value passed to this routine. The given timer must have been previously initialized.

A timer is attached to the clock specified in xntimer_init().

Parameters

timer	The address of a valid timer descriptor.
value	The date of the initial timer shot, expressed in nanoseconds.
interval	The reload value of the timer. It is a periodic interval value to be used for reprogramming the next timer shot, expressed in nanoseconds. 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 xnclock_read_monotonic()), or XN_REALTIME if the absolute date is based on the adjustable real-time date for the relevant clock (obtained from xnclock_read_realtime()).

Returns

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

Tags

unrestricted, atomic-entry

Referenced by program_htick_shot(), rtdm_timer_start(), switch_htick_mode(), xnthread_set_periodic(), xnthread_set_slice(), and xnthread_suspend().

5.44.2.13 int xntimer_stop (struct xntimer * 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.

Tags

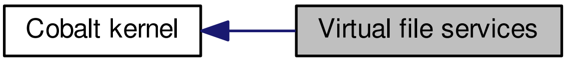
unrestricted, atomic-entry

Referenced by __xntimer_migrate(), rtdm_timer_stop(), switch_htick_mode(), xnthread_resume(), xnthread_set_periodic(), xnthread_set_slice(), and xntimer_destroy().

5.45 Virtual file services

Virtual files provide a mean to export Xenomai object states to user-space, based on common kernel interfaces.

Collaboration diagram for Virtual file services:



Data Structures

- struct xnvfile_lock_ops

  Vfile locking operations.
- struct xnvfile_regular_ops

  Regular vfile operation descriptor.
- struct xnvfile_regular_iterator

  Regular vfile iterator.
- struct xnvfile_snapshot_ops

  Snapshot vfile operation descriptor.
- struct xnvfile_rev_tag

  Snapshot revision tag.
- struct xnvfile_snapshot

  Snapshot vfile descriptor.
- struct xnvfile_snapshot_iterator

  Snapshot-driven vfile iterator.

Functions

- int xnvfile_init_snapshot (const char *name, struct xnvfile_snapshot *vfile, struct xnvfile_directory *parent)

  Initialize a snapshot-driven vfile.
- int xnvfile_init_regular (const char *name, struct xnvfile_regular *vfile, struct xnvfile_directory *parent)

  Initialize a regular vfile.
- int xnvfile_init_dir (const char *name, struct xnvfile_directory *vdir, struct xnvfile_directory *parent)

  Initialize a virtual directory entry.
- int xnvfile_init_link (const char *from, const char *to, struct xnvfile_link *vlink, struct xnvfile_-directory *parent)

  Initialize a virtual link entry.
- void xnvfile_destroy (struct xnvfile *vfile)

  Removes a virtual file entry.
- ssize_t xnvfile_get_blob (struct xnvfile_input *input, void *data, size_t size)

  Read in a data bulk written to the vfile.
- ssize_t xnvfile_get_string (struct xnvfile_input *input, char *s, size_t maxlen)

Read in a C-string written to the vfile.
- ssize_t xnvfile_get_integer (struct xnvfile_input *input, long *valp)

  Evaluate the string written to the vfile as a long integer.

Variables

- struct xnvfile_directory nkvfroot

  Xenomai vfile root directory.
- struct xnvfile_directory nkvfroot

  Xenomai vfile root directory.

5.45.1 Detailed Description

Virtual files provide a mean to export Xenomai object states to user-space, based on common kernel interfaces. This encapsulation is aimed at:

- supporting consistent collection of very large record-based output, without encurring latency peaks for undergoing real-time activities.
- in the future, hiding discrepancies between linux kernel releases, regarding the proper way to export kernel object states to userland, either via the /proc interface or by any other mean.

This virtual file implementation offers record-based read support based on seq_files, single-buffer write support, directory and link handling, all visible from the /proc namespace.

The vfile support exposes four filesystem object types:

- snapshot-driven file (struct xnvfile_snapshot). This is commonly used to export real-time object states via the /proc filesystem. To minimize the latency involved in protecting the vfile routines from changes applied by real-time code on such objects, a snapshot of the data to output is first taken under proper locking, before the collected data is formatted and sent out in a lockless manner.

Because a large number of records may have to be output, the data collection phase is not strictly atomic as a whole, but only protected at record level. The vfile implementation can be notified of updates to the underlying data set, and restart the collection from scratch until the snapshot is fully consistent.

- regular sequential file (struct xnvfile_regular). This is basically an encapsulated sequential file object as available from the host kernel (i.e. seq_file), with a few additional features to make it more handy in a Xenomai environment, like implicit locking support and shortened declaration for simplest, single-record output.
- virtual link (struct xnvfile_link). This is a symbolic link feature integrated with the vfile semantics. The link target is computed dynamically at creation time from a user-given helper routine.
- virtual directory (struct xnvfile_directory). A directory object, which can be used to create a hierarchy for ordering a set of vfile objects.

5.45.2 Function Documentation

5.45.2.1 void xnvfile_destroy (struct xnvfile * vfile)

Removes a virtual file entry.

Parameters

vfile	A pointer to the virtual file descriptor to remove.

Tags

secondary-only

5.45.2.2 ssize_t xnvfile_get_blob (struct xnvfile_input * input, void * data, size_t size)

Read in a data bulk written to the vfile.

When writing to a vfile, the associated store() handler from the snapshot-driven vfile or regular vfile is called, with a single argument describing the input data. xnvfile_get_blob() retrieves this data as an untyped binary blob, and copies it back to the caller's buffer.

Parameters

input	A pointer to the input descriptor passed to the store() handler.
data	The address of the destination buffer to copy the input data to.
size	The maximum number of bytes to copy to the destination buffer. If *size* is larger than the actual data size, the input is truncated to *size*.

Returns

The number of bytes read and copied to the destination buffer upon success. Otherwise, a negative error code is returned:

- -EFAULT indicates an invalid source buffer address.

Tags

secondary-only

Referenced by xnvfile_get_integer(), and xnvfile_get_string().

5.45.2.3 ssize_t xnvfile_get_integer (struct xnvfile_input * input, long * valp)

Evaluate the string written to the vfile as a long integer.

When writing to a vfile, the associated store() handler from the snapshot-driven vfile or regular vfile is called, with a single argument describing the input data. xnvfile_get_integer() retrieves and interprets this data as a long integer, and copies the resulting value back to *valp*.

The long integer can be expressed in decimal, octal or hexadecimal bases depending on the prefix found.

Parameters

input	A pointer to the input descriptor passed to the store() handler.
valp	The address of a long integer variable to receive the value.

Returns

The number of characters read while evaluating the input as a long integer upon success. Otherwise, a negative error code is returned:

- -EINVAL indicates a parse error on the input stream; the written text cannot be evaluated as a long integer.

- -EFAULT indicates an invalid source buffer address.

Tags

secondary-only

References xnvfile_get_blob().

5.45.2.4 ssize_t xnvfile_get_string (struct xnvfile_input * input, char * s, size_t maxlen)

Read in a C-string written to the vfile.

When writing to a vfile, the associated store() handler from the snapshot-driven vfile or regular vfile is called, with a single argument describing the input data. xnvfile_get_string() retrieves this data as a null-terminated character string, and copies it back to the caller's buffer.

Parameters

input	A pointer to the input descriptor passed to the store() handler.
s	The address of the destination string buffer to copy the input data to.
maxlen	The maximum number of bytes to copy to the destination buffer, including the ending null character. If *maxlen* is larger than the actual string length, the input is truncated to *maxlen*.

Returns

The number of characters read and copied to the destination buffer upon success. Otherwise, a negative error code is returned:

- -EFAULT indicates an invalid source buffer address.

Tags

secondary-only

References xnvfile_get_blob().

5.45.2.5 int xnvfile_init_dir (const char * name, struct xnvfile_directory * vdir, struct xnvfile_directory * parent)

Initialize a virtual directory entry.

Parameters

name	The name which should appear in the pseudo-filesystem, identifying the vdir entry.
vdir	A pointer to the virtual directory descriptor to initialize.
parent	A pointer to a virtual directory descriptor standing for the parent directory of the new vdir. If NULL, the /proc root directory will be used. /proc/xenomai is mapped on the globally available *nkvfroot* vdir.

Returns

0 is returned on success. Otherwise:

- -ENOMEM is returned if the virtual directory entry cannot be created in the /proc hierarchy.

Tags

secondary-only

5.45.2.6 int xnvfile_init_link (const char * from, const char * to, struct xnvfile_link * vlink, struct xnvfile_directory * parent)

Initialize a virtual link entry.

Parameters

from	The name which should appear in the pseudo-filesystem, identifying the vlink entry.
to	The target file name which should be referred to symbolically by *name*.
vlink	A pointer to the virtual link descriptor to initialize.
parent	A pointer to a virtual directory descriptor standing for the parent directory of the new vlink. If NULL, the /proc root directory will be used. /proc/xenomai is mapped on the globally available *nkvfroot* vdir.

Returns

0 is returned on success. Otherwise:

- -ENOMEM is returned if the virtual link entry cannot be created in the /proc hierarchy.

Tags

secondary-only

5.45.2.7 int xnvfile_init_regular (const char * name, struct xnvfile_regular * vfile, struct xnvfile_directory * parent)

Initialize a regular vfile.

Parameters

name	The name which should appear in the pseudo-filesystem, identifying the vfile entry.
vfile	A pointer to a vfile descriptor to initialize from. The following fields in this structure should be filled in prior to call this routine:

- .privsz is the size (in bytes) of the private data area to be reserved in the vfile iterator. A NULL value indicates that no private area should be reserved.
- entry.lockops is a pointer to a lockingdescriptor", defining the lock and unlock operations for the vfile. This pointer may be left to NULL, in which case no locking will be applied.
- .ops is a pointer to an operation descriptor.

Parameters

parent	A pointer to a virtual directory descriptor; the vfile entry will be created into this directory. If NULL, the /proc root directory will be used. /proc/xenomai is mapped on the globally available *nkvfroot* vdir.

Returns

0 is returned on success. Otherwise:

- -ENOMEM is returned if the virtual file entry cannot be created in the /proc hierarchy.

Tags

secondary-only

5.45.2.8 int xnvfile_init_snapshot (const char * name, struct **xnvfile_snapshot** * vfile, struct xnvfile_directory * parent)

Initialize a snapshot-driven vfile.

Parameters

name	The name which should appear in the pseudo-filesystem, identifying the vfile entry.
vfile	A pointer to a vfile descriptor to initialize from. The following fields in this structure should be filled in prior to call this routine:

- .privsz is the size (in bytes) of the private data area to be reserved in the vfile iterator. A NULL value indicates that no private area should be reserved.
- .datasz is the size (in bytes) of a single record to be collected by the next() handler from the operation descriptor.
- .tag is a pointer to a mandatory vfile revision tag structure (struct xnvfile_rev_tag). This tag will be monitored for changes by the vfile core while collecting data to output, so that any update detected will cause the current snapshot data to be dropped, and the collection to restart from the beginning. To this end, any change to the data which may be part of the collected records, should also invoke xnvfile_touch() on the associated tag.
- entry.lockops is a pointer to a lock descriptor, defining the lock and unlock operations for the vfile. This pointer may be left to NULL, in which case the operations on the nucleus lock (i.e. nklock) will be used internally around calls to data collection handlers (see operation descriptor).
- .ops is a pointer to an operation descriptor.

Parameters

parent	A pointer to a virtual directory descriptor; the vfile entry will be created into this directory. If NULL, the /proc root directory will be used. /proc/xenomai is mapped on the globally available *nkvfroot* vdir.

Returns

0 is returned on success. Otherwise:

- -ENOMEM is returned if the virtual file entry cannot be created in the /proc hierarchy.

Tags

secondary-only

References xnvfile_snapshot_ops::store.

5.45.3 Variable Documentation

5.45.3.1 struct xnvfile_directory nkvfroot

Xenomai vfile root directory.

This vdir maps the /proc/xenomai directory. It can be used to create a hierarchy of Xenomai-related vfiles under this root.

5.45.3.2 struct xnvfile_directory nkvfroot

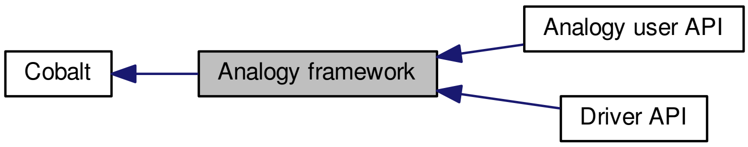
Xenomai vfile root directory.

This vdir maps the /proc/xenomai directory. It can be used to create a hierarchy of Xenomai-related vfiles under this root.

5.46 Analogy framework

A RTDM-based interface for implementing DAQ card drivers.

Collaboration diagram for Analogy framework:



Modules

- Driver API

    Programming interface provided to DAQ card drivers.
- Analogy user API

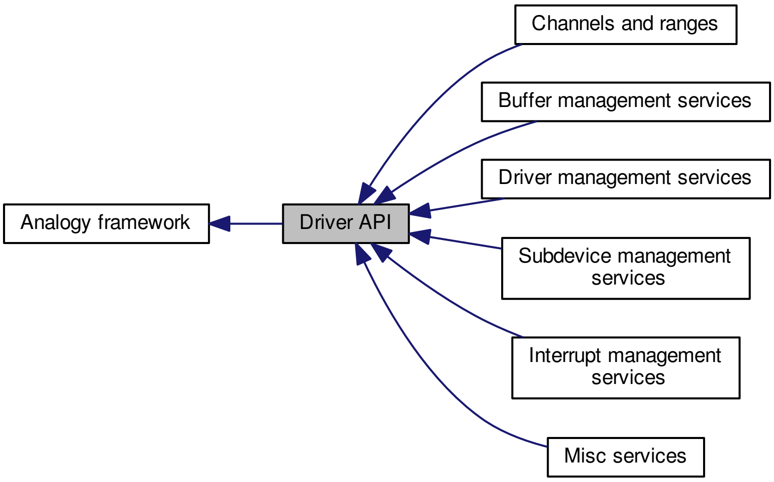
5.46.1 Detailed Description

A RTDM-based interface for implementing DAQ card drivers.

5.47 Driver API

Programming interface provided to DAQ card drivers.

Collaboration diagram for Driver API:



Modules

- Channels and ranges

    Channels.
- Driver management services

    Analogy driver registration / unregistration.
- Subdevice management services

    Subdevice declaration in a driver.
- Buffer management services

    Buffer management services.
- Interrupt management services
- Misc services

5.47.1 Detailed Description

Programming interface provided to DAQ card drivers.

5.48 Driver management services

Analogy driver registration / unregistration.

Collaboration diagram for Driver management services:

Functions

- int a4l_register_drv (struct a4l_driver *drv)
  Register an Analogy driver.
- int a4l_unregister_drv (struct a4l_driver *drv)
  Unregister an Analogy driver.

5.48.1 Detailed Description

Analogy driver registration / unregistration. In a common Linux char driver, the developer has to register a fops structure filled with callbacks for read / write / mmap / ioctl operations.

Analogy drivers do not have to implement read / write / mmap / ioctl functions, these procedures are implemented in the Analogy generic layer. Then, the transfers between user-space and kernel-space are already managed. Analogy drivers work with commands and instructions which are some kind of more dedicated read / write operations. And, instead of registering a fops structure, a Analogy driver must register some a4l_driver structure.

5.48.2 Function Documentation

5.48.2.1 int a4l_register_drv (struct **a4l_driver** * drv)

Register an Analogy driver.

After initialising a driver structure, the driver must be made available so as to be attached.

Parameters

in	*drv*	Driver descriptor structure

Returns

0 on success, otherwise negative error code.

References a4l_driver::board_name, and a4l_driver::list.

5.48.2.2 int a4l_unregister_drv (struct **a4l_driver** * drv)

Unregister an Analogy driver.

This function removes the driver descriptor from the Analogy driver list. The driver cannot be attached anymore.

Parameters

in	*drv*	Driver descriptor structure

Returns

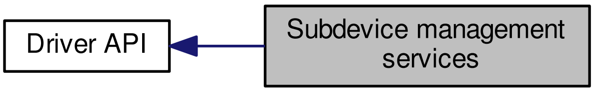
0 on success, otherwise negative error code.

References a4l_driver::board_name, and a4l_driver::list.

5.49 Subdevice management services

Subdevice declaration in a driver.

Collaboration diagram for Subdevice management services:



Functions

- struct a4l_subdevice * a4l_alloc_subd (int sizeof_priv, void(*setup)(struct a4l_subdevice *))

  Allocate a subdevice descriptor.
- int a4l_add_subd (struct a4l_device *dev, struct a4l_subdevice *subd)

  Add a subdevice to the driver descriptor.
- struct a4l_subdevice * a4l_get_subd (struct a4l_device *dev, int idx)

  Get a pointer to the subdevice descriptor referenced by its registration index.

Subdevices types

Flags to define the subdevice type

- #define A4L_SUBD_UNUSED (A4L_SUBD_MASK_SPECIAL|0x1)

  Unused subdevice.
- #define A4L_SUBD_AI (A4L_SUBD_MASK_READ|0x2)

  Analog input subdevice.
- #define A4L_SUBD_AO (A4L_SUBD_MASK_WRITE|0x4)

  Analog output subdevice.
- #define A4L_SUBD_DI (A4L_SUBD_MASK_READ|0x8)

  Digital input subdevice.
- #define A4L_SUBD_DO (A4L_SUBD_MASK_WRITE|0x10)

  Digital output subdevice.
- #define A4L_SUBD_DIO (A4L_SUBD_MASK_SPECIAL|0x20)

  Digital input/output subdevice.
- #define A4L_SUBD_COUNTER (A4L_SUBD_MASK_SPECIAL|0x40)

  Counter subdevice.
- #define A4L_SUBD_TIMER (A4L_SUBD_MASK_SPECIAL|0x80)

  Timer subdevice.
- #define A4L_SUBD_MEMORY (A4L_SUBD_MASK_SPECIAL|0x100)

  Memory, EEPROM, DPRAM.
- #define A4L_SUBD_CALIB (A4L_SUBD_MASK_SPECIAL|0x200)

  Calibration subdevice DACs.
- #define A4L_SUBD_PROC (A4L_SUBD_MASK_SPECIAL|0x400)

Processor, DSP.

- #define A4L_SUBD_SERIAL (A4L_SUBD_MASK_SPECIAL|0x800)

  Serial IO subdevice.
- #define A4L_SUBD_TYPES

  Mask which gathers all the types.

Subdevice features

Flags to define the subdevice's capabilities

- #define A4L_SUBD_CMD 0x1000

  The subdevice can handle command (i.e it can perform asynchronous acquisition)
- #define A4L_SUBD_MMAP 0x8000

  The subdevice support mmap operations (technically, any driver can do it; however, the developer might want that his driver must be accessed through read / write.

Subdevice status

Flags to define the subdevice's status

- #define A4L_SUBD_BUSY_NR 0

  The subdevice is busy, a synchronous or an asynchronous acquisition is occuring.
- #define A4L_SUBD_BUSY (1 << A4L_SUBD_BUSY_NR)

  The subdevice is busy, a synchronous or an asynchronous acquisition is occuring.
- #define A4L_SUBD_CLEAN_NR 1

  The subdevice is about to be cleaned in the middle of the detach procedure.
- #define A4L_SUBD_CLEAN (1 << A4L_SUBD_CLEAN_NR)

  The subdevice is busy, a synchronous or an asynchronous acquisition is occuring.

5.49.1 Detailed Description

Subdevice declaration in a driver. The subdevice structure is the most complex one in the Analogy driver layer. It contains some description fields to fill and some callbacks to declare.

The description fields are:

- flags: to define the subdevice type and its capabilities;
- chan_desc: to describe the channels which compose the subdevice;
- rng_desc: to declare the usable ranges;

The functions callbakcs are:

- do_cmd() and do_cmdtest(): to performe asynchronous acquisitions thanks to commands;
- cancel(): to abort a working asynchronous acquisition;
- munge(): to apply modifications on the data freshly acquired during an asynchronous transfer. Warning: using this feature with can significantly reduce the performances (if the munge operation is complex, it will trigger high CPU charge and if the acquisition device is DMA capable, many cache-misses and cache-replaces will occur (the benefits of the DMA controller will vanish);
- trigger(): optionnaly to launch an asynchronous acquisition;

- insn_read(), insn_write(), insn_bits(), insn_config(): to perform synchronous acquisition operations.

Once the subdevice is filled, it must be inserted into the driver structure thanks to a4l_add_subd().

5.49.2 Function Documentation

5.49.2.1 int a4l_add_subd (struct a4l_device * dev, struct **a4l_subdevice** * subd)

Add a subdevice to the driver descriptor.

Once the driver descriptor structure is initialized, the function a4l_add_subd() must be used so to add some subdevices to the driver.

Parameters

in	*dev*	Device descriptor structure
in	*subd*	Subdevice descriptor structure

Returns

the index with which the subdevice has been registered, in case of error a negative error code is returned.

References a4l_subdevice::dev, a4l_subdevice::idx, and a4l_subdevice::list.

5.49.2.2 struct **a4l_subdevice*** a4l_alloc_subd (int sizeof_priv, void(*)(struct **a4l_subdevice** *) setup)

Allocate a subdevice descriptor.

This is a helper function so as to get a suitable subdevice descriptor

Parameters

in	*sizeof_priv*	Size of the subdevice's private data
in	*setup*	Setup function to be called after the allocation

Returns

the index with which the subdevice has been registered, in case of error a negative error code is returned.

References rtdm_malloc().

5.49.2.3 struct **a4l_subdevice*** a4l_get_subd (struct a4l_device * dev, int idx)

Get a pointer to the subdevice descriptor referenced by its registration index.

This function is scarcely useful as all the drivers callbacks get the related subdevice descriptor as first argument. This function is not optimized, it goes through a linked list to get the proper pointer. So it must not be used in real-time context but at initialization / cleanup time (attach / detach).

Parameters

in	*dev*	Device descriptor structure
in	*idx*	Subdevice index

Returns

0 on success, otherwise negative error code.

5.50 Buffer management services

Buffer management services.

Collaboration diagram for Buffer management services:

Functions

- int a4l_buf_prepare_absput (struct a4l_subdevice *subd, unsigned long count)

  Update the absolute count of data sent from the device to the buffer since the start of the acquisition and after the next DMA shot.
- int a4l_buf_commit_absput (struct a4l_subdevice *subd, unsigned long count)

  Set the absolute count of data which was sent from the device to the buffer since the start of the acquisition and until the last DMA shot.
- int a4l_buf_prepare_put (struct a4l_subdevice *subd, unsigned long count)

  Set the count of data which is to be sent to the buffer at the next DMA shot.
- int a4l_buf_commit_put (struct a4l_subdevice *subd, unsigned long count)

  Set the count of data sent to the buffer during the last completed DMA shots.
- int a4l_buf_put (struct a4l_subdevice *subd, void *bufdata, unsigned long count)

  Copy some data from the device driver to the buffer.
- int a4l_buf_prepare_absget (struct a4l_subdevice *subd, unsigned long count)

  Update the absolute count of data sent from the buffer to the device since the start of the acquisition and after the next DMA shot.
- int a4l_buf_commit_absget (struct a4l_subdevice *subd, unsigned long count)

  Set the absolute count of data which was sent from the buffer to the device since the start of the acquisition and until the last DMA shot.
- int a4l_buf_prepare_get (struct a4l_subdevice *subd, unsigned long count)

  Set the count of data which is to be sent from the buffer to the device at the next DMA shot.
- int a4l_buf_commit_get (struct a4l_subdevice *subd, unsigned long count)

  Set the count of data sent from the buffer to the device during the last completed DMA shots.
- int a4l_buf_get (struct a4l_subdevice *subd, void *bufdata, unsigned long count)

  Copy some data from the buffer to the device driver.
- int a4l_buf_evt (struct a4l_subdevice *subd, unsigned long evts)

  Signal some event(s) to a user-space program involved in some read / write operation.
- unsigned long a4l_buf_count (struct a4l_subdevice *subd)

  Get the data amount available in the Analogy buffer.
- struct a4l_cmd_desc * a4l_get_cmd (struct a4l_subdevice *subd)

  Get the current Analogy command descriptor.
- int a4l_get_chan (struct a4l_subdevice *subd)

  Get the channel index according to its type.

5.50.1 Detailed Description

Buffer management services. The buffer is the key component of the Analogy infrastructure. It manages transfers between the user-space and the Analogy drivers thanks to generic functions which are described hereafter. Thanks to the buffer subsystem, the driver developer does not have to care about the way the user program retrieves or sends data.

To write a classical char driver, the developer has to fill a fops structure so as to provide transfer operations to the user program (read, write, ioctl and mmap if need be).

The Analogy infrastructure manages the whole interface with the userspace; the common read, write, mmap, etc. callbacks are generic Analogy functions. These functions manage (and perform, if need be) tranfers between the user-space and an asynchronous buffer thanks to lockless mechanisms.

Consequently, the developer has to use the proper buffer functions in order to write / read acquired data into / from the asynchronous buffer.

Here are listed the functions:

- a4l_buf_prepare_(abs)put() and a4l_buf_commit_(abs)put()
- a4l_buf_prepare_(abs)get() and a4l_buf_commit_(abs)get()
- a4l_buf_put()
- a4l_buf_get()
- a4l_buf_evt().

The functions count might seem high; however, the developer needs a few of them to write a driver. Having so many functions enables to manage any transfer cases:

- If some DMA controller is available, there is no need to make the driver copy the acquired data into the asynchronous buffer, the DMA controller must directly trigger DMA shots into / from the buffer. In that case, a function a4l_buf_prepare_*() must be used so as to set up the DMA transfer and a function a4l_buf_commit_*() has to be called to complete the transfer().
- For DMA controllers which need to work with global counter (the transfered data count since the beginning of the acquisition), the functions a4l_buf_*_abs_*() have been made available.
- If no DMA controller is available, the driver has to perform the copy between the hardware component and the asynchronous buffer. In such cases, the functions a4l_buf_get() and a4l_buf_put() are useful.

5.50.2 Function Documentation

5.50.2.1 int a4l_buf_commit_absget (struct **a4l_subdevice** * subd, unsigned long count)

Set the absolute count of data which was sent from the buffer to the device since the start of the acquisition and until the last DMA shot.

The functions a4l_buf_prepare_(abs)put(), a4l_buf_commit_(abs)put(), a4l_buf_prepare_(abs)get() and a4l_buf_commit_(abs)get() have been made available for DMA transfers. In such situations, no data copy is needed between the Analogy buffer and the device as some DMA controller is in charge of performing data shots from / to the Analogy buffer. However, some pointers still have to be updated so as to monitor the tranfers.

Parameters

in	*subd*	Subdevice descriptor structure
in	*count*	The data count transferred to the device during the last DMA shot plus the data count which have been sent since the beginning of the acquisition

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.2 int a4l_buf_commit_absput (struct **a4l_subdevice** * subd, unsigned long count)

Set the absolute count of data which was sent from the device to the buffer since the start of the acquisition and until the last DMA shot.

The functions a4l_buf_prepare_(abs)put(), a4l_buf_commit_(abs)put(), a4l_buf_prepare_(abs)get() and a4l_buf_commit_(abs)get() have been made available for DMA transfers. In such situations, no data copy is needed between the Analogy buffer and the device as some DMA controller is in charge of performing data shots from / to the Analogy buffer. However, some pointers still have to be updated so as to monitor the tranfers.

Parameters

in	*subd*	Subdevice descriptor structure
in	*count*	The data count transferred to the buffer during the last DMA shot plus the data count which have been sent / retrieved since the beginning of the acquisition

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.3 int a4l_buf_commit_get (struct **a4l_subdevice** * subd, unsigned long count)

Set the count of data sent from the buffer to the device during the last completed DMA shots.

The functions a4l_buf_prepare_(abs)put(), a4l_buf_commit_(abs)put(), a4l_buf_prepare_(abs)get() and a4l_buf_commit_(abs)get() have been made available for DMA transfers. In such situations, no data copy is needed between the Analogy buffer and the device as some DMA controller is in charge of performing data shots from / to the Analogy buffer. However, some pointers still have to be updated so as to monitor the tranfers.

Parameters

in	*subd*	Subdevice descriptor structure
in	*count*	The amount of data transferred

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.4 int a4l_buf_commit_put (struct **a4l_subdevice** * subd, unsigned long count)

Set the count of data sent to the buffer during the last completed DMA shots.

The functions a4l_buf_prepare_(abs)put(), a4l_buf_commit_(abs)put(), a4l_buf_prepare_(abs)get() and a4l_buf_commit_(abs)get() have been made available for DMA transfers. In such situations, no data copy is needed between the Analogy buffer and the device as some DMA controller is in charge of performing data shots from / to the Analogy buffer. However, some pointers still have to be updated so as to monitor the tranfers.

Parameters

in	*subd*	Subdevice descriptor structure
in	*count*	The amount of data transferred

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.5 unsigned long a4l_buf_count (struct **a4l_subdevice** * subd)

Get the data amount available in the Analogy buffer.

Parameters

in	*subd*	Subdevice descriptor structure

Returns

the amount of data available in the Analogy buffer.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.6 int a4l_buf_evt (struct **a4l_subdevice** * subd, unsigned long evts)

Signal some event(s) to a user-space program involved in some read / write operation.

The function a4l_buf_evt() is useful in many cases:

- To wake-up a process waiting for some data to read.
- To wake-up a process waiting for some data to write.
- To notify the user-process an error has occured during the acquistion.

Parameters

in	*subd*	Subdevice descriptor structure
in	*evts*	Some specific event to notify: • A4L_BUF_ERROR to indicate some error has occured during the transfer • A4L_BUF_EOA to indicate the acquisition is complete (this event is automatically set, it should not be used).

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.7 int a4l_buf_get (struct **a4l_subdevice** * subd, void * bufdata, unsigned long count)

Copy some data from the buffer to the device driver.

The function a4l_buf_get() must copy data coming from the Analogy buffer to some acquisition device. This ring-buffer is an intermediate area between the device driver and the user-space program, which is supposed to provide the data to send to the device.

Parameters

in	*subd*	Subdevice descriptor structure
in	*bufdata*	The data buffer to copy into the Analogy buffer
in	*count*	The amount of data to copy

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.8 int a4l_buf_prepare_absget (struct **a4l_subdevice** * subd, unsigned long count)

Update the absolute count of data sent from the buffer to the device since the start of the acquisition and after the next DMA shot.

The functions a4l_buf_prepare_(abs)put(), a4l_buf_commit_(abs)put(), a4l_buf_prepare_(abs)get() and a4l_buf_commit_(absg)et() have been made available for DMA transfers. In such situations, no data copy is needed between the Analogy buffer and the device as some DMA controller is in charge of performing data shots from / to the Analogy buffer. However, some pointers still have to be updated so as to monitor the tranfers.

Parameters

in	*subd*	Subdevice descriptor structure
in	*count*	The data count to be transferred during the next DMA shot plus the data count which have been copied since the start of the acquisition

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.9 int a4l_buf_prepare_absput (struct **a4l_subdevice** * subd, unsigned long count)

Update the absolute count of data sent from the device to the buffer since the start of the acquisition and after the next DMA shot.

The functions a4l_buf_prepare_(abs)put(), a4l_buf_commit_(abs)put(), a4l_buf_prepare_(abs)get() and a4l_buf_commit_(absg)et() have been made available for DMA transfers. In such situations, no data copy is needed between the Analogy buffer and the device as some DMA controller is in charge of performing data shots from / to the Analogy buffer. However, some pointers still have to be updated so as to monitor the tranfers.

Parameters

in	*subd*	Subdevice descriptor structure
in	*count*	The data count to be transferred during the next DMA shot plus the data count which have been copied since the start of the acquisition

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.10 int a4l_buf_prepare_get (struct **a4l_subdevice** * subd, unsigned long count)

Set the count of data which is to be sent from the buffer to the device at the next DMA shot.

The functions a4l_buf_prepare_(abs)put(), a4l_buf_commit_(abs)put(), a4l_buf_prepare_(abs)get() and a4l_buf_commit_(abs)get() have been made available for DMA transfers. In such situations, no data copy is needed between the Analogy buffer and the device as some DMA controller is in charge of performing data shots from / to the Analogy buffer. However, some pointers still have to be updated so as to monitor the tranfers.

Parameters

in	*subd*	Subdevice descriptor structure
in	*count*	The data count to be transferred

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.11 int a4l_buf_prepare_put (struct **a4l_subdevice** * subd, unsigned long count)

Set the count of data which is to be sent to the buffer at the next DMA shot.

The functions a4l_buf_prepare_(abs)put(), a4l_buf_commit_(abs)put(), a4l_buf_prepare_(abs)get() and a4l_buf_commit_(abs)get() have been made available for DMA transfers. In such situations, no data copy is needed between the Analogy buffer and the device as some DMA controller is in charge of performing data shots from / to the Analogy buffer. However, some pointers still have to be updated so as to monitor the tranfers.

Parameters

in	*subd*	Subdevice descriptor structure
in	*count*	The data count to be transferred

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.12 int a4l_buf_put (struct **a4l_subdevice** * subd, void * bufdata, unsigned long count)

Copy some data from the device driver to the buffer.

The function a4l_buf_put() must copy data coming from some acquisition device to the Analogy buffer. This ring-buffer is an intermediate area between the device driver and the user-space program, which is supposed to recover the acquired data.

Parameters

in	*subd*	Subdevice descriptor structure
in	*bufdata*	The data buffer to copy into the Analogy buffer
in	*count*	The amount of data to copy

Returns

0 on success, otherwise negative error code.

References A4L_SUBD_BUSY_NR, a4l_subdevice::buf, and a4l_subdevice::status.

5.50.2.13 int a4l_get_chan (struct **a4l_subdevice** * subd)

Get the channel index according to its type.

Parameters

in	*subd*	Subdevice descriptor structure

Returns

the channel index.

References A4L_CHAN_GLOBAL_CHANDESC, a4l_get_cmd(), a4l_subdevice::buf, a4l_subdevice::chan_desc, a4l_cmd_desc::chan_descs, a4l_channels_desc::chans, a4l_channels_desc::mode, a4l_channel::nb_bits, and a4l_cmd_desc::nb_chan.

5.50.2.14 struct **a4l_cmd_desc*** a4l_get_cmd (struct **a4l_subdevice** * subd)

Get the current Analogy command descriptor.

Parameters

in	*subd*	Subdevice descriptor structure

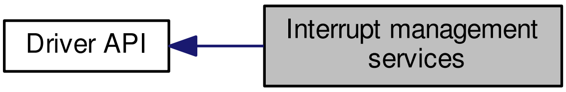
Returns

the command descriptor.

Referenced by a4l_get_chan().

5.51 Interrupt management services

Collaboration diagram for Interrupt management services:



Functions

- unsigned int a4l_get_irq (struct a4l_device *dev)

    Get the interrupt number in use for a specific device.
- int a4l_request_irq (struct a4l_device *dev, unsigned int irq, a4l_irq_hdlr_t handler, unsigned long flags, void *cookie)

    Register an interrupt handler for a specific device.
- int a4l_free_irq (struct a4l_device *dev, unsigned int irq)

    Release an interrupt handler for a specific device.

5.51.1 Detailed Description

5.51.2 Function Documentation

5.51.2.1 int a4l_free_irq (struct a4l_device * dev, unsigned int irq)

Release an interrupt handler for a specific device.

Parameters

in	*dev*	Device descriptor structure
in	*irq*	Line number of the addressed IRQ

Returns

0 on success, otherwise negative error code.

5.51.2.2 unsigned int a4l_get_irq (struct a4l_device * dev)

Get the interrupt number in use for a specific device.

Parameters

in	*dev*	Device descriptor structure

Returns

the line number used or A4L_IRQ_UNUSED if no interrupt is registered.

5.51.2.3 int a4l_request_irq (struct a4l_device * dev, unsigned int irq, a4l_irq_hdlr_t handler, unsigned long flags, void * cookie)

Register an interrupt handler for a specific device.

Parameters

in	*dev*	Device descriptor structure
in	*irq*	Line number of the addressed IRQ
in	*handler*	Interrupt handler
in	*flags*	Registration flags: • RTDM_IRQTYPE_SHARED: enable IRQ-sharing with other drivers (Warning: real-time drivers and non-real-time drivers cannot share an interrupt line). • RTDM_IRQTYPE_EDGE: mark IRQ as edge-triggered (Warning: this flag is meaningless in RTDM-less context). • A4L_IRQ_DISABLED: keep IRQ disabled when calling the action handler (Warning: this flag is ignored in RTDM-enabled configuration).
in	*cookie*	Pointer to be passed to the interrupt handler on invocation

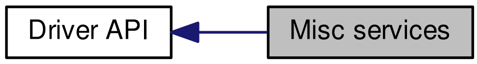
Returns

0 on success, otherwise negative error code.

References rtdm_lock_put_irqrestore().

5.52 Misc services

Collaboration diagram for Misc services:



Functions

- unsigned long long a4l_get_time (void)

  Get the absolute time in nanoseconds.

5.52.1 Detailed Description

5.52.2 Function Documentation

5.52.2.1 unsigned long long a4l_get_time (void)

Get the absolute time in nanoseconds.

Returns

the absolute time expressed in nanoseconds

References rtdm_clock_read().

5.53 Clocks and timers

Cobalt/POSIX clock and timer services.

Collaboration diagram for Clocks and timers:

Functions

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

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

  Start or stop a timer.
- int timer_gettime (timer_t timerid, struct itimerspec *value)

  Get timer next expiration date and reload value.

5.53.1 Detailed Description

Cobalt/POSIX clock and timer services. Cobalt supports three built-in clocks:

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

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

CLOCK_MONOTONIC_RAW is Linux-specific, and provides monotonic time values from a hardware timer which is not adjusted by NTP. This is strictly equivalent to CLOCK_MONOTONIC with Xenomai, which is not NTP adjusted either.

In addition, external clocks can be dynamically registered using the cobalt_clock_register() service. These clocks are fully managed by Cobalt extension code, which should advertise each incoming tick by calling xnclock_tick() for the relevant clock, from an interrupt context.

Timer objects may be created with the timer_create() service using any of the built-in or external clocks. The resolution of these timers is clock-specific. However, built-in clocks all have nanosecond resolution, as specified for clock_nanosleep().

See Also

`Specification.`

5.53.2 Function Documentation

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

Create a timer.

This service creates a timer based on the clock *clockid*.

If *evp* is not *NULL*, it describes the notification mechanism used on timer expiration. Only thread-directed notification is supported (evp->sigev_notify set to *SIGEV_THREAD_ID*).

If *evp* is NULL, the current Cobalt thread will receive the notifications with signal SIGALRM.

The recipient thread is delivered notifications when it calls any of the sigwait(), sigtimedwait() or sigwait-info() services.

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

Parameters

clockid	clock used as a timing base;
evp	description of the asynchronous notification to occur when the timer expires;
timerid	address where the identifier of the created timer will be stored on success.

Return values

0	on success;
-1	with *errno* set if: • EINVAL, the clock *clockid* is invalid; • EINVAL, the member *sigev_notify* of the **sigevent** structure at the address *evp* is not SIGEV_THREAD_ID; • EINVAL, the member *sigev_signo* of the **sigevent** structure is an invalid signal number; • EAGAIN, the maximum number of timers was exceeded, recompile with a larger value.

See Also

Specification.

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

Get timer next expiration date and reload value.

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

Parameters

timerid	timer identifier;

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

Return values

0	on success;
-1	with *errno* set if: • EINVAL, *timerid* is invalid. For *timerid* to be valid, it must belong to the current process.

See Also

Specification.

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

Start or stop a timer.

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

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

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

Expiration date and reload value are rounded to an integer count of nanoseconds.

Parameters

timerid	identifier of the timer to be started or stopped;
flags	one of 0 or TIMER_ABSTIME;
value	address where the specified timer expiration date and reload value are read;
ovalue	address where the specified timer previous expiration date and reload value are stored if not *NULL*.

Return values

0	on success;
-1	with *errno* set if: • EINVAL, the specified timer identifier, expiration date or reload value is invalid. For *timerid* to be valid, it must belong to the current process.

Valid contexts:

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

See Also

`Specification.`

5.54 Condition variables

Cobalt/POSIX condition variable services.

Collaboration diagram for Condition variables:

Functions

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

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

    Destroy a condition variable.

5.54.1 Detailed Description

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

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

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

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

5.54.2 Function Documentation

5.54.2.1 int pthread_cond_destroy (pthread_cond_t * cond)

Destroy a condition variable.

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

Parameters

cond	the condition variable to be destroyed.

Returns

0 on succes,
an error number if:

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

See Also

Specification.

Referenced by rt_cond_create(), and rt_cond_delete().

5.54.2.2 int pthread_cond_init (pthread_cond_t * cond, const pthread_condattr_t * attr)

Initialize a condition variable.

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

Parameters

cond	the condition variable to be initialized;
attr	the condition variable attributes object.

Returns

0 on succes,
an error number if:

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

See Also

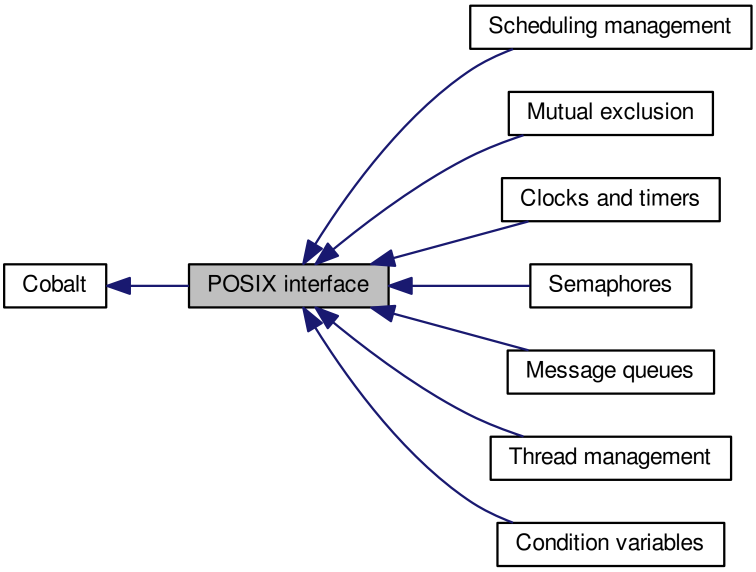
Specification.

Referenced by rt_cond_create().

5.55 POSIX interface

The Cobalt/POSIX interface is an implementation of a subset of the `Single Unix specification` over the Cobalt core.

Collaboration diagram for POSIX interface:



Modules

- Clocks and timers

    Cobalt/POSIX clock and timer services.
- Condition variables

    Cobalt/POSIX condition variable services.
- Message queues

    Cobalt/POSIX message queue services.
- Mutual exclusion

    Cobalt/POSIX mutual exclusion services.
- Semaphores

    Cobalt/POSIX semaphore services.
- Thread management

    Cobalt/POSIX thread management services.
- Scheduling management

    Cobalt/POSIX scheduling management services.

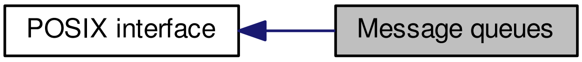
5.55.1 Detailed Description

The Cobalt/POSIX interface is an implementation of a subset of the `Single Unix specification` over the Cobalt core.

5.56 Message queues

Cobalt/POSIX message queue services.

Collaboration diagram for Message queues:



Functions

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

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

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

  Unlink a message queue.
- int mq_getattr (mqd_t mqd, struct mq_attr *attr)

  Get message queue attributes.
- int mq_setattr (mqd_t mqd, const struct mq_attr *__restrict__ attr, struct mq_attr *__restrict__ oattr)

  Set message queue attributes.
- int mq_notify (mqd_t mqd, const struct sigevent *evp)

  Enable notification on message arrival.

5.56.1 Detailed Description

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

5.56.2 Function Documentation

5.56.2.1 int mq_close (mqd_t mqd)

Close a message queue.

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

Parameters

mqd	message queue descriptor.

Return values

0	on success;
-1	with *errno* set if: • EBADF, *mqd* is an invalid message queue descriptor; • EPERM, the caller context is invalid.

Valid contexts:

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

See Also

`Specification.`

5.56.2.2 int mq_getattr (mqd_t mqd, struct mq_attr * attr)

Get message queue attributes.

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

The following attributes are set:

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

Parameters

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

Return values

0	on success;
-1	with *errno* set if: • EBADF, *mqd* is not a valid descriptor.

See Also

`Specification.`

5.56.2.3 int mq_notify (mqd_t mqd, const struct sigevent * evp)

Enable notification on message arrival.

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

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

Only one thread may be registered at a time.

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

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

Parameters

mqd	message queue descriptor;
evp	pointer to an event notification structure.

Return values

0	on success;
-1	with *errno* set if: • EINVAL, *evp* is invalid; • EPERM, the caller context is invalid; • EBADF, *mqd* is not a valid message queue descriptor; • EBUSY, another thread is already registered.

Valid contexts:

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

See Also

Specification.

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

Open a message queue.

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

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

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

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

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

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

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

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

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

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

Parameters

name	name of the message queue to open;
oflags	flags.

Returns

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

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

Valid contexts:

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

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

See Also

Specification.

5.56.2.5 int mq_setattr (mqd_t mqd, const struct mq_attr *__restrict__ attr, struct mq_attr *__restrict__ oattr)

Set message queue attributes.

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

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

Only setting or clearing the O_NONBLOCK flag has an effect.

Parameters

mqd	message queue descriptor;
attr	pointer to new attributes (only *mq_flags* is used);
oattr	if not *NULL*, address where previous message queue attributes will be stored on success.

Return values

0	on success;
-1	with *errno* set if: • EBADF, *mqd* is not a valid message queue descriptor.

See Also

Specification.

5.56.2.6 int mq_unlink (const char * name)

Unlink a message queue.

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

Parameters

name	name of the message queue to be unlinked.

Return values

0	on success;
-1	with *errno* set if: • EPERM, the caller context is invalid; • ENAMETOOLONG, the length of the *name* argument exceeds 64 characters; • ENOENT, the message queue does not exist.

Valid contexts:

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

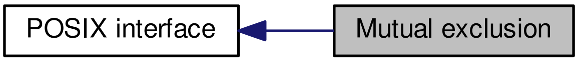
See Also

Specification.

5.57 Mutual exclusion

Cobalt/POSIX mutual exclusion services.

Collaboration diagram for Mutual exclusion:



5.57.1 Detailed Description

Cobalt/POSIX mutual exclusion services. A mutex is a MUTual EXclusion device, and is useful for protecting shared data structures from concurrent modifications, and implementing critical sections and monitors.

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

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

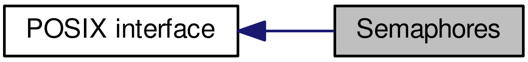
By default, Cobalt mutexes are of the normal type, use no priority protocol and may not be shared between several processes.

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

5.58 Semaphores

Cobalt/POSIX semaphore services.

Collaboration diagram for Semaphores:



Functions

- int sem_destroy (sem_t *sem)

  Destroy an unnamed semaphore.
- int sem_post (sem_t *sem)

  Post a semaphore.
- int sem_trywait (sem_t *sem)

  Attempt to decrement a semaphore.
- int sem_wait (sem_t *sem)

  Decrement a semaphore.
- int sem_timedwait (sem_t *sem, const struct timespec *abs_timeout)

  Attempt to decrement a semaphore with a time limit.
- int sem_close (sem_t *sem)

  Close a named semaphore.
- int sem_unlink (const char *name)

  Unlink a named semaphore.

5.58.1 Detailed Description

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

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

5.58.2 Function Documentation

5.58.2.1 int sem_close (sem_t * sem)

Close a named semaphore.

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

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

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

Parameters

sem	the semaphore to be closed.

Return values

0	on success;
-1	with *errno* set if: • EINVAL, the semaphore *sem* is invalid or is an unnamed semaphore.

See Also

Specification.

5.58.2.2 int sem_destroy (sem_t * sem)

Destroy an unnamed semaphore.

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

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

Parameters

sem	the semaphore to be destroyed.

Return values

always	0 on success. If SEM_WARNDEL was mentioned in sem_init_np(), the semaphore is deleted as requested and a strictly positive value is returned to warn the caller if threads were pending on it, otherwise zero is returned. If SEM_NOBUSYDEL was mentioned in sem_init_np(), sem_destroy() may succeed only if no thread is waiting on the semaphore to delete, otherwise -EBUSY is returned.
-1	with *errno* set if: • EINVAL, the semaphore *sem* is invalid or a named semaphore; • EPERM, the semaphore *sem* is not process-shared and does not belong to the current process. • EBUSY, a thread is currently waiting on the semaphore *sem* with SEM_NOBUSYDEL set.

See Also

Specification.

5.58.2.3 int sem_post (sem_t * sem)

Post a semaphore.

This service posts the semaphore *sem*.

If no thread is currently blocked on this semaphore, its count is incremented unless "pulse" mode is enabled for it (see sem_init_np(), SEM_PULSE). If a thread is blocked on the semaphore, the thread heading the wait queue is unblocked.

Parameters

sem	the semaphore to be signaled.

Return values

0	on success;
-1	with errno set if: • EINVAL, the specified semaphore is invalid or uninitialized; • EPERM, the semaphore *sm* is not process-shared and does not belong to the current process; • EAGAIN, the semaphore count is *SEM_VALUE_MAX*.

See Also

Specification.

5.58.2.4 int sem_timedwait (sem_t * sem, const struct timespec * abs_timeout)

Attempt to decrement a semaphore with a time limit.

This service is equivalent to sem_wait(), except that the caller is only blocked until the timeout *abs_-timeout* expires.

Parameters

sem	the semaphore to be decremented;
abs_timeout	the timeout, expressed as an absolute value of the relevant clock for the semaphore, either CLOCK_MONOTONIC if SEM_RAWCLOCK was mentioned via sem_init_-np(), or CLOCK_REALTIME otherwise.

Return values

0	on success;
-1	with *errno* set if: • EPERM, the caller context is invalid; • EINVAL, the semaphore is invalid or uninitialized; • EINVAL, the specified timeout is invalid; • EPERM, the semaphore *sm* is not process-shared and does not belong to the current process; • EINTR, the caller was interrupted by a signal while blocked in this service; • ETIMEDOUT, the semaphore could not be decremented and the specified timeout expired.

Valid contexts:

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

See Also

`Specification.`

References sem_trywait().

5.58.2.5 int sem_trywait (sem_t * sem)

Attempt to decrement a semaphore.

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

Parameters

sem	the semaphore to be decremented.

Return values

0	on success;
-1	with *errno* set if: • EINVAL, the specified semaphore is invalid or uninitialized; • EPERM, the semaphore *sem* is not process-shared and does not belong to the current process; • EAGAIN, the specified semaphore is currently fully depleted. •

See Also

`Specification.`

Referenced by sem_timedwait(), and sem_wait().

5.58.2.6 int sem_unlink (const char * name)

Unlink a named semaphore.

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

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

Parameters

name	the name of the semaphore to be unlinked.

Return values

0	on success;
-1	with *errno* set if: • ENAMETOOLONG, the length of the *name* argument exceeds 64 characters; • ENOENT, the named semaphore does not exist.

See Also

Specification.

5.58.2.7 int sem_wait (sem_t * sem)

Decrement a semaphore.

This service decrements the semaphore *sem* if it is currently if its value is greater than 0. If the semaphore's value is currently zero, the calling thread is suspended until the semaphore is posted, or a signal is delivered to the calling thread.

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

Parameters

sem	the semaphore to be decremented.

Return values

0	on success;
-1	with *errno* set if: • EPERM, the caller context is invalid; • EINVAL, the semaphore is invalid or uninitialized; • EPERM, the semaphore *sem* is not process-shared and does not belong to the current process; • EINTR, the caller was interrupted by a signal while blocked in this service.

Valid contexts:

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

See Also

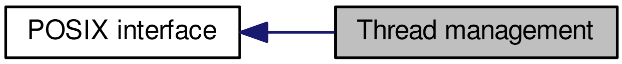
Specification.

References sem_trywait().

5.59 Thread management

Cobalt/POSIX thread management services.

Collaboration diagram for Thread management:



Functions

- int pthread_setschedparam_ex (pthread_t thread, int policy, const struct sched_param_ex *param-_ex)

    Set extended scheduling policy of thread.
- int pthread_getschedparam_ex (pthread_t thread, int *__restrict__ policy_r, struct sched_param_-ex *__restrict__ param_ex)

    Get extended scheduling policy of thread.
- int pthread_create (pthread_t *ptid_r, const pthread_attr_t *attr, void *(*start)(void *), void *arg)

    Create a new thread.
- int pthread_set_mode_np (int clrmask, int setmask, int *mode_r)

    Set the mode of the current thread.

5.59.1 Detailed Description

Cobalt/POSIX thread management services.

See Also

`Specification.`

5.59.2 Function Documentation

5.59.2.1 int pthread_create (pthread_t * ptid_r, const pthread_attr_t * attr, void *(*)(void *) start, void * arg)

Create a new thread.

This service creates a thread managed by the Xenomai nucleus in dual kernel configuration.

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

Other attributes of the new thread depend on the *attr* argument. If *attr* is NULL, default values for these attributes are used.

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

Parameters

ptid_r	address where the identifier of the new thread will be stored on success;
attr	thread attributes;
start	thread start routine;
arg	opaque user-supplied argument passed to *start*;

Returns

0 on success;
an error number if:

- EINVAL, *attr* is invalid;
- EAGAIN, insufficient memory exists in the system heap to create a new thread, increase CONFIG_XENO_OPT_SYS_HEAPSZ;
- EINVAL, thread attribute *inheritsched* is set to PTHREAD_INHERIT_SCHED and the calling thread does not belong to the Cobalt interface;

See Also

Specification.

Note

When creating or shadowing a Xenomai thread for the first time in user-space, Xenomai installs a handler for the SIGSHADOW signal. If you had installed a handler before that, it will be automatically called by Xenomai for SIGSHADOW signals that it has not sent.

If, however, you install a signal handler for SIGSHADOW after creating or shadowing the first Xenomai thread, you have to explicitly call the function cobalt_sigshadow_handler at the beginning of your signal handler, using its return to know if the signal was in fact an internal signal of Xenomai (in which case it returns 1), or if you should handle the signal (in which case it returns 0). cobalt_sigshadow_handler prototype is:

int cobalt_sigshadow_handler(int sig, struct siginfo *si, void *ctxt);

Which means that you should register your handler with sigaction, using the SA_SIGINFO flag, and pass all the arguments you received to cobalt_sigshadow_handler.

5.59.2.2 int pthread_getschedparam_ex (pthread_t thread, int *__restrict__ policy_r, struct sched_param_ex *__restrict__ param_ex)

Get extended scheduling policy of thread.

This service is an extended version of the regular pthread_getschedparam() service, which also supports Xenomai-specific or additional POSIX scheduling policies, not available with the host Linux environment.

Parameters

thread	target thread;
policy_r	address where the scheduling policy of *thread* is stored on success;
param_ex	address where the scheduling parameters of *thread* are stored on success.

Returns

0 on success;
an error number if:

- ESRCH, *thread* is invalid.

See Also

Specification.

5.59.2.3 int pthread_set_mode_np (int clrmask, int setmask, int * mode_r)

Set the mode of the current thread.

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

- PTHREAD_LOCK_SCHED, when set, locks the scheduler, which prevents the current thread from being switched out until the scheduler is unlocked;
- PTHREAD_WARNSW, when set, causes the signal SIGXCPU to be sent to the current thread, whenever it involontary switches to secondary mode;
- PTHREAD_CONFORMING can be passed in *setmask* to switch the current user-space task to its preferred runtime mode. The only meaningful use of this switch is to force a real-time shadow back to primary mode. Any other use leads to a nop.
- PTHREAD_DISABLE_LOCKBREAK disallows breaking the scheduler lock. In the default case, a thread which holds the scheduler lock is allowed to drop it temporarily for sleeping. If this mode bit is set, such thread would return with EINTR immediately from any blocking call.

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

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

Parameters

clrmask	set of bits to be cleared;
setmask	set of bits to be set.
mode_r	If non-NULL, *mode_r* must be a pointer to a memory location which will be written upon success with the previous set of active mode bits. If NULL, the previous set of active mode bits will not be returned.

Returns

0 on success;
an error number if:

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

Note

Setting *clrmask* and *setmask* to zero leads to a nop, only returning the previous mode if *mode_r* is a valid address.

5.59.2.4 int pthread_setschedparam_ex (pthread_t thread, int policy, const struct sched_param_ex * param_ex)

Set extended scheduling policy of thread.

This service is an extended version of the regular pthread_setschedparam() service, which supports Xenomai-specific or additional scheduling policies, not available with the host Linux environment.

This service set the scheduling policy of the Xenomai thread *thread* to the value *policy*, and its scheduling parameters (e.g. its priority) to the value pointed to by *param_ex*.

If *thread* does not match the identifier of a Xenomai thread, this action falls back to the regular pthread-_setschedparam() service.

Parameters

thread	target Cobalt thread;
policy	scheduling policy, one of SCHED_WEAK, SCHED_FIFO, SCHED_COBALT, SCH-ED_RR, SCHED_SPORADIC, SCHED_TP, SCHED_QUOTA or SCHED_NORMA-L;
param_ex	scheduling parameters address. As a special exception, a negative sched_priority value is interpreted as if SCHED_WEAK was given in *policy*, using the absolute value of this parameter as the weak priority level.

When CONFIG_XENO_OPT_SCHED_WEAK is enabled, SCHED_WEAK exhibits priority levels in the [0..99] range (inclusive). Otherwise, sched_priority must be zero for the SCHED_WEAK policy.

Returns

0 on success;
an error number if:

- ESRCH, *thread* is invalid;
- EINVAL, *policy* or *param_ex->sched_priority* is invalid;
- EAGAIN, in user-space, insufficient memory exists in the system heap, increase CONFIG_X-ENO_OPT_SYS_HEAPSZ;
- EFAULT, in user-space, *param_ex* is an invalid address;
- EPERM, in user-space, the calling process does not have superuser permissions.

See Also

Specification.

Note

When creating or shadowing a Xenomai thread for the first time in user-space, Xenomai installs a handler for the SIGSHADOW signal. If you had installed a handler before that, it will be automatically called by Xenomai for SIGSHADOW signals that it has not sent.

If, however, you install a signal handler for SIGSHADOW after creating or shadowing the first Xenomai thread, you have to explicitly call the function cobalt_sigshadow_handler at the beginning of your signal handler, using its return to know if the signal was in fact an internal signal of Xenomai (in which case it returns 1), or if you should handle the signal (in which case it returns 0). cobalt_sigshadow_handler prototype is:

int cobalt_sigshadow_handler(int sig, struct siginfo *si, void *ctxt);

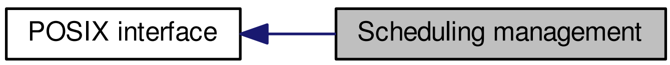
Which means that you should register your handler with sigaction, using the SA_SIGINFO flag, and pass all the arguments you received to cobalt_sigshadow_handler.

pthread_setschedparam_ex() may switch the caller to secondary mode.

5.60 Scheduling management

Cobalt/POSIX scheduling management services.

Collaboration diagram for Scheduling management:



Functions

- int sched_setconfig_np (int cpu, int policy, const union sched_config *config, size_t len)
  Set CPU-specific scheduler settings for a policy.
- ssize_t sched_getconfig_np (int cpu, int policy, union sched_config *config, size_t *len_r)
  Retrieve CPU-specific scheduler settings for a policy.

5.60.1 Detailed Description

Cobalt/POSIX scheduling management services.

5.60.2 Function Documentation

5.60.2.1 ssize_t sched_getconfig_np (int cpu, int policy, union sched_config * config, size_t * len_r)

Retrieve CPU-specific scheduler settings for a policy.

A configuration is strictly local to the target *cpu*, and may differ from other processors.

Parameters

cpu	processor to retrieve the configuration of.
policy	scheduling policy to which the configuration data applies. Currently, SCHED_TP and SCHED_QUOTA are valid.
config	a pointer to a memory area where the configuration data will be copied back. This area must be at least **len_r* bytes long.
len_r	overall length of the configuration data returned (in bytes).

Returns

the number of bytes copied to *config* on success;
a negative error number if:

- EINVAL, *cpu* is invalid, or *policy* is unsupported by the current kernel configuration, or *len* cannot hold the retrieved configuration data.
- ESRCH, with *policy* equal to SCHED_QUOTA, if the group identifier required to perform the operation is not valid.

- ENOMEM, lack of memory to perform the operation.
- ENOSPC, *len* is too short.

5.60.2.2 int sched_setconfig_np (int cpu, int policy, const union sched_config * config, size_t len)

Set CPU-specific scheduler settings for a policy.

A configuration is strictly local to the target *cpu*, and may differ from other processors.

Parameters

cpu	processor to load the configuration of.
policy	scheduling policy to which the configuration data applies. Currently, SCHED_TP and SCHED_QUOTA are valid.
config	a pointer to the configuration data to load on *cpu*, applicable to *policy*.

Settings applicable to SCHED_TP

This call installs the temporal partitions for *cpu*.

- config.tp.windows should be a non-null set of time windows, defining the scheduling time slots for *cpu*. Each window defines its offset from the start of the global time frame (windows[].offset), a duration (windows[].duration), and the partition id it applies to (windows[].ptid).

Time windows must be strictly contiguous, i.e. windows[n].offset + windows[n].duration shall equal windows[n + 1].offset. If windows[].ptid is in the range [0..CONFIG_XENO_OPT_SCHED_TP_NRPART-1], SCHED_TP threads which belong to the partition being referred to may run for the duration of the time window.

Time holes may be defined using windows assigned to the pseudo partition #-1, during which no SCHED_TP threads may be scheduled.

- config.tp.nr_windows should define the number of elements present in the config.tp.windows[] array.

Settings applicable to SCHED_QUOTA

This call manages thread groups running on *cpu*.

- config.quota.op should define the operation to be carried out. Valid operations are:
  - sched_quota_add for creating a new thread group on *cpu*. The new group identifier will be written back to config.quota.add.tgid_r upon success. A new group is given no initial runtime budget when created. sched_quota_set should be issued to enable it.
  - sched_quota_remove for deleting a thread group on *cpu*. The group identifier should be passed in config.quota.remove.tgid.
  - sched_quota_set for updating the scheduling parameters of a thread group defined on *cpu*. The group identifier should be passed in config.quota.set.tgid, along with the allotted percentage of the quota interval (config.quota.set.quota), and the peak percentage allowed (config.quota.set.quota_peak).
  - sched_quota_get for retrieving the scheduling parameters of a thread group defined on *cpu*. The group identifier should be passed in config.quota.get.tgid. The allotted percentage of the quota interval (config.quota.get.quota_r), and the peak percentage (config.quota.get.quota_peak_r) will be written to the given output variables. The result of this operation is identical to calling sched_getconfig_np().

Parameters

len	overall length of the configuration data (in bytes).

Returns

0 on success;
an error number if:

- EINVAL, *cpu* is invalid, or *policy* is unsupported by the current kernel configuration, *len* is invalid, or *config* contains invalid parameters.
- ENOMEM, lack of memory to perform the operation.
- EBUSY, with *policy* equal to SCHED_QUOTA, if an attempt is made to remove a thread group which still manages threads.
- ESRCH, with *policy* equal to SCHED_QUOTA, if the group identifier required to perform the operation is not valid.

5.61 Asynchronous acquisition API

Collaboration diagram for Asynchronous acquisition API:

Data Structures

- struct a4l_cmd_desc

  Structure describing the asynchronous instruction.

Functions

- int a4l_snd_command (a4l_desc_t *dsc, a4l_cmd_t *cmd)

  Send a command to an Analoy device.
- int a4l_snd_cancel (a4l_desc_t *dsc, unsigned int idx_subd)

  Cancel an asynchronous acquisition.
- int a4l_set_bufsize (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long size)

  Change the size of the asynchronous buffer.
- int a4l_get_bufsize (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long *size)

  Get the size of the asynchronous buffer.
- int a4l_mark_bufrw (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long cur, unsigned long *new)

  Update the asynchronous buffer state.
- int a4l_poll (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long ms_timeout)

  Get the available data count.
- int a4l_mmap (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long size, void **ptr)

  Map the asynchronous ring-buffer into a user-space.

ANALOGY_CMD_xxx

Common command flags definitions

- #define A4L_CMD_SIMUL 0x1

  Do not execute the command, just check it.
- #define A4L_CMD_BULK 0x2

  Perform data recovery / transmission in bulk mode.
- #define A4L_CMD_WRITE 0x4

  Perform a command which will write data to the device.

TRIG_xxx

Command triggers flags definitions

- #define TRIG_NONE 0x00000001

  Never trigger.
- #define TRIG_NOW 0x00000002

  Trigger now + N ns.
- #define TRIG_FOLLOW 0x00000004

  Trigger on next lower level trig.
- #define TRIG_TIME 0x00000008

  Trigger at time N ns.
- #define TRIG_TIMER 0x00000010

  Trigger at rate N ns.
- #define TRIG_COUNT 0x00000020

  Trigger when count reaches N.
- #define TRIG_EXT 0x00000040

  Trigger on external signal N.
- #define TRIG_INT 0x00000080

  Trigger on analogy-internal signal N.
- #define TRIG_OTHER 0x00000100

  Driver defined trigger.
- #define TRIG_WAKE_EOS 0x0020

  Wake up on end-of-scan.
- #define TRIG_ROUND_MASK 0x00030000

  Trigger not implemented yet.
- #define TRIG_ROUND_NEAREST 0x00000000

  Trigger not implemented yet.
- #define TRIG_ROUND_DOWN 0x00010000

  Trigger not implemented yet.
- #define TRIG_ROUND_UP 0x00020000

  Trigger not implemented yet.
- #define TRIG_ROUND_UP_NEXT 0x00030000

  Trigger not implemented yet.

Channel macros

Specific precompilation macros and constants useful for the channels descriptors tab located in the command structure

- #define CHAN(a) ((a) & 0xffff)

  Channel indication macro.
- #define RNG(a) (((a) & 0xff) << 16)

  Range definition macro.
- #define AREF(a) (((a) & 0xf) << 24)

  Reference definition macro.
- #define FLAGS(a) ((a) & CR_FLAGS_MASK)

  Flags definition macro.
- #define PACK(a, b, c) (CHAN(a) | RNG(b) | AREF(c))

  Channel + range + reference definition macro.

- #define PACK_FLAGS(a, b, c, d) (CHAN(a) | RNG(b) | AREF(c) | FLAGS(d))

    Channel + range + reference + flags definition macro.
- #define AREF_GROUND 0x00

    Analog reference is analog ground.
- #define AREF_COMMON 0x01

    Analog reference is analog common.
- #define AREF_DIFF 0x02

    Analog reference is differential.
- #define AREF_OTHER 0x03

    Analog reference is undefined.

5.61.1 Detailed Description

5.61.2 Function Documentation

5.61.2.1 int a4l_get_bufsize (**a4l_desc_t** ∗ dsc, unsigned int idx_subd, unsigned long ∗ size)

Get the size of the asynchronous buffer.

During asynchronous acquisition, a ring-buffer enables the transfers from / to user-space. Functions like a4l_read() or a4l_write() recovers / sends data through this intermediate buffer. Please note, there is one ring-buffer per subdevice capable of asynchronous acquisition. By default, each buffer size is set to 64 KB.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Index of the concerned subdevice
out	*size*	Buffer size

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong

References a4l_descriptor::fd.

5.61.2.2 int a4l_mark_bufrw (**a4l_desc_t** ∗ dsc, unsigned int idx_subd, unsigned long cur, unsigned long ∗ new)

Update the asynchronous buffer state.

When the mapping of the asynchronous ring-buffer (thanks to a4l_mmap() is disabled, common read / write syscalls have to be used. In input case, a4l_read() must be used for:

- the retrieval of the acquired data.
- the notification to the Analogy layer that the acquired data have been consumed, then the area in the ring-buffer which was containing becomes available. In output case, a4l_write() must be called to:
- send some data to the Analogy layer.
- signal the Analogy layer that a chunk of data in the ring-buffer must be used by the driver.

In mmap configuration, these features are provided by unique function named a4l_mark_bufrw(). In input case, a4l_mark_bufrw() can :

- recover the count of data newly available in the ring-buffer.
- notify the Analogy layer how many bytes have been consumed. In output case, a4l_mark_bufrw() can:
- recover the count of data available for writing.
- notify Analogy that some bytes have been written.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Index of the concerned subdevice
in	*cur*	Amount of consumed data
out	*new*	Amount of available data

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong; the descriptor and the new pointer should be checked; check also the kernel log ("dmesg")
- -EFAULT is returned if a user <-> kernel transfer went wrong

References a4l_descriptor::fd.

5.61.2.3 int a4l_mmap (**a4l_desc_t** * dsc, unsigned int idx_subd, unsigned long size, void ** ptr)

Map the asynchronous ring-buffer into a user-space.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Index of the concerned subdevice
in	*size*	Size of the buffer to map
out	*ptr*	Address of the pointer containing the assigned address on return

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong, the descriptor and the pointer should be checked; check also the kernel log
- -EPERM is returned if the function is called in an RT context or if the buffer to resize is mapped in user-space (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -EBUSY is returned if the buffer is already mapped in user-space

References a4l_descriptor::fd.

5.61.2.4 int a4l_poll (**a4l_desc_t** * dsc, unsigned int idx_subd, unsigned long ms_timeout)

Get the available data count.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Index of the concerned subdevice
in	*ms_timeout*	The number of miliseconds to wait for some data to be available. Passing A4L_INFINITE causes the caller to block indefinitely until some data is available. Passing A4L_NONBLOCK causes the function to return immediately without waiting for any available data

Returns

the available data count. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -EINTR is returned if calling task has been unblocked by a signal

References a4l_descriptor::fd.

Referenced by a4l_async_read(), and a4l_async_write().

5.61.2.5 int a4l_set_bufsize (**a4l_desc_t** * dsc, unsigned int idx_subd, unsigned long size)

Change the size of the asynchronous buffer.

During asynchronous acquisition, a ring-buffer enables the transfers from / to user-space. Functions like a4l_read() or a4l_write() recovers / sends data through this intermediate buffer. The function a4l_set_bufsize() can change the size of the ring-buffer. Please note, there is one ring-buffer per subdevice capable of asynchronous acquisition. By default, each buffer size is set to 64 KB.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Index of the concerned subdevice
in	*size*	New buffer size, the maximal tolerated value is 16MB (A4L_BUF_MAXSIZE)

Returns

0 on success. Otherwise:

- -EINVAL is returned if the analogy descriptor is not correct or if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EPERM is returned if the function is called in an RT context or if the buffer to resize is mapped in user-space (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -EBUSY is returned if the selected subdevice is already processing an asynchronous operation
- -ENOMEM is returned if the system is out of memory

References a4l_sys_bufcfg(), and a4l_descriptor::fd.

5.61.2.6 int a4l_snd_cancel (**a4l_desc_t** * dsc, unsigned int idx_subd)

Cancel an asynchronous acquisition.

The function a4l_snd_cancel() is devoted to stop an asynchronous acquisition configured thanks to an Analogy command.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Subdevice index

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EIO is returned if the selected subdevice does not support asynchronous operation

References a4l_descriptor::fd.

5.61.2.7 int a4l_snd_command (**a4l_desc_t** * dsc, **a4l_cmd_t** * cmd)

Send a command to an Analoy device.

The function a4l_snd_command() triggers asynchronous acquisition.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*cmd*	Command structure

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -ENOMEM is returned if the system is out of memory
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -EIO is returned if the selected subdevice cannot handle command
- -EBUSY is returned if the selected subdevice is already processing an asynchronous operation

References a4l_descriptor::fd.

5.62 Asynchronous acquisition API

Collaboration diagram for Asynchronous acquisition API:

Functions

- int a4l_async_read (a4l_desc_t *dsc, void *buf, size_t nbyte, unsigned long ms_timeout)
  Perform asynchronous read operation on the analog input subdevice.
- int a4l_async_write (a4l_desc_t *dsc, void *buf, size_t nbyte, unsigned long ms_timeout)
  Perform asynchronous write operation on the analog input subdevice.

5.62.1 Detailed Description

5.62.2 Function Documentation

5.62.2.1 int a4l_async_read (**a4l_desc_t** * dsc, void * buf, size_t nbyte, unsigned long ms_timeout)

Perform asynchronous read operation on the analog input subdevice.

The function a4l_async_read() is only useful for acquisition configured through an Analogy command.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
out	*buf*	Input buffer
in	*nbyte*	Number of bytes to read
in	*ms_timeout*	The number of miliseconds to wait for some data to be available. Passing A4L_INFINITE causes the caller to block indefinitely until some data is available. Passing A4L_NONBLOCK causes the function to return immediately without waiting for any available data

Returns

Number of bytes read, otherwise negative error code:

- -EINVAL is returned if some argument is missing or wrong, the descriptor should be checked; check also the kernel log
- -ENOENT is returned if the device's reading subdevice is idle (no command was sent)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -EINTR is returned if calling task has been unblocked by a signal

References a4l_poll(), a4l_sys_read(), a4l_descriptor::fd, and a4l_descriptor::idx_read_subd.

5.62.2.2 int a4l_async_write (**a4l_desc_t** * dsc, void * buf, size_t nbyte, unsigned long ms_timeout)

Perform asynchronous write operation on the analog input subdevice.

The function a4l_async_write() is only useful for acquisition configured through an Analogy command.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*buf*	Ouput buffer
in	*nbyte*	Number of bytes to write
in	*ms_timeout*	The number of miliseconds to wait for some free area to be available. Passing A4L_INFINITE causes the caller to block indefinitely until some data is available. Passing A4L_NONBLOCK causes the function to return immediately without waiting any available space to write data.

Returns

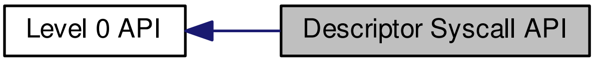
Number of bytes written, otherwise negative error code:

- -EINVAL is returned if some argument is missing or wrong, the descriptor should be checked; check also the kernel log
- -ENOENT is returned if the device's reading subdevice is idle (no command was sent)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -EINTR is returned if calling task has been unblocked by a signal

References a4l_poll(), a4l_sys_write(), a4l_descriptor::fd, and a4l_descriptor::idx_write_subd.

5.63 Descriptor Syscall API

Collaboration diagram for Descriptor Syscall API:



Data Structures

- struct a4l_descriptor

  Structure containing device-information useful to users.

Functions

- int a4l_sys_desc (int fd, a4l_desc_t *dsc, int pass)

  Get a descriptor on an attached device.

ANALOGY_xxx_DESC

Constants used as argument so as to define the description depth to recover

- #define A4L_BSC_DESC 0x0

  BSC stands for basic descriptor (device data)
- #define A4L_CPLX_DESC 0x1

  CPLX stands for complex descriptor (subdevice + channel + range data)

5.63.1 Detailed Description

5.63.2 Function Documentation

5.63.2.1 int a4l_sys_desc (int fd, **a4l_desc_t** * dsc, int pass)

Get a descriptor on an attached device.

Once the device has been attached, the function a4l_get_desc() retrieves various information on the device (subdevices, channels, ranges, etc.). The function a4l_get_desc() can be called twice:

- The first time, almost all the fields, except sbdata, are set (board_name, nb_subd, idx_read_subd, idx_write_subd, magic, sbsize); the last field , sbdata, is supposed to be a pointer on a buffer, which size is defined by the field sbsize.

- The second time, the buffer pointed by sbdata is filled with data about the subdevices, the channels and the ranges.

Between the two calls, an allocation must be performed in order to recover a buffer large enough to contain all the data. These data are set up according a root-leaf organization (device -> subdevice -> channel -> range). They cannot be accessed directly; specific functions are available so as to retrieve them:

- a4l_get_subdinfo() to get some subdevice's characteristics.
- a4l_get_chaninfo() to get some channel's characteristics.
- a4l_get_rnginfo() to get some range's characteristics.

Parameters

`in`	*fd*	Driver file descriptor
`out`	*dsc*	Device descriptor
`in`	*pass*	Description level to retrieve: • A4L_BSC_DESC to get the basic descriptor (notably the size of the data buffer to allocate). • A4L_CPLX_DESC to get the complex descriptor, the data buffer is filled with characteristics about the subdevices, the channels and the ranges.

Returns

0 on success. Otherwise:

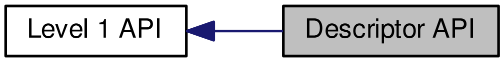
- -EINVAL is returned if some argument is missing or wrong; the pass argument should be checked; check also the kernel log ("dmesg")
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -ENODEV is returned if the descriptor is incoherent (the device may be unattached)

References A4L_BSC_DESC, a4l_descriptor::magic, a4l_descriptor::sbdata, and a4l_descriptor::sbsize.

Referenced by a4l_fill_desc(), and a4l_open().

5.64 Descriptor API

Collaboration diagram for Descriptor API:



Functions

- int a4l_open (a4l_desc_t *dsc, const char *fname)

    Open an Analogy device and basically fill the descriptor.
- int a4l_close (a4l_desc_t *dsc)

    Close the Analogy device related with the descriptor.
- int a4l_fill_desc (a4l_desc_t *dsc)

    Fill the descriptor with subdevices, channels and ranges data.
- int a4l_get_subdinfo (a4l_desc_t *dsc, unsigned int subd, a4l_sbinfo_t **info)

    Get an information structure on a specified subdevice.
- int a4l_get_chinfo (a4l_desc_t *dsc, unsigned int subd, unsigned int chan, a4l_chinfo_t **info)

    Get an information structure on a specified channel.
- int a4l_get_rnginfo (a4l_desc_t *dsc, unsigned int subd, unsigned int chan, unsigned int rng, a4l_rnginfo_t **info)

    Get an information structure on a specified range.

5.64.1 Detailed Description

This is the API interface used to fill and use Analogy device descriptor structure

5.64.2 Function Documentation

5.64.2.1 int a4l_close (**a4l_desc_t** * dsc)

Close the Analogy device related with the descriptor.

The file descriptor is associated with a context. The context is one of the enabler of asynchronous transfers. So, by closing the file descriptor, the programer must keep in mind that the currently occuring asynchronous transfer will cancelled.

Parameters

`in`	*dsc*	Device descriptor

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong; the the dsc pointer should be checked; check also the kernel log ("dmesg")

References a4l_sys_close(), and a4l_descriptor::fd.

5.64.2.2 int a4l_fill_desc (**a4l_desc_t** * dsc)

Fill the descriptor with subdevices, channels and ranges data.

Parameters

in	*dsc*	Device descriptor partly filled by a4l_open().

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong; the the dsc pointer should be checked; check also the kernel log ("dmesg")
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -ENODEV is returned if the descriptor is incoherent (the device may be unattached)

References A4L_CPLX_DESC, a4l_sys_desc(), a4l_descriptor::fd, and a4l_descriptor::magic.

5.64.2.3 int a4l_get_chinfo (**a4l_desc_t** * dsc, unsigned int subd, unsigned int chan, a4l_chinfo_t ** info)

Get an information structure on a specified channel.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() and a4l_fill_desc()
in	*subd*	Subdevice index
in	*chan*	Channel index
out	*info*	Channel information structure

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong; subd, chan and the dsc pointer should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_get_chinfo()

References a4l_descriptor::magic, a4l_descriptor::nb_subd, and a4l_descriptor::sbdata.

Referenced by a4l_find_range().

5.64.2.4 int a4l_get_rnginfo (**a4l_desc_t** * dsc, unsigned int subd, unsigned int chan, unsigned int rng, a4l_rnginfo_t ** info)

Get an information structure on a specified range.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() and a4l_fill_desc()
in	*subd*	Subdevice index
in	*chan*	Channel index
in	*rng*	Range index
out	*info*	Range information structure

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong; subd, chan, rng and the dsc pointer should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_get_rnginfo()

References a4l_descriptor::magic, a4l_descriptor::nb_subd, and a4l_descriptor::sbdata.

Referenced by a4l_find_range().

5.64.2.5 int a4l_get_subdinfo (**a4l_desc_t** * dsc, unsigned int subd, a4l_sbinfo_t ** info)

Get an information structure on a specified subdevice.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() and a4l_fill_desc()
in	*subd*	Subdevice index
out	*info*	Subdevice information structure

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong; subd and the dsc pointer should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_get_subdinfo().

References a4l_descriptor::magic, a4l_descriptor::nb_subd, and a4l_descriptor::sbdata.

Referenced by a4l_sync_dio().

5.64.2.6 int a4l_open (**a4l_desc_t** * dsc, const char * fname)

Open an Analogy device and basically fill the descriptor.

Parameters

out	*dsc*	Device descriptor
in	*fname*	Device name

Returns

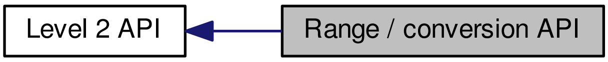
0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong; the fname and the dsc pointer should be checked; check also the kernel log ("dmesg")
- -EFAULT is returned if a user <-> kernel transfer went wrong

References A4L_BSC_DESC, a4l_sys_close(), a4l_sys_desc(), a4l_sys_open(), and a4l_descriptor::fd.

5.65 Range / conversion API

Collaboration diagram for Range / conversion API:



Functions

- int a4l_sizeof_chan (a4l_chinfo_t *chan)
  Get the size in memory of an acquired element.
- int a4l_sizeof_subd (a4l_sbinfo_t *subd)
  Get the size in memory of a digital acquired element.
- int a4l_find_range (a4l_desc_t *dsc, unsigned int idx_subd, unsigned int idx_chan, unsigned long unit, double min, double max, a4l_rnginfo_t **rng)
  Find the must suitable range.
- int a4l_rawtoul (a4l_chinfo_t *chan, unsigned long *dst, void *src, int cnt)
  Unpack raw data (from the driver) into unsigned long values.
- int a4l_rawtof (a4l_chinfo_t *chan, a4l_rnginfo_t *rng, float *dst, void *src, int cnt)
  Convert raw data (from the driver) to float-typed samples.
- int a4l_rawtod (a4l_chinfo_t *chan, a4l_rnginfo_t *rng, double *dst, void *src, int cnt)
  Convert raw data (from the driver) to double-typed samples.
- int a4l_ultoraw (a4l_chinfo_t *chan, void *dst, unsigned long *src, int cnt)
  Pack unsigned long values into raw data (for the driver)
- int a4l_ftoraw (a4l_chinfo_t *chan, a4l_rnginfo_t *rng, void *dst, float *src, int cnt)
  Convert float-typed samples to raw data (for the driver)
- int a4l_dtoraw (a4l_chinfo_t *chan, a4l_rnginfo_t *rng, void *dst, double *src, int cnt)
  Convert double-typed samples to raw data (for the driver)

5.65.1 Detailed Description

5.65.2 Function Documentation

5.65.2.1 int a4l_dtoraw (a4l_chinfo_t * chan, a4l_rnginfo_t * rng, void * dst, double * src, int cnt)

Convert double-typed samples to raw data (for the driver)

Parameters

in	*chan*	Channel descriptor
in	*rng*	Range descriptor

out	*dst*	Ouput buffer
in	*src*	Input buffer
in	*cnt*	Count of conversion to perform

Returns

the count of conversion performed, otherwise a negative error code:

- -EINVAL is returned if some argument is missing or wrong; chan, rng and the pointers should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_dtoraw()

References A4L_RNG_FACTOR, and a4l_sizeof_chan().

5.65.2.2 int a4l_find_range (**a4l_desc_t** * dsc, unsigned int idx_subd, unsigned int idx_chan, unsigned long unit, double min, double max, a4l_rnginfo_t ** rng)

Find the must suitable range.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() and a4l_fill_desc()
in	*idx_subd*	Index of the concerned subdevice
in	*idx_chan*	Index of the concerned channel
in	*unit*	Unit type used in the range
in	*min*	Minimal limit value
in	*max*	Maximal limit value
out	*rng*	Found range

Returns

The index of the most suitable range on success. Otherwise:

- -ENOENT is returned if a suitable range is not found.
- -EINVAL is returned if some argument is missing or wrong; idx_subd, idx_chan and the dsc pointer should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_find_range()

References a4l_get_chinfo(), a4l_get_rnginfo(), A4L_RNG_FACTOR, A4L_RNG_UNIT, and a4l_-descriptor::magic.

5.65.2.3 int a4l_ftoraw (a4l_chinfo_t * chan, a4l_rnginfo_t * rng, void * dst, float * src, int cnt)

Convert float-typed samples to raw data (for the driver)

Parameters

in	*chan*	Channel descriptor
in	*rng*	Range descriptor
out	*dst*	Ouput buffer
in	*src*	Input buffer

in	*cnt*	Count of conversion to perform

Returns

the count of conversion performed, otherwise a negative error code:

- -EINVAL is returned if some argument is missing or wrong; chan, rng and the pointers should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_ftoraw()

References A4L_RNG_FACTOR, and a4l_sizeof_chan().

5.65.2.4 int a4l_rawtod (a4l_chinfo_t * chan, a4l_rnginfo_t * rng, double * dst, void * src, int cnt)

Convert raw data (from the driver) to double-typed samples.

Parameters

in	*chan*	Channel descriptor
in	*rng*	Range descriptor
out	*dst*	Ouput buffer
in	*src*	Input buffer
in	*cnt*	Count of conversion to perform

Returns

the count of conversion performed, otherwise a negative error code:

- -EINVAL is returned if some argument is missing or wrong; chan, rng and the pointers should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_rawtod()

References A4L_RNG_FACTOR, and a4l_sizeof_chan().

5.65.2.5 int a4l_rawtof (a4l_chinfo_t * chan, a4l_rnginfo_t * rng, float * dst, void * src, int cnt)

Convert raw data (from the driver) to float-typed samples.

Parameters

in	*chan*	Channel descriptor
in	*rng*	Range descriptor
out	*dst*	Ouput buffer
in	*src*	Input buffer
in	*cnt*	Count of conversion to perform

Returns

the count of conversion performed, otherwise a negative error code:

- -EINVAL is returned if some argument is missing or wrong; chan, rng and the pointers should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_rawtod()

References A4L_RNG_FACTOR, and a4l_sizeof_chan().

5.65.2.6 int a4l_rawtoul (a4l_chinfo_t * chan, unsigned long * dst, void * src, int cnt)

Unpack raw data (from the driver) into unsigned long values.

This function takes as input driver-specific data and scatters each element into an entry of an unsigned long table. It is a convenience routine which performs no conversion, just copy.

Parameters

in	*chan*	Channel descriptor
out	*dst*	Ouput buffer
in	*src*	Input buffer
in	*cnt*	Count of transfer to copy

Returns

the count of copy performed, otherwise a negative error code:

- -EINVAL is returned if some argument is missing or wrong; chan, dst and src pointers should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_ultoraw()

References a4l_sizeof_chan().

5.65.2.7 int a4l_sizeof_chan (a4l_chinfo_t * chan)

Get the size in memory of an acquired element.

According to the board, the channels have various acquisition widths. With values like 8, 16 or 32, there is no problem finding out the size in memory (1, 2, 4); however with widths like 12 or 24, this function might be helpful to guess the size needed in RAM for a single acquired element.

Parameters

in	*chan*	Channel descriptor

Returns

the size in memory of an acquired element, otherwise a negative error code:

- -EINVAL is returned if the argument chan is NULL

Referenced by a4l_dtoraw(), a4l_ftoraw(), a4l_rawtod(), a4l_rawtof(), a4l_rawtoul(), and a4l_ultoraw().

5.65.2.8 int a4l_sizeof_subd (a4l_sbinfo_t * subd)

Get the size in memory of a digital acquired element.

This function is only useful for DIO subdevices. Digital subdevices are a specific kind of subdevice on which channels are regarded as bits composing the subdevice's bitfield. During a DIO acquisition, all bits are sampled. Therefore, a4l_sizeof_chan() is useless in this case and we have to use a4l_sizeof_subd(). With bitfields which sizes are 8, 16 or 32, there is no problem finding out the size in memory (1, 2, 4); however with widths like 12 or 24, this function might be helpful to guess the size needed in RAM for a single acquired element.

Parameters

in	*subd*	Subdevice descriptor

Returns

the size in memory of an acquired element, otherwise a negative error code:

- -EINVAL is returned if the argument chan is NULL or if the subdevice is not a digital subdevice

References A4L_SUBD_DI, A4L_SUBD_DIO, A4L_SUBD_DO, and A4L_SUBD_TYPES.

Referenced by a4l_sync_dio().

5.65.2.9 int a4l_ultoraw (a4l_chinfo_t * chan, void * dst, unsigned long * src, int cnt)

Pack unsigned long values into raw data (for the driver)

This function takes as input a table of unsigned long values and gather them according to the channel width. It is a convenience routine which performs no conversion, just formatting.

Parameters

in	*chan*	Channel descriptor
out	*dst*	Ouput buffer
in	*src*	Input buffer
in	*cnt*	Count of transfer to copy

Returns

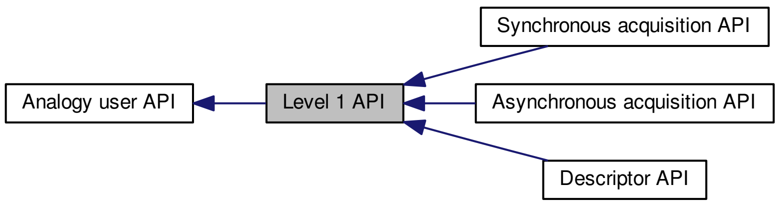
the count of copy performed, otherwise a negative error code:

- -EINVAL is returned if some argument is missing or wrong; chan, dst and src pointers should be checked; check also the kernel log ("dmesg"); WARNING: a4l_fill_desc() should be called before using a4l_ultoraw()

References a4l_sizeof_chan().

5.66 Level 1 API

Collaboration diagram for Level 1 API:



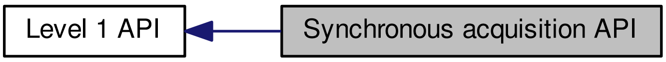
Modules

- Asynchronous acquisition API
- Descriptor API
- Synchronous acquisition API

5.66.1 Detailed Description

5.67 Synchronous acquisition API

Collaboration diagram for Synchronous acquisition API:



Data Structures

- struct a4l_instruction
  Structure describing the synchronous instruction.
- struct a4l_instruction_list
  Structure describing the list of synchronous instructions.

Macros

- #define A4L_INSN_WAIT_MAX 100000
  Maximal wait duration.

Functions

- int a4l_snd_insnlist (a4l_desc_t *dsc, a4l_insnlst_t *arg)
  Perform a list of synchronous acquisition misc operations.
- int a4l_snd_insn (a4l_desc_t *dsc, a4l_insn_t *arg)
  Perform a synchronous acquisition misc operation.

Instruction type

Flags to define the type of instruction

- #define A4L_INSN_READ (0 | A4L_INSN_MASK_READ)
  Read instruction.
- #define A4L_INSN_WRITE (1 | A4L_INSN_MASK_WRITE)
  Write instruction.
- #define A4L_INSN_BITS
  "Bits" instruction
- #define A4L_INSN_CONFIG
  Configuration instruction.
- #define A4L_INSN_GTOD
  Get time instruction.
- #define A4L_INSN_WAIT
  Wait instruction.
- #define A4L_INSN_INTTRIG
  Trigger instruction (to start asynchronous acquisition)

Configuration instruction type

Values to define the type of configuration instruction

- #define **A4L_INSN_CONFIG_DIO_INPUT** 0
- #define **A4L_INSN_CONFIG_DIO_OUTPUT** 1
- #define **A4L_INSN_CONFIG_DIO_OPENDRAIN** 2
- #define **A4L_INSN_CONFIG_ANALOG_TRIG** 16
- #define **A4L_INSN_CONFIG_ALT_SOURCE** 20
- #define **A4L_INSN_CONFIG_DIGITAL_TRIG** 21
- #define **A4L_INSN_CONFIG_BLOCK_SIZE** 22
- #define **A4L_INSN_CONFIG_TIMER_1** 23
- #define **A4L_INSN_CONFIG_FILTER** 24
- #define **A4L_INSN_CONFIG_CHANGE_NOTIFY** 25
- #define **A4L_INSN_CONFIG_SERIAL_CLOCK** 26
- #define **A4L_INSN_CONFIG_BIDIRECTIONAL_DATA** 27
- #define **A4L_INSN_CONFIG_DIO_QUERY** 28
- #define **A4L_INSN_CONFIG_PWM_OUTPUT** 29
- #define **A4L_INSN_CONFIG_GET_PWM_OUTPUT** 30
- #define **A4L_INSN_CONFIG_ARM** 31
- #define **A4L_INSN_CONFIG_DISARM** 32
- #define **A4L_INSN_CONFIG_GET_COUNTER_STATUS** 33
- #define **A4L_INSN_CONFIG_RESET** 34
- #define **A4L_INSN_CONFIG_GPCT_SINGLE_PULSE_GENERATOR** 1001 /* Use CTR as single pulsegenerator */
- #define **A4L_INSN_CONFIG_GPCT_PULSE_TRAIN_GENERATOR** 1002 /* Use CTR as pulse-traingenerator */
- #define **A4L_INSN_CONFIG_GPCT_QUADRATURE_ENCODER** 1003 /* Use the counter as encoder */
- #define **A4L_INSN_CONFIG_SET_GATE_SRC** 2001 /* Set gate source */
- #define **A4L_INSN_CONFIG_GET_GATE_SRC** 2002 /* Get gate source */
- #define **A4L_INSN_CONFIG_SET_CLOCK_SRC** 2003 /* Set master clock source */
- #define **A4L_INSN_CONFIG_GET_CLOCK_SRC** 2004 /* Get master clock source */
- #define **A4L_INSN_CONFIG_SET_OTHER_SRC** 2005 /* Set other source */
- #define **A4L_INSN_CONFIG_SET_COUNTER_MODE** 4097
- #define **A4L_INSN_CONFIG_SET_ROUTING** 4099
- #define **A4L_INSN_CONFIG_GET_ROUTING** 4109

Counter status bits

Status bits for INSN_CONFIG_GET_COUNTER_STATUS

- #define **A4L_COUNTER_ARMED** 0x1
- #define **A4L_COUNTER_COUNTING** 0x2
- #define **A4L_COUNTER_TERMINAL_COUNT** 0x4

IO direction

Values to define the IO polarity

- #define **A4L_INPUT** 0
- #define **A4L_OUTPUT** 1
- #define **A4L_OPENDRAIN** 2

Events types

Values to define the Analogy events. They might used to send some specific events through the instruction interface.

- #define **A4L_EV_START** 0x00040000
- #define **A4L_EV_SCAN_BEGIN** 0x00080000
- #define **A4L_EV_CONVERT** 0x00100000
- #define **A4L_EV_SCAN_END** 0x00200000
- #define **A4L_EV_STOP** 0x00400000

5.67.1 Detailed Description

5.67.2 Function Documentation

5.67.2.1 int a4l_snd_insn (**a4l_desc_t** * dsc, **a4l_insn_t** * arg)

Perform a synchronous acquisition misc operation.

The function a4l_snd_insn() triggers a synchronous acquisition.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*arg*	Instruction structure

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -ENOMEM is returned if the system is out of memory

References a4l_descriptor::fd.

Referenced by a4l_config_subd(), a4l_sync_dio(), a4l_sync_read(), and a4l_sync_write().

5.67.2.2 int a4l_snd_insnlist (**a4l_desc_t** * dsc, **a4l_insnlst_t** * arg)

Perform a list of synchronous acquisition misc operations.

The function a4l_snd_insnlist() is able to send many synchronous instructions on a various set of subdevices, channels, etc.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*arg*	Instructions list structure

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong

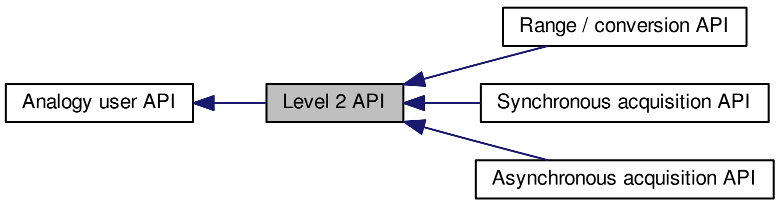
- -ENOMEM is returned if the system is out of memory

References a4l_descriptor::fd.

Referenced by a4l_sync_read(), and a4l_sync_write().

5.68 Level 2 API

Collaboration diagram for Level 2 API:



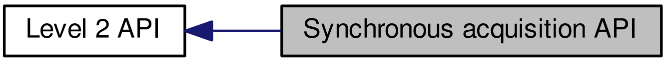
Modules

- Asynchronous acquisition API
- Range / conversion API
- Synchronous acquisition API

5.68.1 Detailed Description

5.69 Synchronous acquisition API

Collaboration diagram for Synchronous acquisition API:



Functions

- int a4l_sync_write (a4l_desc_t *dsc, unsigned int idx_subd, unsigned int chan_desc, unsigned int ns_delay, void *buf, size_t nbyte)

  Perform a synchronous acquisition write operation.
- int a4l_sync_read (a4l_desc_t *dsc, unsigned int idx_subd, unsigned int chan_desc, unsigned int ns_delay, void *buf, size_t nbyte)

  Perform a synchronous acquisition read operation.
- int a4l_sync_dio (a4l_desc_t *dsc, unsigned int idx_subd, void *mask, void *buf)

  Perform a synchronous acquisition digital acquisition.
- int a4l_config_subd (a4l_desc_t *dsc, unsigned int idx_subd, unsigned int type,...)

  Configure a subdevice.

5.69.1 Detailed Description

5.69.2 Function Documentation

5.69.2.1 int a4l_config_subd (**a4l_desc_t** * dsc, unsigned int idx_subd, unsigned int type, ...)

Configure a subdevice.

a4l_config_subd() takes a variable count of arguments. According to the configuration type, some additional argument is necessary:

- A4L_INSN_CONFIG_DIO_INPUT: the channel index (unsigned int)
- A4L_INSN_CONFIG_DIO_OUTPUT: the channel index (unsigned int)
- A4L_INSN_CONFIG_DIO_QUERY: the returned DIO polarity (unsigned int *)

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Index of the concerned subdevice
in	*type*	Configuration parameter

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -ENOSYS is returned if the configuration parameter is not supported

References A4L_INSN_CONFIG, a4l_snd_insn(), CHAN, a4l_instruction::chan_desc, a4l_instruction::data_size, and a4l_instruction::type.

5.69.2.2 int a4l_sync_dio (**a4l_desc_t** * dsc, unsigned int idx_subd, void * mask, void * buf)

Perform a synchronous acquisition digital acquisition.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Index of the concerned subdevice
in	*mask*	Write mask which indicates which bit(s) must be modified
in,out	*buf*	Input / output buffer

Returns

Number of bytes read, otherwise negative error code:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -ENOMEM is returned if the system is out of memory
- -ENOSYS is returned if the driver does not provide any handler "instruction bits"

References a4l_get_subdinfo(), A4L_INSN_BITS, a4l_sizeof_subd(), a4l_snd_insn(), a4l_instruction::data_size, and a4l_instruction::type.

5.69.2.3 int a4l_sync_read (**a4l_desc_t** * dsc, unsigned int idx_subd, unsigned int chan_desc, unsigned int ns_delay, void * buf, size_t nbyte)

Perform a synchronous acquisition read operation.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Index of the concerned subdevice
in	*chan_desc*	Channel descriptor (channel, range and reference)
in	*ns_delay*	Optional delay (in nanoseconds) to wait between the setting of the input channel and sample(s) acquisition(s).
in	*buf*	Input buffer
in	*nbyte*	Number of bytes to read

Returns

Number of bytes read, otherwise negative error code:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong

- -ENOMEM is returned if the system is out of memory

References A4L_INSN_READ, A4L_INSN_WAIT, a4l_snd_insn(), a4l_snd_insnlist(), a4l_instruction_-list::count, a4l_instruction::data, a4l_instruction::data_size, and a4l_instruction::type.

5.69.2.4 int a4l_sync_write (**a4l_desc_t** * dsc, unsigned int idx_subd, unsigned int chan_desc, unsigned int ns_delay, void * buf, size_t nbyte)

Perform a synchronous acquisition write operation.

Parameters

in	*dsc*	Device descriptor filled by a4l_open() (and optionally a4l_fill_desc())
in	*idx_subd*	Index of the concerned subdevice
in	*chan_desc*	Channel descriptor (channel, range and reference)
in	*ns_delay*	Optional delay (in nanoseconds) to wait between the setting of the input channel and sample(s) acquisition(s).
in	*buf*	Output buffer
in	*nbyte*	Number of bytes to write

Returns

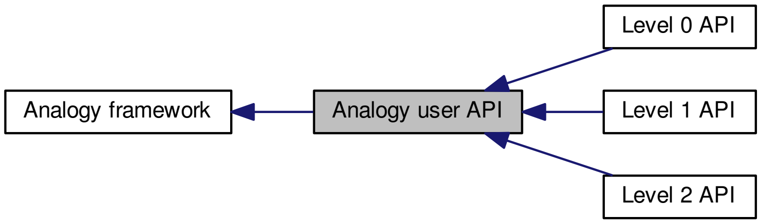
Number of bytes written, otherwise negative error code:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -ENOMEM is returned if the system is out of memory

References A4L_INSN_WAIT, A4L_INSN_WRITE, a4l_snd_insn(), a4l_snd_insnlist(), a4l_instruction_-list::count, a4l_instruction::data, a4l_instruction::data_size, and a4l_instruction::type.

5.70 Analogy user API

Collaboration diagram for Analogy user API:



Modules

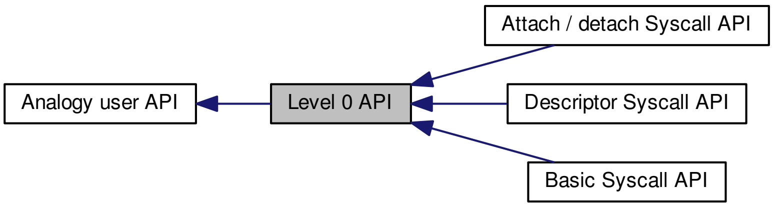
- Level 1 API
- Level 2 API
- Level 0 API

5.70.1 Detailed Description

This is the API interface of Analogy library

5.71 Level 0 API

Collaboration diagram for Level 0 API:



Modules

- Descriptor Syscall API
- Basic Syscall API
- Attach / detach Syscall API

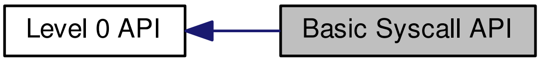
5.71.1 Detailed Description

System call interface to core Analogy services

This interface should not be used directly by applications.

5.72 Basic Syscall API

Collaboration diagram for Basic Syscall API:



Functions

- int a4l_sys_open (const char *fname)
  Open an Analogy device.
- int a4l_sys_close (int fd)
  Close an Analogy device.
- int a4l_sys_read (int fd, void *buf, size_t nbyte)
  Read from an Analogy device.
- int a4l_sys_write (int fd, void *buf, size_t nbyte)
  Write to an Analogy device.

5.72.1 Detailed Description

5.72.2 Function Documentation

5.72.2.1 int a4l_sys_close (int fd)

Close an Analogy device.

Parameters

in	*fd*	File descriptor as returned by a4l_sys_open()

Returns

0 on success, otherwise a negative error code.

Referenced by a4l_close(), and a4l_open().

5.72.2.2 int a4l_sys_open (const char * fname)

Open an Analogy device.

Parameters

in	*fname*	Device name

Returns

Positive file descriptor value on success, otherwise a negative error code.

Referenced by a4l_open().

5.72.2.3 int a4l_sys_read (int fd, void * buf, size_t nbyte)

Read from an Analogy device.

The function a4l_read() is only useful for acquisition configured through an Analogy command.

Parameters

in	*fd*	File descriptor as returned by a4l_sys_open()
out	*buf*	Input buffer
in	*nbyte*	Number of bytes to read

Returns

Number of bytes read. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -ENOENT is returned if the device's reading subdevice is idle (no command was sent)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -EINTR is returned if calling task has been unblocked by a signal

Referenced by a4l_async_read().

5.72.2.4 int a4l_sys_write (int fd, void * buf, size_t nbyte)

Write to an Analogy device.

The function a4l_write() is only useful for acquisition configured through an Analogy command.

Parameters

in	*fd*	File descriptor as returned by a4l_sys_open()
in	*buf*	Output buffer
in	*nbyte*	Number of bytes to write

Returns

Number of bytes written. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -ENOENT is returned if the device's writing subdevice is idle (no command was sent)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -EINTR is returned if calling task has been unblocked by a signal

Referenced by a4l_async_write().

5.73 Attach / detach Syscall API

Collaboration diagram for Attach / detach Syscall API:

Functions

- int a4l_sys_attach (int fd, a4l_lnkdesc_t *arg)
  Attach an Analogy device to a driver.
- int a4l_sys_detach (int fd)
  Detach an Analogy device from a driver.
- int a4l_sys_bufcfg (int fd, unsigned int idx_subd, unsigned long size)
  Configure the buffer size.

5.73.1 Detailed Description

5.73.2 Function Documentation

5.73.2.1 int a4l_sys_attach (int fd, a4l_lnkdesc_t * arg)

Attach an Analogy device to a driver.

Parameters

in	*fd*	File descriptor as returned by a4l_sys_open()
in	*arg*	Link descriptor argument

Returns

0 on success. Otherwise:

- -ENOMEM is returned if the system is out of memory
- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -ENODEV is returned in case of internal error (Please, type "dmesg" for more info)
- -ENXIO is returned in case of internal error (Please, type "dmesg" for more info)

5.73.2.2 int a4l_sys_bufcfg (int fd, unsigned int idx_subd, unsigned long size)

Configure the buffer size.

This function can configure the buffer size of the file descriptor currently in use. If the subdevice index is set to A4L_BUF_DEFMAGIC, it can also define the default buffser size at open time.

Parameters

in	*fd*	File descriptor as returned by a4l_sys_open()
in	*idx_subd*	Index of the concerned subdevice
in	*size*	Buffer size to be set

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EPERM is returned if the function is called in an RT context or if the buffer to resize is mapped in user-space (Please, type "dmesg" for more info)
- -EFAULT is returned if a user <-> kernel transfer went wrong
- -EBUSY is returned if the selected subdevice is already processing an asynchronous operation
- -ENOMEM is returned if the system is out of memory

Referenced by a4l_set_bufsize().

5.73.2.3 int a4l_sys_detach (int fd)

Detach an Analogy device from a driver.

Parameters

in	*fd*	File descriptor as returned by a4l_sys_open()

Returns

0 on success. Otherwise:

- -EINVAL is returned if some argument is missing or wrong (Please, type "dmesg" for more info)
- -EBUSY is returned if the device to be detached is in use
- -EPERM is returned if the devive to be detached still has some buffer mapped in user-space
- -ENODEV is returned in case of internal error (Please, type "dmesg" for more info)
- -ENXIO is returned in case of internal error (Please, type "dmesg" for more info)

5.74 Alarm services

General-purpose watchdog timers.

Collaboration diagram for Alarm services:

Data Structures

- struct RT_ALARM_INFO

    Alarm status descriptor.

Functions

- int rt_alarm_create (RT_ALARM *alarm, const char *name, void(*handler)(void *arg), void *arg)

    Create an alarm object.
- int rt_alarm_delete (RT_ALARM *alarm)

    Delete an alarm.
- int rt_alarm_start (RT_ALARM *alarm, RTIME value, RTIME interval)

    Start an alarm.
- int rt_alarm_stop (RT_ALARM *alarm)

    Stop an alarm.
- int rt_alarm_inquire (RT_ALARM *alarm, RT_ALARM_INFO *info)

    Query alarm status.

5.74.1 Detailed Description

General-purpose watchdog timers. Alarms are general-purpose watchdog timers. Alchemy tasks may create any number of alarms and use them to run a user-defined handler, after a specified initial delay has elapsed. Alarms can be either one shot or periodic; in the latter case, the real-time system automatically reprograms the alarm for the next shot according to a user-defined interval value.

5.74.2 Function Documentation

5.74.2.1 int rt_alarm_create (RT_ALARM * alarm, const char * name, void(*)(void *arg) handler, void * arg)

Create an alarm object.

This routine creates an object triggering an alarm routine at a specified time in the future. Alarms can be periodic or oneshot, depending on the reload interval value passed to rt_alarm_start().

Parameters

alarm	The address of an alarm descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the alarm. When non-NULL and non-empty, a copy of this string is used for indexing the created alarm into the object registry.
handler	The address of the routine to call when the alarm expires. This routine is passed the *arg* value.
arg	A user-defined opaque argument passed to the *handler*.

Returns

Zero is returned upon success. Otherwise:

- -ENOMEM is returned if the system fails to get memory from the local pool in order to create the alarm.
- -EEXIST is returned if the *name* is conflicting with an already registered alarm.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

Alarms are process-private objects and thus cannot be shared by multiple processes, even if they belong to the same Xenomai session.

5.74.2.2 int rt_alarm_delete (RT_ALARM * alarm)

Delete an alarm.

This routine deletes an alarm object previously created by a call to rt_alarm_create().

Parameters

alarm	The descriptor address of the deleted alarm.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *alarm* is not a valid alarm descriptor.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling contexts:

- Regular POSIX threads
- Xenomai threads

5.74.2.3 int rt_alarm_inquire (RT_ALARM * alarm, **RT_ALARM_INFO** * info)

Query alarm status.

This routine returns the status information about the specified *alarm*.

Parameters

alarm	The descriptor address of the alarm to get the status of.
info	A pointer to the returnbuffer" to copy the information to.

Returns

Zero is returned and status information is written to the structure pointed at by *info* upon success. Otherwise:

- -EINVAL is returned if *alarm* is not a valid alarm descriptor.

Valid calling context: any.

References RT_ALARM_INFO::active, RT_ALARM_INFO::expiries, and RT_ALARM_INFO::name.

5.74.2.4 int rt_alarm_start (RT_ALARM * alarm, RTIME value, RTIME interval)

Start an alarm.

This routine programs the trigger date of an alarm object. An alarm can be either periodic or oneshot, depending on the *interval* value.

Alarm handlers are always called on behalf of Xenomai's internal timer event routine. Therefore, Xenomai routines which can be called from such handlers are restricted to the set of services available on behalf of an asynchronous context.

This service overrides any previous setup of the expiry date and reload interval for the alarm.

Parameters

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

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *alarm* is not a valid alarm descriptor.

Valid calling context: any.

Note

Each of the initial *value* and *interval* is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.74.2.5 int rt_alarm_stop (RT_ALARM * alarm)

Stop an alarm.

This routine disables an alarm object, preventing any further expiry until it is re-enabled via rt_alarm_start().

Parameters

alarm	The descriptor address of the stopped alarm.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *alarm* is not a valid alarm descriptor.

Valid calling context: any.

5.75 Buffer services

Lightweight FIFO IPC mechanism.

Collaboration diagram for Buffer services:

Data Structures

- struct RT_BUFFER_INFO

  Buffer status descriptor.

Macros

- #define B_PRIO 0x1 /* Pend by task priority order. */

  Creation flags.

Functions

- int rt_buffer_create (RT_BUFFER *bf, const char *name, size_t bufsz, int mode)

  Create an IPC buffer.
- int rt_buffer_delete (RT_BUFFER *bf)

  Delete an IPC buffer.
- ssize_t rt_buffer_write_timed (RT_BUFFER *bf, const void *ptr, size_t size, const struct timespec *abs_timeout)

  Write to an IPC buffer.
- static ssize_t rt_buffer_write_until (RT_BUFFER *bf, const void *ptr, size_t size, RTIME timeout)

  Write to an IPC buffer (with absolute scalar timeout).
- static ssize_t rt_buffer_write (RT_BUFFER *bf, const void *ptr, size_t size, RTIME timeout)

  Write to an IPC buffer (with relative scalar timeout).
- ssize_t rt_buffer_read_timed (RT_BUFFER *bf, void *ptr, size_t size, const struct timespec *abs_-timeout)

  Read from an IPC buffer.
- static ssize_t rt_buffer_read_until (RT_BUFFER *bf, void *ptr, size_t size, RTIME timeout)

  Read from an IPC buffer (with absolute scalar timeout).
- static ssize_t rt_buffer_read (RT_BUFFER *bf, void *ptr, size_t size, RTIME timeout)

  Read from an IPC buffer (with relative scalar timeout).
- int rt_buffer_clear (RT_BUFFER *bf)

  Clear an IPC buffer.
- int rt_buffer_inquire (RT_BUFFER *bf, RT_BUFFER_INFO *info)

  Query buffer status.
- int rt_buffer_bind (RT_BUFFER *bf, const char *name, RTIME timeout)

Bind to an IPC buffer.

- int rt_buffer_unbind (RT_BUFFER *bf)

  Unbind from an IPC buffer.

5.75.1 Detailed Description

Lightweight FIFO IPC mechanism. A buffer is a lightweight IPC mechanism, implementing a fast, one-way producer-consumer data path. All messages written are buffered in a single memory area in strict FIFO order, until read either in blocking or non-blocking mode.

Message are always atomically handled on the write side (i.e. no interleave, no short writes), whilst only complete messages are normally returned to the read side. However, short reads may happen under a well-defined situation (see note in rt_buffer_read()), albeit they can be fully avoided by proper use of the buffer.

5.75.2 Macro Definition Documentation

5.75.2.1 #define B_PRIO 0x1 /* Pend by task priority order. */

Creation flags.

Referenced by rt_buffer_create().

5.75.3 Function Documentation

5.75.3.1 int rt_buffer_bind (RT_BUFFER * bf, const char * name, RTIME timeout)

Bind to an IPC buffer.

This routine creates a new descriptor to refer to an existing IPC buffer identified by its symbolic name. If the object does not exist on entry, the caller may block until a buffer of the given name is created.

Parameters

bf	The address of a buffer descriptor filled in by the operation. Contents of this memory is undefined upon failure.
name	A valid NULL-terminated name which identifies the buffer to bind to. This string should match the object name argument passed to rt_buffer_create().
timeout	The number of clock ticks to wait for the registration to occur (see note). Passing TM_INFINITE causes the caller to block indefinitely until the object is registered. Passing TM_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task before the retrieval has completed.
- -EWOULDBLOCK is returned if *timeout* is equal to TM_NONBLOCK and the searched object is not registered on entry.
- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *timeout* equals TM_NONBLOCK.

Note

The *timeout* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.75.3.2 int rt_buffer_clear (RT_BUFFER * bf)

Clear an IPC buffer.

This routine empties a buffer from any data.

Parameters

bf	The descriptor address of the buffer to clear.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *bf* is not a valid buffer descriptor.

Valid calling context: any.

5.75.3.3 int rt_buffer_create (RT_BUFFER * bf, const char * name, size_t bufsz, int mode)

Create an IPC buffer.

This routine creates an IPC object that allows tasks to send and receive data asynchronously via a memory buffer. Data may be of an arbitrary length, albeit this IPC is best suited for small to medium-sized messages, since data always have to be copied to the buffer during transit. Large messages may be more efficiently handled by message queues (RT_QUEUE).

Parameters

bf	The address of a buffer descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the buffer. When non-NULL and non-empty, a copy of this string is used for indexing the created buffer into the object registry.
bufsz	The size of the buffer space available to hold data. The required memory is obtained from the main heap.
mode	The buffer creation mode. The following flags can be OR'ed into this bitmask, each of them affecting the new buffer:

- B_FIFO makes tasks pend in FIFO order for reading data from the buffer.
- B_PRIO makes tasks pend in priority order for reading data from the buffer.

This parameter also applies to tasks blocked on the buffer's write side (see rt_buffer_write()).

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *mode* is invalid or *bufsz* is zero.
- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the buffer.
- -EEXIST is returned if the *name* is conflicting with an already registered buffer.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

Buffers can be shared by multiple processes which belong to the same Xenomai session.

References B_PRIO.

5.75.3.4 int rt_buffer_delete (RT_BUFFER * bf)

Delete an IPC buffer.

This routine deletes a buffer object previously created by a call to rt_buffer_create().

Parameters

bf	The descriptor address of the deleted buffer.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *bf* is not a valid buffer descriptor.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

5.75.3.5 int rt_buffer_inquire (RT_BUFFER * bf, **RT_BUFFER_INFO** * info)

Query buffer status.

This routine returns the status information about the specified buffer.

Parameters

bf	The descriptor address of the buffer to get the status of.
info	A pointer to the returnbuffer" to copy the information to.

Returns

Zero is returned and status information is written to the structure pointed at by *info* upon success. Otherwise:

- -EINVAL is returned if *bf* is not a valid buffer descriptor.

Valid calling context: any.

References RT_BUFFER_INFO::availmem, RT_BUFFER_INFO::iwaiters, RT_BUFFER_INFO::name, RT_BUFFER_INFO::owaiters, and RT_BUFFER_INFO::totalmem.

5.75.3.6 ssize_t rt_buffer_read (RT_BUFFER * bf, void * ptr, size_t len, RTIME timeout) [inline], [static]

Read from an IPC buffer (with relative scalar timeout).

This routine is a variant of rt_buffer_read_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

bf	The descriptor address of the buffer to read from.
ptr	A pointer to a memory area which will be written upon success with the received data.
len	The length in bytes of the memory area pointed to by *ptr*.
timeout	A delay expressed in clock ticks.

References rt_buffer_read_timed().

5.75.3.7 ssize_t rt_buffer_read_timed (RT_BUFFER * bf, void * ptr, size_t len, const struct timespec * abs_timeout)

Read from an IPC buffer.

This routine reads the next message from the specified buffer. If no message is available on entry, the caller is allowed to block until enough data is written to the buffer, or a timeout elapses.

Parameters

bf	The descriptor address of the buffer to read from.
ptr	A pointer to a memory area which will be written upon success with the received data.
len	The length in bytes of the memory area pointed to by *ptr*. Under normal circumstances, rt_buffer_read_timed() only returns entire messages as specified by the *len* argument, or an error value. However, short reads are allowed when a potential deadlock situation is detected (see note below).

abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for a message to be available from the buffer (see note). Passing NULL causes the caller to block indefinitely until enough data is available. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return immediately without blocking in case not enough data is available.

Returns

The number of bytes read from the buffer is returned upon success. Otherwise:

- -ETIMEDOUT is returned if *abs_timeout* is reached before a complete message arrives.
- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } and not enough data is immediately available on entry to form a complete message.
- -EINTR is returned if rt_task_unblock() was called for the current task before enough data became available to form a complete message.
- -EINVAL is returned if *bf* is not a valid buffer descriptor, or *len* is greater than the actual buffer length.
- -EIDRM is returned if *bf* is deleted while the caller was waiting for data. In such event, *bf* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Note

A short read (i.e. fewer bytes returned than requested by *len*) may happen whenever a pathological use of the buffer is encountered. This condition only arises when the system detects that one or more writers are waiting for sending data, while a reader would have to wait for receiving a complete message at the same time. For instance, consider the following sequence, involving a 1024-byte buffer (bf) and two threads:

writer thread > rt_write_buffer(&bf, ptr, 1, TM_INFINITE); (one byte to read, 1023 bytes available for sending) writer thread > rt_write_buffer(&bf, ptr, 1024, TM_INFINITE); (writer blocks - no space for another 1024-byte message) reader thread > rt_read_buffer(&bf, ptr, 1024, TM_INFINITE); (short read - a truncated (1-byte) message is returned)

In order to prevent both threads to wait for each other indefinitely, a short read is allowed, which may be completed by a subsequent call to rt_buffer_read() or rt_buffer_read_until(). If that case arises, thread priorities, buffer and/or message lengths should likely be fixed, in order to eliminate such condition.

Valid calling contexts:

- Xenomai threads
- Any other context if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 }.

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_buffer_read(), and rt_buffer_read_until().

5.75.3.8 ssize_t rt_buffer_read_until (RT_BUFFER * bf, void * ptr, size_t len, RTIME abs_timeout) [inline], [static]

Read from an IPC buffer (with absolute scalar timeout).

This routine is a variant of rt_buffer_read_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

bf	The descriptor address of the buffer to read from.
ptr	A pointer to a memory area which will be written upon success with the received data.
len	The length in bytes of the memory area pointed to by *ptr*.
abs_timeout	An absolute date expressed in clock ticks.

References rt_buffer_read_timed().

5.75.3.9 int rt_buffer_unbind (RT_BUFFER * bf)

Unbind from an IPC buffer.

Parameters

bf	The descriptor address of the buffer to unbind from.

This routine releases a previous binding to an IPC buffer. After this call has returned, the descriptor is no more valid for referencing this object.

5.75.3.10 ssize_t rt_buffer_write (RT_BUFFER * bf, const void * ptr, size_t len, RTIME timeout) [inline], [static]

Write to an IPC buffer (with relative scalar timeout).

This routine is a variant of rt_buffer_write_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

bf	The descriptor address of the buffer to write to.
ptr	The address of the message data to be written to the buffer.
len	The length in bytes of the message data.
timeout	A delay expressed in clock ticks.

References rt_buffer_write_timed().

5.75.3.11 ssize_t rt_buffer_write_timed (RT_BUFFER * bf, const void * ptr, size_t len, const struct timespec * abs_timeout)

Write to an IPC buffer.

This routine writes a message to the specified buffer. If not enough buffer space is available on entry to hold the message, the caller is allowed to block until enough room is freed, or a timeout elapses, whichever comes first.

Parameters

bf	The descriptor address of the buffer to write to.
ptr	The address of the message data to be written to the buffer.
len	The length in bytes of the message data. Zero is a valid value, in which case the buffer is left untouched, and zero is returned to the caller.
abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for enough buffer space to be available to hold the message (see note). Passing NULL causes the caller to block indefinitely until enough buffer space is available. Passing { .tv_-sec = 0, .tv_nsec = 0 } causes the service to return immediately without blocking in case of buffer space shortage.

Returns

The number of bytes written to the buffer is returned upon success. Otherwise:

- -ETIMEDOUT is returned if the absolute *abs_timeout* date is reached before enough buffer space is available to hold the message.
- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } and no buffer space is immediately available on entry to hold the message.
- -EINTR is returned if rt_task_unblock() was called for the current task before enough buffer space became available to hold the message.
- -EINVAL is returned if *bf* is not a valid buffer descriptor, or *len* is greater than the actual buffer length.
- -EIDRM is returned if *bf* is deleted while the caller was waiting for buffer space. In such event, *bf* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } .

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_buffer_write(), and rt_buffer_write_until().

5.75.3.12 ssize_t rt_buffer_write_until (RT_BUFFER * bf, const void * ptr, size_t len, RTIME abs_timeout) [inline], [static]

Write to an IPC buffer (with absolute scalar timeout).

This routine is a variant of rt_buffer_write_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

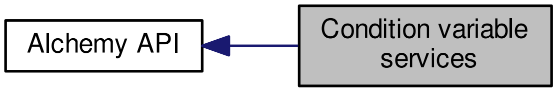
bf	The descriptor address of the buffer to write to.
ptr	The address of the message data to be written to the buffer.
len	The length in bytes of the message data.
abs_timeout	An absolute date expressed in clock ticks.

References rt_buffer_write_timed().

5.76 Condition variable services

POSIXish condition variable mechanism.

Collaboration diagram for Condition variable services:



Data Structures

- struct RT_COND_INFO

  Condition variable status descriptor.

Functions

- int rt_cond_create (RT_COND *cond, const char *name)

  Create a condition variable.
- int rt_cond_delete (RT_COND *cond)

  Delete a condition variable.
- int rt_cond_signal (RT_COND *cond)

  Signal a condition variable.
- int rt_cond_broadcast (RT_COND *cond)

  Broadcast a condition variable.
- int rt_cond_wait_timed (RT_COND *cond, RT_MUTEX *mutex, const struct timespec *abs_-timeout)

  Wait on a condition variable.
- static int rt_cond_wait_until (RT_COND *cond, RT_MUTEX *mutex, RTIME timeout)

  Wait on a condition variable (with absolute scalar timeout).
- static int rt_cond_wait (RT_COND *cond, RT_MUTEX *mutex, RTIME timeout)

  Wait on a condition variable (with relative scalar timeout).
- int rt_cond_inquire (RT_COND *cond, RT_COND_INFO *info)

  Query condition variable status.
- int rt_cond_bind (RT_COND *cond, const char *name, RTIME timeout)

  Bind to a condition variable.
- int rt_cond_unbind (RT_COND *cond)

  Unbind from a condition variable.

5.76.1 Detailed Description

POSIXish condition variable mechanism. A condition variable is a synchronization mechanism which allows tasks to suspend execution until some predicate on some arbitrary shared data is satisfied.

The basic operations on conditions are: signal the condition (when the predicate becomes true), and wait for the condition, blocking the task execution until another task signals the condition. A condition variable must always be associated with a mutex, to avoid a well-known race condition where a task prepares to wait on a condition variable and another task signals the condition just before the first task actually waits on it.

5.76.2 Function Documentation

5.76.2.1 int rt_cond_bind (RT_COND * cond, const char * name, RTIME timeout)

Bind to a condition variable.

This routine creates a new descriptor to refer to an existing condition variable identified by its symbolic name. If the object not exist on entry, the caller may block until a condition variable of the given name is created.

Parameters

cond	The address of a condition variable descriptor filled in by the operation. Contents of this memory is undefined upon failure.
name	A valid NULL-terminated name which identifies the condition variable to bind to. This string should match the object name argument passed to rt_cond_create().
timeout	The number of clock ticks to wait for the registration to occur (see note). Passing TM_INFINITE causes the caller to block indefinitely until the object is registered. Passing TM_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task before the retrieval has completed.
- -EWOULDBLOCK is returned if *timeout* is equal to TM_NONBLOCK and the searched object is not registered on entry.
- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *timeout* equals TM_NONBLOCK.

Note

The *timeout* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.76.2.2 int rt_cond_broadcast (RT_COND * cond)

Broadcast a condition variable.

All tasks currently waiting on the condition variable are immediately unblocked.

Parameters

cond	The descriptor address of the condition variable to broadcast.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *cond* is not a valid condition variable descriptor.

Valid calling context: any.

5.76.2.3 int rt_cond_create (RT_COND * cond, const char * name)

Create a condition variable.

Create a synchronization object which allows tasks to suspend execution until some predicate on shared data is satisfied.

Parameters

cond	The address of a condition variable descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the condition variable. When non-NULL and non-empty, a copy of this string is used for indexing the created condition variable into the object registry.

Returns

Zero is returned upon success. Otherwise:

- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the condition variable.
- -EEXIST is returned if the *name* is conflicting with an already registered condition variable.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

Condition variables can be shared by multiple processes which belong to the same Xenomai session.

References pthread_cond_destroy(), and pthread_cond_init().

5.76.2.4 int rt_cond_delete (RT_COND * cond)

Delete a condition variable.

This routine deletes a condition variable object previously created by a call to rt_cond_create().

Parameters

cond	The descriptor address of the deleted condition variable.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *alarm* is not a valid condition variable descriptor.
- -EPERM is returned if this service was called from an asynchronous context.
- -EBUSY is returned upon an attempt to destroy the object referenced by *cond* while it is referenced (for example, while being used in a rt_cond_wait(), rt_cond_wait_timed() or rt_cond_wait_until() by another task).

Valid calling context:

- Regular POSIX threads
- Xenomai threads

References pthread_cond_destroy().

5.76.2.5 int rt_cond_inquire (RT_COND ∗ cond, **RT_COND_INFO** ∗ info)

Query condition variable status.

This routine returns the status information about the specified condition variable.

Parameters

cond	The descriptor address of the condition variable to get the status of.
info	A pointer to the returnbuffer" to copy the information to.

Returns

Zero is returned and status information is written to the structure pointed at by *info* upon success. Otherwise:

- -EINVAL is returned if *cond* is not a valid condition variable descriptor.

Valid calling context: any.

References RT_COND_INFO::name.

5.76.2.6 int rt_cond_signal (RT_COND ∗ cond)

Signal a condition variable.

If the condition variable *cond* is pended, this routine immediately unblocks the first waiting task (by queuing priority order).

Parameters

cond	The descriptor address of the condition variable to signal.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *cond* is not a valid condition variable descriptor.

Valid calling context: any.

5.76.2.7 int rt_cond_unbind (RT_COND * cond)

Unbind from a condition variable.

Parameters

cond	The descriptor address of the condition variable to unbind from.

This routine releases a previous binding to a condition variable. After this call has returned, the descriptor is no more valid for referencing this object.

5.76.2.8 int rt_cond_wait (RT_COND * cond, RT_MUTEX * mutex, RTIME timeout) [inline], [static]

Wait on a condition variable (with relative scalar timeout).

This routine is a variant of rt_cond_wait_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

cond	The descriptor address of the condition variable to wait on.
mutex	The address of the mutex serializing the access to the shared data.
timeout	A delay expressed in clock ticks.

References rt_cond_wait_timed().

5.76.2.9 int rt_cond_wait_timed (RT_COND * cond, RT_MUTEX * mutex, const struct timespec * abs_timeout)

Wait on a condition variable.

This service atomically releases the mutex and blocks the calling task, until the condition variable *cond* is signaled or a timeout occurs, whichever comes first. The mutex is re-acquired before returning from this service.

Parameters

cond	The descriptor address of the condition variable to wait on.
mutex	The address of the mutex serializing the access to the shared data.
abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for the condition variable to be signaled (see note). Passing NULL causes the caller to block indefinitely.

Returns

Zero is returned upon success. Otherwise:

- -ETIMEDOUT is returned if *abs_timeout* is reached before the condition variable is signaled.

- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } .
- -EINTR is returned if rt_task_unblock() was called for the current task.
- -EINVAL is returned if *cond* is not a valid condition variable descriptor.
- -EIDRM is returned if *cond* is deleted while the caller was waiting on the condition variable. In such event, *cond* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_cond_wait(), and rt_cond_wait_until().

5.76.2.10 int rt_cond_wait_until (RT_COND * cond, RT_MUTEX * mutex, RTIME abs_timeout) [inline], [static]

Wait on a condition variable (with absolute scalar timeout).

This routine is a variant of rt_cond_wait_timed() accepting an abs_timeout specification expressed as a scalar value.

Parameters

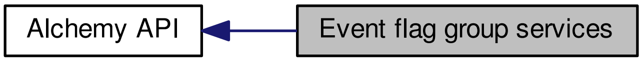
cond	The descriptor address of the condition variable to wait on.
mutex	The address of the mutex serializing the access to the shared data.
abs_timeout	An absolute date expressed in clock ticks.

References rt_cond_wait_timed().

5.77 Event flag group services

Inter-task notification mechanism based on discrete flags.

Collaboration diagram for Event flag group services:



Data Structures

- struct RT_EVENT_INFO

    Event status descriptor.

Macros

- #define EV_PRIO 0x1 /* Pend by task priority order. */

    Creation flags.
- #define EV_ANY 0x1 /* Disjunctive wait. */

    Operation flags.

Functions

- int rt_event_create (RT_EVENT *event, const char *name, unsigned long ivalue, int mode)

    Create an event flag group.
- int rt_event_delete (RT_EVENT *event)

    Delete an event flag group.
- int rt_event_signal (RT_EVENT *event, unsigned long mask)

    Signal an event.
- int rt_event_wait_timed (RT_EVENT *event, unsigned long mask, unsigned long *mask_r, int mode, const struct timespec *abs_timeout)

    Wait for an arbitrary set of events.
- static int rt_event_wait_until (RT_EVENT *event, unsigned long mask, unsigned long *mask_r, int mode, RTIME timeout)

    Wait for an arbitrary set of events (with absolute scalar timeout).
- static int rt_event_wait (RT_EVENT *event, unsigned long mask, unsigned long *mask_r, int mode, RTIME timeout)

    Wait for an arbitrary set of events (with relative scalar timeout).
- int rt_event_clear (RT_EVENT *event, unsigned long mask, unsigned long *mask_r)

    Clear event flags.
- int rt_event_inquire (RT_EVENT *event, RT_EVENT_INFO *info)

    Query event flag group status.
- int rt_event_bind (RT_EVENT *event, const char *name, RTIME timeout)

    Bind to an event flag group.
- int rt_event_unbind (RT_EVENT *event)

    Unbind from an event flag group.

5.77.1 Detailed Description

Inter-task notification mechanism based on discrete flags. An event flag group is a synchronization object represented by a long-word structure; every available bit in this word represents a user-defined event flag.

When a bit is set, the associated event is said to have occurred. Xenomai tasks can use this mechanism to signal the occurrence of particular events to other tasks.

Tasks can either wait for events to occur in a conjunctive manner (all awaited events must have occurred to satisfy the wait request), or in a disjunctive way (at least one of the awaited events must have occurred to satisfy the wait request).

5.77.2 Macro Definition Documentation

5.77.2.1 #define EV_ANY 0x1 /* Disjunctive wait. */

Operation flags.

Referenced by rt_event_wait_timed().

5.77.2.2 #define EV_PRIO 0x1 /* Pend by task priority order. */

Creation flags.

Referenced by rt_event_create().

5.77.3 Function Documentation

5.77.3.1 int rt_event_bind (RT_EVENT * event, const char * name, RTIME timeout)

Bind to an event flag group.

This routine creates a new descriptor to refer to an existing event flag group identified by its symbolic name. If the object does not exist on entry, the caller may block until an event flag group of the given name is created.

Parameters

event	The address of an event flag group descriptor filled in by the operation. Contents of this memory is undefined upon failure.
name	A valid NULL-terminated name which identifies the event flag group to bind to. This string should match the object name argument passed to rt_event_create().
timeout	The number of clock ticks to wait for the registration to occur (see note). Passing TM_INFINITE causes the caller to block indefinitely until the object is registered. Passing TM_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task before the retrieval has completed.
- -EWOULDBLOCK is returned if *timeout* is equal to TM_NONBLOCK and the searched object is not registered on entry.
- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.

- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *timeout* equals TM_NONBLOCK.

Note

The *timeout* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.77.3.2 int rt_event_clear (RT_EVENT * event, unsigned long mask, unsigned long * mask_r)

Clear event flags.

This routine clears a set of flags from *event*.

Parameters

event	The descriptor address of the affected event.
mask	The set of event flags to be cleared.
mask_r	If non-NULL, *mask_r* is the address of a memory location which will receive the previous value of the event flag group before the flags are cleared.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *event* is not a valid event flag group descriptor.

Valid calling context: any.

5.77.3.3 int rt_event_create (RT_EVENT * event, const char * name, unsigned long ivalue, int mode)

Create an event flag group.

Event groups provide for task synchronization by allowing a set of flags (or "events") to be waited for and posted atomically. An event group contains a mask of received events; an arbitrary set of event flags can be pended or posted in a single operation.

Parameters

event	The address of an event descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the event. When non-NULL and non-empty, a copy of this string is used for indexing the created event into the object registry.

ivalue	The initial value of the group's event mask.
mode	The event group creation mode. The following flags can be OR'ed into this bitmask:

- EV_FIFO makes tasks pend in FIFO order on the event flag group.
- EV_PRIO makes tasks pend in priority order on the event flag group.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *mode* is invalid.
- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the event flag group.
- -EEXIST is returned if the *name* is conflicting with an already registered event flag group.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

Event flag groups can be shared by multiple processes which belong to the same Xenomai session.

References EV_PRIO.

5.77.3.4 int rt_event_delete (RT_EVENT * event)

Delete an event flag group.

This routine deletes a event flag group previously created by a call to rt_event_create().

Parameters

event	The descriptor address of the deleted object.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *event* is not a valid event flag group descriptor.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

5.77.3.5 int rt_event_inquire (RT_EVENT * event, **RT_EVENT_INFO** * info)

Query event flag group status.

This routine returns the status information about *event*.

Parameters

event	The descriptor address of the event flag group to get the status of.
info	A pointer to the returnbuffer" to copy the information to.

Returns

Zero is returned and status information is written to the structure pointed at by *info* upon success. Otherwise:

- -EINVAL is returned if *event* is not a valid event flag group descriptor.

Valid calling context: any.

References RT_EVENT_INFO::name, RT_EVENT_INFO::nwaiters, and RT_EVENT_INFO::value.

5.77.3.6 int rt_event_signal (RT_EVENT * event, unsigned long mask)

Signal an event.

Post a set of flags to *event*. All tasks having their wait request satisfied as a result of this operation are immediately readied.

Parameters

event	The descriptor address of the event flag group to signal.
mask	The set of events to be posted.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *event* is not an event flag group descriptor.

Valid calling context: any.

5.77.3.7 int rt_event_unbind (RT_EVENT * event)

Unbind from an event flag group.

Parameters

event	The descriptor address of the object to unbind from.

This routine releases a previous binding to an event flag group. After this call has returned, the descriptor is no more valid for referencing this object.

5.77.3.8 int rt_event_wait (RT_EVENT * event, unsigned long mask, unsigned long * mask_r, int mode, RTIME timeout) [inline], [static]

Wait for an arbitrary set of events (with relative scalar timeout).

This routine is a variant of rt_event_wait_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

event	The descriptor address of the event flag group to wait on.
mask	The set of bits to wait for.
mask_r	The value of the event mask at the time the task was readied.
mode	The pend mode.
timeout	A delay expressed in clock ticks,

References rt_event_wait_timed().

5.77.3.9 int rt_event_wait_timed (RT_EVENT ∗ event, unsigned long mask, unsigned long ∗ mask_r, int mode, const struct timespec ∗ abs_timeout)

Wait for an arbitrary set of events.

Waits for one or more events to be signaled in *event*, or until a timeout elapses.

Parameters

event	The descriptor address of the event flag group to wait on.
mask	The set of bits to wait for. Passing zero causes this service to return immediately with a success value; the current value of the event mask is also copied to *mask_r*.
mask_r	The value of the event mask at the time the task was readied.
mode	The pend mode. The following flags can be OR'ed into this bitmask, each of them affecting the operation:

- EV_ANY makes the task pend in disjunctive mode (i.e. OR); this means that the request is fulfilled when at least one bit set into *mask* is set in the current event mask.
- EV_ALL makes the task pend in conjunctive mode (i.e. AND); this means that the request is fulfilled when at all bits set into *mask* are set in the current event mask.

Parameters

abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for the request to be satisfied (see note). Passing NULL causes the caller to block indefinitely until the request is satisfied. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return without blocking in case the request cannot be satisfied immediately.

Returns

Zero is returned upon success. Otherwise:

- -ETIMEDOUT is returned if *abs_timeout* is reached before the request is satisfied.
- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } and the requested flags are not set on entry to the call.
- -EINTR is returned if rt_task_unblock() was called for the current task before the request is satisfied.
- -EINVAL is returned if *mode* is invalid, or *event* is not a valid event flag group descriptor.
- -EIDRM is returned if *event* is deleted while the caller was sleeping on it. In such a case, *event* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads.

- Any other context if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 }.

Note

abs_timeout value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

References EV_ANY.

Referenced by rt_event_wait(), and rt_event_wait_until().

5.77.3.10 int rt_event_wait_until (RT_EVENT * event, unsigned long mask, unsigned long * mask_r, int mode, RTIME abs_timeout) [inline], [static]

Wait for an arbitrary set of events (with absolute scalar timeout).

This routine is a variant of rt_event_wait_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

event	The descriptor address of the event flag group to wait on.
mask	The set of bits to wait for.
mask_r	The value of the event mask at the time the task was readied.
mode	The pend mode.
abs_timeout	An absolute date expressed in clock ticks.

References rt_event_wait_timed().

5.78 Heap management services

Region of memory dedicated to real-time allocation.

Collaboration diagram for Heap management services:

Data Structures

- struct RT_HEAP_INFO

  Heap status descriptor.

Macros

- #define H_PRIO 0x1 /* Pend by task priority order. */

  Creation flags.

Functions

- int rt_heap_create (RT_HEAP *heap, const char *name, size_t heapsize, int mode)

  Create a heap.
- int rt_heap_delete (RT_HEAP *heap)

  Delete a heap.
- int rt_heap_alloc_timed (RT_HEAP *heap, size_t size, const struct timespec *abs_timeout, void **blockp)

  Allocate a block from a heap.
- static int rt_heap_alloc_until (RT_HEAP *heap, size_t size, RTIME timeout, void **blockp)

  Allocate a block from a heap (with absolute scalar timeout).
- static int rt_heap_alloc (RT_HEAP *heap, size_t size, RTIME timeout, void **blockp)

  Allocate a block from a heap (with relative scalar timeout).
- int rt_heap_free (RT_HEAP *heap, void *block)

  Release a block to a heap.
- int rt_heap_inquire (RT_HEAP *heap, RT_HEAP_INFO *info)

  Query heap status.
- int rt_heap_bind (RT_HEAP *heap, const char *name, RTIME timeout)

  Bind to a heap.
- int rt_heap_unbind (RT_HEAP *heap)

  Unbind from a heap.

5.78.1 Detailed Description

Region of memory dedicated to real-time allocation. Heaps are regions of memory used for dynamic memory allocation in a time-bounded fashion. Blocks of memory are allocated and freed in an arbitrary order and the pattern of allocation and size of blocks is not known until run time.

5.78.2 Macro Definition Documentation

5.78.2.1 #define H_PRIO 0x1 /* Pend by task priority order. */

Creation flags.

Referenced by rt_heap_create().

5.78.3 Function Documentation

5.78.3.1 int rt_heap_alloc (RT_HEAP * heap, size_t size, RTIME timeout, void ** blockp) [inline], [static]

Allocate a block from a heap (with relative scalar timeout).

This routine is a variant of rt_heap_alloc_timed() accepting a relative timeout specification expressed as a scalar value.

References rt_heap_alloc_timed().

5.78.3.2 int rt_heap_alloc_timed (RT_HEAP * heap, size_t size, const struct timespec * abs_timeout, void ** blockp)

Allocate a block from a heap.

This service allocates a block from a given heap, or returns the address of the single memory segment if H_SINGLE was mentioned in the creation mode to rt_heap_create(). When not enough memory is available on entry to this service, tasks may be blocked until their allocation request can be fulfilled.

Parameters

heap	The descriptor address of the heap to allocate from.
size	The requested size (in bytes) of the block. If the heap is managed as a single-block area (H_SINGLE), this value can be either zero, or the same value given to rt_heap_create(). In that case, the same block covering the entire heap space is returned to all callers of this service.
abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for a block of the requested size to be available from the heap (see note). Passing NULL causes the caller to block indefinitely until a block is available. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return immediately without blocking in case not block is available.
blockp	A pointer to a memory location which will be written upon success with the address of the allocated block, or the start address of the single memory segment. In the former case, the block can be freed using rt_heap_free().

Returns

Zero is returned upon success. Otherwise:

- -ETIMEDOUT is returned if *abs_timeout* is reached before a block is available.

- -EWOULDBLOCK is returned if *abs_timeout* is equal to { .tv_sec = 0, .tv_nsec = 0 } and no block is immediately available on entry to fulfill the allocation request.
- -EINTR is returned if rt_task_unblock() was called for the current task before a block became available.
- -EINVAL is returned if *heap* is not a valid heap descriptor, or *heap* is managed as a single-block area (i.e. H_SINGLE mode) and *size* is non-zero but does not match the original heap size passed to rt_heap_create().
- -EIDRM is returned if *heap* is deleted while the caller was waiting for a block. In such event, *heap* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 }.

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_heap_alloc(), and rt_heap_alloc_until().

5.78.3.3 int rt_heap_alloc_until (RT_HEAP * heap, size_t size, RTIME abs_timeout, void ** blockp) [inline], [static]

Allocate a block from a heap (with absolute scalar timeout).

This routine is a variant of rt_heap_alloc_timed() accepting an absolute timeout specification expressed as a scalar value.

References rt_heap_alloc_timed().

5.78.3.4 int rt_heap_bind (RT_HEAP * heap, const char * name, RTIME timeout)

Bind to a heap.

This routine creates a new descriptor to refer to an existing heap identified by its symbolic name. If the object does not exist on entry, the caller may block until a heap of the given name is created.

Parameters

heap	The address of a heap descriptor filled in by the operation. Contents of this memory is undefined upon failure.
name	A valid NULL-terminated name which identifies the heap to bind to. This string should match the object name argument passed to rt_heap_create().
timeout	The number of clock ticks to wait for the registration to occur (see note). Passing TM_INFINITE causes the caller to block indefinitely until the object is registered. Passing TM_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task before the retrieval has completed.
- -EWOULDBLOCK is returned if *timeout* is equal to TM_NONBLOCK and the searched object is not registered on entry.
- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *timeout* equals TM_NONBLOCK.

Note

The *timeout* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.78.3.5 int rt_heap_create (RT_HEAP * heap, const char * name, size_t heapsz, int mode)

Create a heap.

This routine creates a memory heap suitable for time-bounded allocation requests of RAM chunks. When not enough memory is available, tasks may be blocked until their allocation request can be fulfilled.

By default, heaps support allocation of multiple blocks of memory in an arbitrary order. However, it is possible to ask for single-block management by passing the H_SINGLE flag into the *mode* parameter, in which case the entire memory space managed by the heap is made available as a unique block. In this mode, all allocation requests made through rt_heap_alloc() will return the same block address, pointing at the beginning of the heap memory.

Parameters

heap	The address of a heap descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the heap. When non-NULL and non-empty, a copy of this string is used for indexing the created heap into the object registry.
heapsz	The size (in bytes) of the memory pool, blocks will be claimed and released to. This area is not extensible, so this value must be compatible with the highest memory pressure that could be expected. The valid range is between 2k and 2Gb.
mode	The heap creation mode. The following flags can be OR'ed into this bitmask, each of them affecting the new heap:

- H_FIFO makes tasks pend in FIFO order on the heap when waiting for available blocks.
- H_PRIO makes tasks pend in priority order on the heap when waiting for available blocks.
- H_SINGLE causes the entire heap space to be managed as a single memory block.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *mode* is invalid, or *heapsz* is not in the range [2k..2Gb].
- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the heap.
- -EEXIST is returned if the *name* is conflicting with an already registered heap.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

Heaps can be shared by multiple processes which belong to the same Xenomai session.

References H_PRIO.

5.78.3.6 int rt_heap_delete (RT_HEAP * heap)

Delete a heap.

This routine deletes a heap object previously created by a call to rt_heap_create(), releasing all tasks currently blocked on it.

Parameters

heap	The descriptor address of the deleted heap.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *heap* is not a valid heap descriptor.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

5.78.3.7 int rt_heap_free (RT_HEAP * heap, void * block)

Release a block to a heap.

This service should be used to release a block to the heap it belongs to. An attempt to fulfill the request of every task blocked on rt_heap_alloc() is made once *block* is returned to the memory pool.

Parameters

heap	The descriptor address of the heap to release the block to.
block	The address of the block to free.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *heap* is not a valid heap descriptor, or *block* is not a valid block previously allocated by the rt_heap_alloc() service from *heap*.

Valid calling contexts: any.

5.78.3.8 int rt_heap_inquire (RT_HEAP * heap, **RT_HEAP_INFO** * info)

Query heap status.

This routine returns the status information about *heap*.

Parameters

heap	The descriptor address of the heap to get the status of.
info	A pointer to the returnbuffer" to copy the information to.

Returns

Zero is returned and status information is written to the structure pointed at by *info* upon success. Otherwise:

- -EINVAL is returned if *heap* is not a valid heap descriptor.

Valid calling context: any.

References RT_HEAP_INFO::heapsize, RT_HEAP_INFO::name, RT_HEAP_INFO::nwaiters, RT_HEAP_INFO::usablemem, and RT_HEAP_INFO::usedmem.

5.78.3.9 int rt_heap_unbind (RT_HEAP * heap)

Unbind from a heap.

Parameters

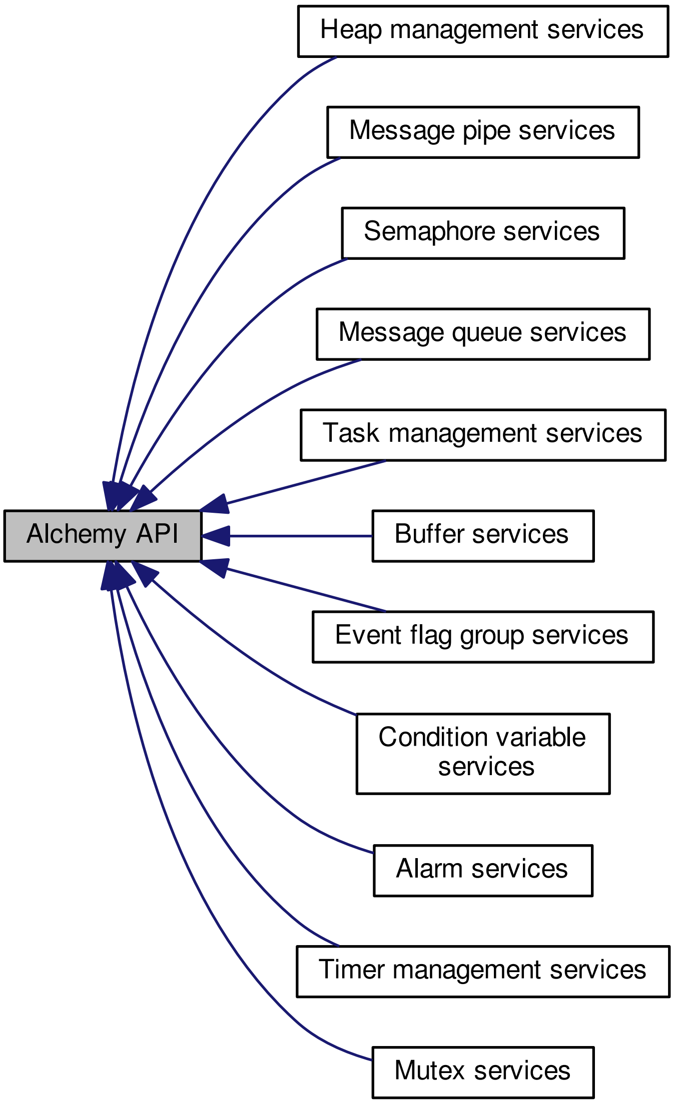
heap	The descriptor address of the heap to unbind from.

This routine releases a previous binding to a heap. After this call has returned, the descriptor is no more valid for referencing this object.

5.79 Alchemy API

A programming interface reminiscent from traditional RTOS APIs.

Collaboration diagram for Alchemy API:



Modules

- Alarm services

  General-purpose watchdog timers.
- Buffer services

  Lightweight FIFO IPC mechanism.
- Condition variable services

  POSIXish condition variable mechanism.

- Event flag group services

  Inter-task notification mechanism based on discrete flags.
- Heap management services

  Region of memory dedicated to real-time allocation.
- Mutex services

  POSIXish mutual exclusion servicesl.
- Message pipe services

  Two-way communication channel between Xenomai & Linux domains.
- Message queue services

  real-time IPC mechanism for sending messages of arbitrary size
- Semaphore services

  Counting semaphore IPC mechanism.
- Task management services

  Services dealing with preemptive multi-tasking.
- Timer management services

  Services for reading and spinning on the hardware timer.

5.79.1 Detailed Description

A programming interface reminiscent from traditional RTOS APIs. This interface is an evolution of the former *native* API available with the Xenomai 2.x series.

5.80 Mutex services

POSIXish mutual exclusion servicesl.

Collaboration diagram for Mutex services:

Data Structures

- struct RT_MUTEX_INFO

  Mutex status descriptor.

Functions

- int rt_mutex_create (RT_MUTEX *mutex, const char *name)

  Create a mutex.
- int rt_mutex_delete (RT_MUTEX *mutex)

  Delete a mutex.
- int rt_mutex_acquire_timed (RT_MUTEX *mutex, const struct timespec *abs_timeout)

  Acquire/lock a mutex (with absolute timeout date).
- static int rt_mutex_acquire_until (RT_MUTEX *mutex, RTIME timeout)

  Acquire/lock a mutex (with absolute scalar timeout).
- static int rt_mutex_acquire (RT_MUTEX *mutex, RTIME timeout)

  Acquire/lock a mutex (with relative scalar timeout).
- int rt_mutex_release (RT_MUTEX *mutex)

  Release/unlock a mutex.
- int rt_mutex_inquire (RT_MUTEX *mutex, RT_MUTEX_INFO *info)

  Query mutex status.
- int rt_mutex_bind (RT_MUTEX *mutex, const char *name, RTIME timeout)

  Bind to a mutex.
- int rt_mutex_unbind (RT_MUTEX *mutex)

  Unbind from a mutex.

5.80.1 Detailed Description

POSIXish mutual exclusion servicesl. A mutex is a MUTual EXclusion object, and is useful for protecting shared data structures from concurrent modifications, and implementing critical sections and monitors.

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

Xenomai mutex services enforce a priority inheritance protocol in order to solve priority inversions.

5.80.2 Function Documentation

5.80.2.1 int rt_mutex_acquire (RT_MUTEX * mutex, RTIME timeout) [inline], [static]

Acquire/lock a mutex (with relative scalar timeout).

This routine is a variant of rt_mutex_acquire_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

mutex	The descriptor address of the mutex to acquire.
timeout	A delay expressed in clock ticks.

References rt_mutex_acquire_timed().

5.80.2.2 int rt_mutex_acquire_timed (RT_MUTEX * mutex, const struct timespec * abs_timeout)

Acquire/lock a mutex (with absolute timeout date).

Attempt to lock a mutex. The calling task is blocked until the mutex is available, in which case it is locked again before this service returns. Xenomai mutexes are implicitely recursive and implement the priority inheritance protocol.

Parameters

mutex	The descriptor address of the mutex to acquire.
abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for the mutex to be available (see note). Passing NULL the caller to block indefinitely. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return immediately without blocking in case *mutex* is already locked by another task.

Returns

Zero is returned upon success. Otherwise:

- -ETIMEDOUT is returned if *abs_timeout* is reached before the mutex is available.
- -EWOULDBLOCK is returned if *timeout* is { .tv_sec = 0, .tv_nsec = 0 } and the mutex is not immediately available.
- -EINTR is returned if rt_task_unblock() was called for the current task.
- -EINVAL is returned if *mutex* is not a valid mutex descriptor.
- -EIDRM is returned if *mutex* is deleted while the caller was waiting on it. In such event, *mutex* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads

Core specifics:

Over the Cobalt core, a real-time task with effective priority zero keeps running in primary mode until it releases the mutex.

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_mutex_acquire(), and rt_mutex_acquire_until().

5.80.2.3 int rt_mutex_acquire_until (RT_MUTEX * mutex, RTIME abs_timeout) [inline], [static]

Acquire/lock a mutex (with absolute scalar timeout).

This routine is a variant of rt_mutex_acquire_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

mutex	The descriptor address of the mutex to acquire.
abs_timeout	An absolute date expressed in clock ticks.

References rt_mutex_acquire_timed().

5.80.2.4 int rt_mutex_bind (RT_MUTEX * mutex, const char * name, RTIME timeout)

Bind to a mutex.

This routine creates a new descriptor to refer to an existing mutex identified by its symbolic name. If the object not exist on entry, the caller may block until a mutex of the given name is created.

Parameters

mutex	The address of a mutex descriptor filled in by the operation. Contents of this memory is undefined upon failure.
name	A valid NULL-terminated name which identifies the mutex to bind to. This string should match the object name argument passed to rt_mutex_create().
timeout	The number of clock ticks to wait for the registration to occur (see note). Passing TM_INFINITE causes the caller to block indefinitely until the object is registered. Passing TM_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task before the retrieval has completed.
- -EWOULDBLOCK is returned if *timeout* is equal to TM_NONBLOCK and the searched object is not registered on entry.
- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *timeout* equals TM_NONBLOCK.

Note

The *timeout* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.80.2.5 int rt_mutex_create (RT_MUTEX * mutex, const char * name)

Create a mutex.

Create a mutual exclusion object that allows multiple tasks to synchronize access to a shared resource. A mutex is left in an unlocked state after creation.

Parameters

mutex	The address of a mutex descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the mutex. When non-NULL and non-empty, a copy of this string is used for indexing the created mutex into the object registry.

Returns

Zero is returned upon success. Otherwise:

- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the mutex.
- -EEXIST is returned if the *name* is conflicting with an already registered mutex.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

Mutexes can be shared by multiple processes which belong to the same Xenomai session.

5.80.2.6 int rt_mutex_delete (RT_MUTEX * mutex)

Delete a mutex.

This routine deletes a mutex object previously created by a call to rt_mutex_create().

Parameters

mutex	The descriptor address of the deleted mutex.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *alarm* is not a valid mutex descriptor.
- -EPERM is returned if this service was called from an asynchronous context.
- -EBUSY is returned upon an attempt to destroy the object referenced by *mutex* while it is referenced (for example, while being used in a rt_mutex_acquite(), rt_mutex_acquire_timed() or rt_mutex_acquire_until() by another task).

Valid calling context:

- Regular POSIX threads
- Xenomai threads

5.80.2.7 int rt_mutex_inquire (RT_MUTEX * mutex, **RT_MUTEX_INFO** * info)

Query mutex status.

This routine returns the status information about the specified mutex.

Parameters

mutex	The descriptor address of the mutex to get the status of.
info	A pointer to the returnbuffer" to copy the information to.

Returns

Zero is returned and status information is written to the structure pointed at by *info* upon success. Otherwise:

- -EINVAL is returned if *mutex* is not a valid mutex descriptor.
- -EPERM is returned if this service is called from an interrupt context.

Valid calling context:

- Xenomai threads

References RT_MUTEX_INFO::name, and RT_MUTEX_INFO::owner.

5.80.2.8 int rt_mutex_release (RT_MUTEX * mutex)

Release/unlock a mutex.

This routine releases a mutex object previously locked by a call to rt_mutex_acquire() or rt_mutex_-acquire_until(). If the mutex is pended, the first waiting task (by priority order) is immediately unblocked and transfered the ownership of the mutex; otherwise, the mutex is left in an unlocked state.

Parameters

mutex	The descriptor address of the deleted mutex.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *alarm* is not a valid mutex descriptor.
- -EPERM is returned if *mutex* is not owned by the current task, or more generally if this service was called from a context which cannot own any mutex (e.g. interrupt context).

Valid calling context:

- Xenomai threads

5.80.2.9 int rt_mutex_unbind (RT_MUTEX * mutex)

Unbind from a mutex.

Parameters

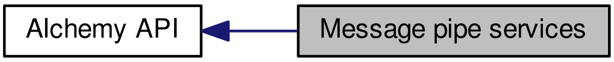
mutex	The descriptor address of the mutex to unbind from.

This routine releases a previous binding to a mutex. After this call has returned, the descriptor is no more valid for referencing this object.

5.81 Message pipe services

Two-way communication channel between Xenomai & Linux domains.

Collaboration diagram for Message pipe services:



Macros

- #define P_MINOR_AUTO XNPIPE_MINOR_AUTO

  Creation flags.
- #define P_URGENT 0x1

  Operation flags.

Functions

- int rt_pipe_create (RT_PIPE *pipe, const char *name, int minor, size_t poolsize)

  Create a message pipe.
- int rt_pipe_delete (RT_PIPE *pipe)

  Delete a message pipe.
- ssize_t rt_pipe_read_timed (RT_PIPE *pipe, void *buf, size_t size, const struct timespec *abs_-timeout)

  Read a message from a pipe.
- static ssize_t rt_pipe_read_until (RT_PIPE *pipe, void *buf, size_t size, RTIME timeout)

  Read from a pipe (with absolute scalar timeout).
- static ssize_t rt_pipe_read (RT_PIPE *pipe, void *buf, size_t size, RTIME timeout)

  Read from a pipe (with relative scalar timeout).
- ssize_t rt_pipe_write (RT_PIPE *pipe, const void *buf, size_t size, int mode)

  Write a message to a pipe.
- int rt_pipe_bind (RT_PIPE *pipe, const char *name, RTIME timeout)

  Bind to a message pipe.
- int rt_pipe_unbind (RT_PIPE *pipe)

  Unbind from a message pipe.

5.81.1 Detailed Description

Two-way communication channel between Xenomai & Linux domains. A message pipe is a two-way communication channel between Xenomai threads and normal Linux threads using regular file I/O operations on a pseudo-device. Pipes can be operated in a message-oriented fashion so that message boundaries are preserved, and also in byte-oriented streaming mode from real-time to normal Linux threads for optimal throughput.

Xenomai threads open their side of the pipe using the rt_pipe_create() service; regular Linux threads do the same by opening one of the /dev/rtpN special devices, where N is the minor number agreed upon between both ends of each pipe.

In addition, named pipes are available through the registry support, which automatically creates a symbolic link from entries under /proc/xenomai/registry/rtipc/xddp/ to the corresponding special device file.

Note

Alchemy's message pipes are fully based on the XDDP protocol available from the RTDM/ipc driver.

5.81.2 Macro Definition Documentation

5.81.2.1 #define P_MINOR_AUTO XNPIPE_MINOR_AUTO

Creation flags.

5.81.2.2 #define P_URGENT 0x1

Operation flags.

Referenced by rt_pipe_write().

5.81.3 Function Documentation

5.81.3.1 int rt_pipe_bind (RT_PIPE * pipe, const char * name, RTIME timeout)

Bind to a message pipe.

This routine creates a new descriptor to refer to an existing message pipe identified by its symbolic name. If the object does not exist on entry, the caller may block until a pipe of the given name is created.

Parameters

pipe	The address of a pipe descriptor filled in by the operation. Contents of this memory is undefined upon failure.
name	A valid NULL-terminated name which identifies the pipe to bind to. This string should match the object name argument passed to rt_pipe_create().
timeout	The number of clock ticks to wait for the registration to occur (see note). Passing TM_INFINITE causes the caller to block indefinitely until the object is registered. Passing TM_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task before the retrieval has completed.
- -EWOULDBLOCK is returned if *timeout* is equal to TM_NONBLOCK and the searched object is not registered on entry.
- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *timeout* equals TM_NONBLOCK.

Note

The *timeout* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.81.3.2 int rt_pipe_create (RT_PIPE * pipe, const char * name, int minor, size_t poolsize)

Create a message pipe.

This service opens a bi-directional communication channel for exchanging messages between Xenomai threads and regular Linux threads. Pipes natively preserve message boundaries, but can also be used in byte-oriented streaming mode from Xenomai to Linux.

rt_pipe_create() always returns immediately, even if no thread has opened the associated special device file yet. On the contrary, the non real-time side could block upon attempt to open the special device file until rt_pipe_create() is issued on the same pipe from a Xenomai thread, unless O_NONBLOCK was given to the open(2) system call.

Parameters

pipe	The address of a pipe descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the pipe. When non-NULL and non-empty, a copy of this string is used for indexing the created pipe into the object registry.

Named pipes are supported through the use of the registry. Passing a valid *name* parameter when creating a message pipe causes a symbolic link to be created from /proc/xenomai/registry/rtipc/xddp/*name* to the associated special device (i.e. /dev/rtp*), so that the specific *minor* information does not need to be known from those processes for opening the proper device file. In such a case, both sides of the pipe only need to agree upon a symbolic name to refer to the same data path, which is especially useful whenever the *minor* number is picked up dynamically using an adaptive algorithm, such as passing P_MINOR_AUTO as *minor* value.

Parameters

minor	The minor number of the device associated with the pipe. Passing P_MINOR_AUTO causes the minor number to be auto-allocated. In such a case, a symbolic link will be automatically created from /proc/xenomai/registry/rtipc/xddp/*name* to the allocated pipe device entry. Valid minor numbers range from 0 to CONFIG_XENO_OPT_PIPE_NRDEV-1.
poolsize	Specifies the size of a dedicated buffer pool for the pipe. Passing 0 means that all message allocations for this pipe are performed on the Cobalt core heap.

Returns

Zero is returned upon success. Otherwise:

- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the pipe.
- -ENODEV is returned if *minor* is different from P_MINOR_AUTO and is not a valid minor number.
- -EEXIST is returned if the *name* is conflicting with an already registered pipe.
- -EBUSY is returned if *minor* is already open.

- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

References IPCPROTO_XDDP, rtipc_port_label::label, sockaddr_ipc::sipc_family, sockaddr_ipc::sipc_-port, XDDP_BUFSZ, XDDP_LABEL, and XDDP_POOLSZ.

5.81.3.3 int rt_pipe_delete (RT_PIPE * pipe)

Delete a message pipe.

This routine deletes a pipe object previously created by a call to rt_pipe_create(). All resources attached to that pipe are automatically released, all pending data is flushed.

Parameters

pipe	The descriptor address of the deleted pipe.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *pipe* is not a valid pipe descriptor.
- -EIDRM is returned if *pipe* is a closed pipe descriptor.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

5.81.3.4 ssize_t rt_pipe_read (RT_PIPE * pipe, void * buf, size_t size, RTIME timeout) [inline], [static]

Read from a pipe (with relative scalar timeout).

This routine is a variant of rt_queue_read_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

pipe	The descriptor address of the message pipe to read from.
buf	A pointer to a memory area which will be written upon success with the message received.
size	The count of bytes from the received message to read up into *buf*. If *size* is lower than the actual message size, -ENOBUFS is returned since the incompletely received message would be lost. If *size* is zero, this call returns immediately with no other action.
timeout	A delay expressed in clock ticks.

References rt_pipe_read_timed().

5.81.3.5 ssize_t rt_pipe_read_timed (RT_PIPE * pipe, void * buf, size_t size, const struct timespec * abs_timeout)

Read a message from a pipe.

This service reads the next available message from a given pipe.

Parameters

pipe	The descriptor address of the message pipe to read from.
buf	A pointer to a memory area which will be written upon success with the message received.
size	The count of bytes from the received message to read up into *buf*. If *size* is lower than the actual message size, -ENOBUFS is returned since the incompletely received message would be lost. If *size* is zero, this call returns immediately with no other action.
abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for a message to be available from the pipe (see note). Passing NULL causes the caller to block indefinitely until a message is available. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return immediately without blocking in case no message is available.

Returns

The number of bytes available from the received message is returned upon success. Otherwise:

- -ETIMEDOUT is returned if *abs_timeout* is reached before a message arrives.
- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } and no message is immediately available on entry to the call.
- -EINTR is returned if rt_task_unblock() was called for the current task before a message was available.
- -EINVAL is returned if *pipe* is not a valid pipe descriptor.
- -EIDRM is returned if *pipe* is deleted while the caller was waiting for a message. In such event, *pipe* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 }.

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

References SO_RCVTIMEO.

Referenced by rt_pipe_read(), and rt_pipe_read_until().

5.81.3.6 ssize_t rt_pipe_read_until (RT_PIPE * pipe, void * buf, size_t size, RTIME abs_timeout) [inline], [static]

Read from a pipe (with absolute scalar timeout).

This routine is a variant of rt_queue_read_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

pipe	The descriptor address of the message pipe to read from.
buf	A pointer to a memory area which will be written upon success with the message received.
size	The count of bytes from the received message to read up into *buf*. If *size* is lower than the actual message size, -ENOBUFS is returned since the incompletely received message would be lost. If *size* is zero, this call returns immediately with no other action.
abs_timeout	An absolute date expressed in clock ticks.

References rt_pipe_read_timed().

5.81.3.7 int rt_pipe_unbind (RT_PIPE * pipe)

Unbind from a message pipe.

Parameters

pipe	The descriptor address of the pipe to unbind from.

This routine releases a previous binding to a message pipe. After this call has returned, the descriptor is no more valid for referencing this object.

5.81.3.8 ssize_t rt_pipe_write (RT_PIPE * pipe, const void * buf, size_t size, int mode)

Write a message to a pipe.

This service writes a complete message to be received from the associated special device. rt_pipe_write() always preserves message boundaries, which means that all data sent through a single call of this service will be gathered in a single read(2) operation from the special device.

This service differs from rt_pipe_send() in that it accepts a pointer to the raw data to be sent, instead of a canned message buffer.

Parameters

pipe	The descriptor address of the pipe to write to.
buf	The address of the first data byte to send. The data will be copied to an internal buffer before transmission.
size	The size in bytes of the message (payload data only). Zero is a valid value, in which case the service returns immediately without sending any message.
mode	A set of flags affecting the operation:

- P_URGENT causes the message to be prepended to the output queue, ensuring a LIFO ordering.
- P_NORMAL causes the message to be appended to the output queue, ensuring a FIFO ordering.

Returns

Upon success, this service returns *size*. Upon error, one of the following error codes is returned:

- -EINVAL is returned if *mode* is invalid or *pipe* is not a pipe descriptor.
- -ENOMEM is returned if not enough buffer space is available to complete the operation.
- -EIDRM is returned if *pipe* is a closed pipe descriptor.

Note

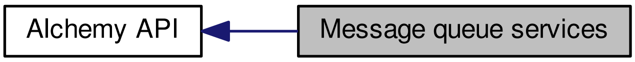
Writing data to a pipe before any peer has opened the associated special device is allowed. The output will be buffered until then, only restricted by the available memory in the associated buffer pool (see rt_pipe_create()).

References P_URGENT.

5.82 Message queue services

real-time IPC mechanism for sending messages of arbitrary size

Collaboration diagram for Message queue services:



Data Structures

- struct RT_QUEUE_INFO

  Queue status descriptor.

Macros

- #define Q_PRIO 0x1 /* Pend by task priority order. */

  Creation flags.
- #define Q_SHARED 0x0

  Deprecated, compat only.

Functions

- int rt_queue_create (RT_QUEUE *queue, const char *name, size_t poolsize, size_t qlimit, int mode)

  Create a message queue.
- int rt_queue_delete (RT_QUEUE *queue)

  Delete a message queue.
- void * rt_queue_alloc (RT_QUEUE *queue, size_t size)

  Allocate a message buffer.
- int rt_queue_free (RT_QUEUE *queue, void *buf)

  Free a message buffer.
- int rt_queue_send (RT_QUEUE *queue, const void *buf, size_t size, int mode)

  Send a message to a queue.
- ssize_t rt_queue_receive_timed (RT_QUEUE *queue, void **bufp, const struct timespec *abs_timeout)

  Receive a message from a queue (with absolute timeout date).
- static ssize_t rt_queue_receive_until (RT_QUEUE *queue, void **bufp, RTIME timeout)

  Receive from a queue (with absolute scalar timeout).
- static ssize_t rt_queue_receive (RT_QUEUE *queue, void **bufp, RTIME timeout)

  Receive from a queue (with relative scalar timeout).
- ssize_t rt_queue_read_timed (RT_QUEUE *queue, void *buf, size_t size, const struct timespec *abs_timeout)

  Read from a queue.

- static ssize_t rt_queue_read_until (RT_QUEUE *queue, void *buf, size_t size, RTIME timeout)
  Read from a queue (with absolute scalar timeout).
- static ssize_t rt_queue_read (RT_QUEUE *queue, void *buf, size_t size, RTIME timeout)
  Read from a queue (with relative scalar timeout).
- int rt_queue_flush (RT_QUEUE *queue)
  Flush pending messages from a queue.
- int rt_queue_inquire (RT_QUEUE *queue, RT_QUEUE_INFO *info)
  Query queue status.
- int rt_queue_bind (RT_QUEUE *queue, const char *name, RTIME timeout)
  Bind to a message queue.
- int rt_queue_unbind (RT_QUEUE *queue)
  Unbind from a message queue.

5.82.1 Detailed Description

real-time IPC mechanism for sending messages of arbitrary size Message queueing is a method by which real-time tasks can exchange or pass data through a Xenomai-managed queue of messages. Messages can vary in length and be assigned different types or usages. A message queue can be created by one task and used by multiple tasks that send and/or receive messages to the queue.

5.82.2 Macro Definition Documentation

5.82.2.1 #define Q_PRIO 0x1 /* Pend by task priority order. */

Creation flags.

Referenced by rt_queue_create().

5.82.2.2 #define Q_SHARED 0x0

Deprecated, compat only.

5.82.3 Function Documentation

5.82.3.1 void * rt_queue_alloc (RT_QUEUE * q, size_t size)

Allocate a message buffer.

This service allocates a message buffer from the queue's internal pool. This buffer can be filled in with payload information, prior enqueuing it by a call to rt_queue_send(). When used in pair, these services provide a zero-copy interface for sending messages.

Parameters

q	The descriptor address of the queue to allocate a buffer from.
size	The requested size in bytes of the buffer. Zero is an acceptable value, which means that the message conveys no payload; in this case, the receiver will get a zero-sized message.

Returns

The address of the allocated buffer upon success, or NULL if the call fails.

Valid calling context: any.

5.82.3.2 int rt_queue_bind (RT_QUEUE * q, const char * name, RTIME timeout)

Bind to a message queue.

This routine creates a new descriptor to refer to an existing message queue identified by its symbolic name. If the object does not exist on entry, the caller may block until a queue of the given name is created.

Parameters

q	The address of a queue descriptor filled in by the operation. Contents of this memory is undefined upon failure.
name	A valid NULL-terminated name which identifies the queue to bind to. This string should match the object name argument passed to rt_queue_create().
timeout	The number of clock ticks to wait for the registration to occur (see note). Passing TM_INFINITE causes the caller to block indefinitely until the object is registered. Passing TM_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task before the retrieval has completed.
- -EWOULDBLOCK is returned if *timeout* is equal to TM_NONBLOCK and the searched object is not registered on entry.
- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *timeout* equals TM_NONBLOCK.

Note

The *timeout* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.82.3.3 int rt_queue_create (RT_QUEUE * q, const char * name, size_t poolsize, size_t qlimit, int mode)

Create a message queue.

Create a message queue object which allows multiple tasks to exchange data through the use of variable-sized messages. A message queue is created empty.

This service needs the special character device /dev/rtheap (10,254) when called from user-space tasks.

Parameters

q	The address of a queue descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the queue. When non-NULL and non-empty, a copy of this string is used for indexing the created queue into the object registry.
poolsize	The size (in bytes) of the message buffer pool to be pre-allocated for holding messages. Message buffers will be claimed and released to this pool. The buffer pool memory cannot be extended. See note.
qlimit	This parameter allows to limit the maximum number of messages which can be queued at any point in time, sending to a full queue begets an error. The special value Q_UNLIMITED can be passed to disable the limit check.
mode	The queue creation mode. The following flags can be OR'ed into this bitmask, each of them affecting the new queue:

- Q_FIFO makes tasks pend in FIFO order on the queue for consuming messages.
- Q_PRIO makes tasks pend in priority order on the queue.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *mode* is invalid or *poolsize* is zero.
- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the queue.
- -EEXIST is returned if the *name* is conflicting with an already registered queue.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

Queues can be shared by multiple processes which belong to the same Xenomai session.
Each message pending into the queue consumes four long words plus the actual payload size, aligned to the next long word boundary. e.g. a 6 byte message on a 32 bit platform would require 24 bytes of storage into the pool.

When *qlimit* is given (i.e. different from Q_UNLIMITED), this overhead is accounted for automatically, so that *qlimit* messages of *poolsize* / *qlimit* bytes can be stored into the pool concurrently. Otherwise, *poolsize* is increased by 5% internally to cope with such overhead.

References Q_PRIO.

5.82.3.4 int rt_queue_delete (RT_QUEUE * q)

Delete a message queue.

This routine deletes a queue object previously created by a call to rt_queue_create(). All resources attached to that queue are automatically released, including all pending messages.

Parameters

q	The descriptor address of the deleted queue.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *q* is not a valid queue descriptor.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

5.82.3.5 int rt_queue_flush (RT_QUEUE * q)

Flush pending messages from a queue.

This routine flushes all messages currently pending in a queue, releasing all message buffers appropriately.

Parameters

q	The descriptor address of the queue to flush.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *q* is not a valid queue descriptor.

Valid calling context: any.

5.82.3.6 int rt_queue_free (RT_QUEUE * q, void * buf)

Free a message buffer.

This service releases a message buffer to the queue's internal pool.

Parameters

q	The descriptor address of the queue to release a buffer to.
buf	The address of the message buffer to free. Even zero-sized messages carrying no payload data must be freed, since they are assigned a valid memory space to store internal information.

Returns

Zero is returned upon success, or -EINVAL if *buf* is not a valid message buffer previously allocated by the rt_queue_alloc() service, or the caller did not get ownership of the message through a successful return from rt_queue_receive().

Valid calling context: any.

5.82.3.7 int rt_queue_inquire (RT_QUEUE * q, **RT_QUEUE_INFO** * info)

Query queue status.

This routine returns the status information about the specified queue.

Parameters

q	The descriptor address of the queue to get the status of.
info	A pointer to the returnbuffer" to copy the information to.

Returns

Zero is returned and status information is written to the structure pointed at by *info* upon success. Otherwise:

- -EINVAL is returned if *q* is not a valid queue descriptor.

Valid calling context: any.

References RT_QUEUE_INFO::mode, RT_QUEUE_INFO::name, RT_QUEUE_INFO::nmessages, RT-_QUEUE_INFO::nwaiters, RT_QUEUE_INFO::poolsize, RT_QUEUE_INFO::qlimit, and RT_QUEUE_I-NFO::usedmem.

5.82.3.8 ssize_t rt_queue_read (RT_QUEUE * q, void * buf, size_t size, RTIME timeout) [inline], [static]

Read from a queue (with relative scalar timeout).

This routine is a variant of rt_queue_read_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

q	The descriptor address of the message queue to read from.
buf	A pointer to a memory area which will be written upon success with the received message payload.
size	The length in bytes of the memory area pointed to by *buf*.
timeout	A delay expressed in clock ticks.

References rt_queue_read_timed().

5.82.3.9 ssize_t rt_queue_read_timed (RT_QUEUE * q, void * buf, size_t size, const struct timespec * abs_timeout)

Read from a queue.

This service reads the next available message from a given queue.

Parameters

q	The descriptor address of the message queue to read from.
buf	A pointer to a memory area which will be written upon success with the received message payload. The internal message buffer conveying the data is automatically freed by this call.
size	The length in bytes of the memory area pointed to by *buf*. Messages larger than *size* are truncated appropriately.
abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for a message to be available from the queue (see note). Passing NULL causes the caller to block indefinitely until a message is available. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return immediately without blocking in case no message is available.

Returns

The number of bytes copied to *buf* is returned upon success. Zero is a possible value corresponding to a zero-sized message passed to rt_queue_send() or rt_queue_write(). Otherwise:

- -ETIMEDOUT is returned if *abs_timeout* is reached before a message arrives.
- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } and no message is immediately available on entry to the call.
- -EINTR is returned if rt_task_unblock() was called for the current task before a message was available.
- -EINVAL is returned if *q* is not a valid queue descriptor.
- -EIDRM is returned if *q* is deleted while the caller was waiting for a message. In such event, *q* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 }.

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_queue_read(), and rt_queue_read_until().

5.82.3.10 ssize_t rt_queue_read_until (RT_QUEUE * q, void * buf, size_t size, RTIME abs_timeout) [inline], [static]

Read from a queue (with absolute scalar timeout).

This routine is a variant of rt_queue_read_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

q	The descriptor address of the message queue to read from.
buf	A pointer to a memory area which will be written upon success with the received message payload.
size	The length in bytes of the memory area pointed to by *buf*.
abs_timeout	An absolute date expressed in clock ticks.

References rt_queue_read_timed().

5.82.3.11 ssize_t rt_queue_receive (RT_QUEUE * q, void ** bufp, RTIME timeout) [inline], [static]

Receive from a queue (with relative scalar timeout).

This routine is a variant of rt_queue_receive_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

q	The descriptor address of the message queue to receive from.
bufp	A pointer to a memory location which will be written with the address of the received message.
timeout	A delay expressed in clock ticks.

References rt_queue_receive_timed().

5.82.3.12 ssize_t rt_queue_receive_timed (RT_QUEUE * q, void ** bufp, const struct timespec * abs_timeout)

Receive a message from a queue (with absolute timeout date).

This service receives the next available message from a given queue.

Parameters

q	The descriptor address of the message queue to receive from.
bufp	A pointer to a memory location which will be written with the address of the received message, upon success. Once consumed, the message space should be freed using rt_queue_free().
abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for a message to be available from the queue (see note). Passing NULL causes the caller to block indefinitely until a message is available. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return immediately without blocking in case no message is available.

Returns

The number of bytes available from the received message is returned upon success. Zero is a possible value corresponding to a zero-sized message passed to rt_queue_send() or rt_queue_-write(). Otherwise:

- -ETIMEDOUT is returned if *abs_timeout* is reached before a message arrives.
- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } and no message is immediately available on entry to the call.
- -EINTR is returned if rt_task_unblock() was called for the current task before a message was available.
- -EINVAL is returned if *q* is not a valid queue descriptor.
- -EIDRM is returned if *q* is deleted while the caller was waiting for a message. In such event, *q* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } .

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_queue_receive(), and rt_queue_receive_until().

5.82.3.13 ssize_t rt_queue_receive_until (RT_QUEUE * q, void ** bufp, RTIME abs_timeout) [inline], [static]

Receive from a queue (with absolute scalar timeout).

This routine is a variant of rt_queue_receive_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

q	The descriptor address of the message queue to receive from.
bufp	A pointer to a memory location which will be written with the address of the received message.
abs_timeout	An absolute date expressed in clock ticks.

References rt_queue_receive_timed().

5.82.3.14 int rt_queue_send (RT_QUEUE * q, const void * buf, size_t size, int mode)

Send a message to a queue.

This service sends a complete message to a given queue. The message must have been allocated by a previous call to rt_queue_alloc().

Parameters

q	The descriptor address of the message queue to send to.
buf	The address of the message buffer to be sent. The message buffer must have been allocated using the rt_queue_alloc() service. Once passed to rt_queue_send(), the memory pointed to by *buf* is no more under the control of the sender and thus should not be referenced by it anymore; deallocation of this memory must be handled on the receiving side.
size	The actual size in bytes of the message, which may be lower than the allocated size for the buffer obtained from rt_queue_alloc(). Zero is a valid value, in which case an empty message will be sent.
mode	A set of flags affecting the operation:

- Q_URGENT causes the message to be prepended to the message queue, ensuring a LIFO ordering.
- Q_NORMAL causes the message to be appended to the message queue, ensuring a FIFO ordering.
- Q_BROADCAST causes the message to be sent to all tasks currently waiting for messages. The message is not copied; a reference count is maintained instead so that the message will remain valid until the last receiver releases its own reference using rt_queue_free(), after which the message space will be returned to the queue's internal pool.

Returns

Upon success, this service returns the number of receivers which got awaken as a result of the operation. If zero is returned, no task was waiting on the receiving side of the queue, and the message has been enqueued. Upon error, one of the following error codes is returned:

- -EINVAL is returned if *q* is not a message queue descriptor, *mode* is invalid, or *buf* is NULL.
- -ENOMEM is returned if queuing the message would exceed the limit defined for the queue at creation.

Valid calling context: any.

5.82.3.15 int rt_queue_unbind (RT_QUEUE * q)

Unbind from a message queue.

Parameters

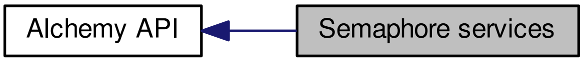
q	The descriptor address of the queue to unbind from.

This routine releases a previous binding to a message queue. After this call has returned, the descriptor is no more valid for referencing this object.

5.83 Semaphore services

Counting semaphore IPC mechanism.

Collaboration diagram for Semaphore services:



Data Structures

- struct RT_SEM_INFO

  Semaphore status descriptor.

Macros

- #define S_PRIO 0x1 /* Pend by task priority order. */

  Creation flags.

Functions

- int rt_sem_create (RT_SEM *sem, const char *name, unsigned long icount, int mode)

  Create a counting semaphore.
- int rt_sem_delete (RT_SEM *sem)

  Delete a semaphore.
- int rt_sem_p_timed (RT_SEM *sem, const struct timespec *abs_timeout)

  Pend on a semaphore.
- static int rt_sem_p_until (RT_SEM *sem, RTIME timeout)

  Pend on a semaphore (with absolute scalar timeout).
- static int rt_sem_p (RT_SEM *sem, RTIME timeout)

  Pend on a semaphore (with relative scalar timeout).
- int rt_sem_v (RT_SEM *sem)

  Signal a semaphore.
- int rt_sem_broadcast (RT_SEM *sem)

  Broadcast a semaphore.
- int rt_sem_inquire (RT_SEM *sem, RT_SEM_INFO *info)

  Query semaphore status.
- int rt_sem_bind (RT_SEM *sem, const char *name, RTIME timeout)

  Bind to a semaphore.
- int rt_sem_unbind (RT_SEM *sem)

  Unbind from a semaphore.

5.83.1 Detailed Description

Counting semaphore IPC mechanism. A counting semaphore is a synchronization object for controlling the concurrency level allowed in accessing a resource from multiple real-time tasks, based on the value of a count variable accessed atomically. The semaphore is used through the P ("Proberen", from the Dutch "test and decrement") and V ("Verhogen", increment) operations. The P operation decrements the semaphore count by one if non-zero, or waits until a V operation is issued by another task. Conversely, the V operation releases a resource by incrementing the count by one, unblocking the heading task waiting on the P operation if any. Waiting on a semaphore may cause a priority inversion.

If no more than a single resource is made available at any point in time, the semaphore enforces mutual exclusion and thus can be used to serialize access to a critical section. However, mutexes should be used instead in order to prevent priority inversions, based on the priority inheritance protocol.

5.83.2 Macro Definition Documentation

5.83.2.1 #define S_PRIO 0x1 /* Pend by task priority order. */

Creation flags.

Referenced by rt_sem_create().

5.83.3 Function Documentation

5.83.3.1 int rt_sem_bind (RT_SEM * sem, const char * name, RTIME timeout)

Bind to a semaphore.

This routine creates a new descriptor to refer to an existing semaphore identified by its symbolic name. If the object does not exist on entry, the caller may block until a semaphore of the given name is created.

Parameters

sem	The address of a semaphore descriptor filled in by the operation. Contents of this memory is undefined upon failure.
name	A valid NULL-terminated name which identifies the semaphore to bind to. This string should match the object name argument passed to rt_sem_create().
timeout	The number of clock ticks to wait for the registration to occur (see note). Passing TM_INFINITE causes the caller to block indefinitely until the object is registered. Passing TM_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task before the retrieval has completed.
- -EWOULDBLOCK is returned if *timeout* is equal to TM_NONBLOCK and the searched object is not registered on entry.
- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads

- Any other context if *timeout* equals TM_NONBLOCK.

Note

The *timeout* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.83.3.2 int rt_sem_broadcast (RT_SEM * sem)

Broadcast a semaphore.

All tasks currently waiting on the semaphore are immediately unblocked. The semaphore count is set to zero.

Parameters

sem	The descriptor address of the semaphore to broadcast.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *sem* is not a valid semaphore descriptor.

Valid calling context: any.

5.83.3.3 int rt_sem_create (RT_SEM * sem, const char * name, unsigned long icount, int mode)

Create a counting semaphore.

Parameters

sem	The address of a semaphore descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the semaphore. When non-NULL and non-empty, a copy of this string is used for indexing the created semaphore into the object registry.
icount	The initial value of the counting semaphore.
mode	The semaphore creation mode. The following flags can be OR'ed into this bitmask:

- S_FIFO makes tasks pend in FIFO order on the semaphore.
- S_PRIO makes tasks pend in priority order on the semaphore.
- S_PULSE causes the semaphore to behave in "pulse" mode. In this mode, the V (signal) operation attempts to release a single waiter each time it is called, without incrementing the semaphore count, even if no waiter is pending. For this reason, the semaphore count in pulse mode remains zero.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *icount* is non-zero and S_PULSE is set in *mode*, or *mode* is otherwise invalid.
- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the semaphore.

- -EEXIST is returned if the *name* is conflicting with an already registered semaphore.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

Semaphores can be shared by multiple processes which belong to the same Xenomai session.

References S_PRIO.

5.83.3.4 int rt_sem_delete (RT_SEM * sem)

Delete a semaphore.

This routine deletes a semaphore previously created by a call to rt_sem_create().

Parameters

sem	The descriptor address of the deleted object.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *sem* is not a valid semaphore descriptor.
- -EPERM is returned if this service was called from an asynchronous context.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

5.83.3.5 int rt_sem_inquire (RT_SEM * sem, **RT_SEM_INFO** * info)

Query semaphore status.

This routine returns the status information about the specified semaphore.

Parameters

sem	The descriptor address of the semaphore to get the status of.
info	A pointer to the returnbuffer" to copy the information to.

Returns

Zero is returned and status information is written to the structure pointed at by *info* upon success. Otherwise:

- -EINVAL is returned if *sem* is not a valid semaphore descriptor.

Valid calling context: any.

References RT_SEM_INFO::count, RT_SEM_INFO::name, and RT_SEM_INFO::nwaiters.

5.83.3.6 int rt_sem_p (RT_SEM * sem, RTIME timeout) [inline], [static]

Pend on a semaphore (with relative scalar timeout).

This routine is a variant of rt_sem_p_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

sem	The descriptor address of the semaphore to wait on.
timeout	A delay expressed in clock ticks.

References rt_sem_p_timed().

5.83.3.7 int rt_sem_p_timed (RT_SEM * sem, const struct timespec * abs_timeout)

Pend on a semaphore.

Test and decrement the semaphore count. If the semaphore value is greater than zero, it is decremented by one and the service immediately returns to the caller. Otherwise, the caller is blocked until the semaphore is either signaled or destroyed, unless a non-blocking operation was required.

Parameters

sem	The descriptor address of the semaphore to wait on.
abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for the request to be satisfied (see note). Passing NULL causes the caller to block indefinitely until the request is satisfied. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return without blocking in case the request cannot be satisfied immediately.

Returns

Zero is returned upon success. Otherwise:

- -ETIMEDOUT is returned if *abs_timeout* is reached before the request is satisfied.
- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } and the semaphore count is zero on entry.
- -EINTR is returned if rt_task_unblock() was called for the current task before the request is satisfied.
- -EINVAL is returned if *sem* is not a valid semaphore descriptor.
- -EIDRM is returned if *sem* is deleted while the caller was sleeping on it. In such a case, *sem* is no more valid upon return of this service.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 }.

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_sem_p(), and rt_sem_p_until().

5.83.3.8 int rt_sem_p_until (RT_SEM * sem, RTIME abs_timeout) [inline], [static]

Pend on a semaphore (with absolute scalar timeout).

This routine is a variant of rt_sem_p_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

sem	The descriptor address of the semaphore to wait on.
abs_timeout	An absolute date expressed in clock ticks.

References rt_sem_p_timed().

5.83.3.9 int rt_sem_unbind (RT_SEM * sem)

Unbind from a semaphore.

Parameters

sem	The descriptor address of the semaphore to unbind from.

This routine releases a previous binding to a semaphore. After this call has returned, the descriptor is no more valid for referencing this object.

5.83.3.10 int rt_sem_v (RT_SEM * sem)

Signal a semaphore.

If the semaphore is pended, the task heading the wait queue is immediately unblocked. Otherwise, the semaphore count is incremented by one, unless the semaphore is used in "pulse" mode (see rt_sem_create()).

Parameters

sem	The descriptor address of the semaphore to signal.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *sem* is not a valid semaphore descriptor.

Valid calling context: any.

5.84 Task management services

Services dealing with preemptive multi-tasking.

Collaboration diagram for Task management services:

Data Structures

- struct RT_TASK_INFO

  Task status descriptor.

Macros

- #define T_LOPRIO 0

  Task priorities.
- #define T_LOCK __THREAD_M_LOCK

  Task mode bits.
- #define T_WARNSW __THREAD_M_WARNSW

  Cobalt only, nop over Mercury.
- #define T_FPU 0x0

  Deprecated, compat only.

Functions

- int rt_task_create (RT_TASK *task, const char *name, int stksize, int prio, int mode)

  Create a real-time task.
- int rt_task_delete (RT_TASK *task)

  Delete a real-time task.
- int rt_task_set_affinity (RT_TASK *task, const cpu_set_t *cpus)

  Set CPU affinity of real-time task.
- int rt_task_start (RT_TASK *task, void(*entry)(void *arg), void *arg)

  Start a real-time task.
- int rt_task_spawn (RT_TASK *task, const char *name, int stksize, int prio, int mode, void(*entry)(void *arg), void *arg)

  Create and start a real-time task.
- int rt_task_shadow (RT_TASK *task, const char *name, int prio, int mode)

  Turn caller into a real-time task.
- int rt_task_join (RT_TASK *task)

  Wait on the termination of a real-time task.
- int rt_task_set_periodic (RT_TASK *task, RTIME idate, RTIME period)

  Make a real-time task periodic.

- int rt_task_wait_period (unsigned long *overruns_r)

  Wait for the next periodic release point.
- int rt_task_sleep (RTIME delay)

  Delay the current real-time task (with relative delay).
- int rt_task_sleep_until (RTIME date)

  Delay the current real-time task (with absolute wakeup date).
- int rt_task_same (RT_TASK *task1, RT_TASK *task2)

  Compare real-time task descriptors.
- int rt_task_suspend (RT_TASK *task)

  Suspend a real-time task.
- int rt_task_resume (RT_TASK *task)

  Resume a real-time task.
- RT_TASK * rt_task_self (void)

  Retrieve the current task descriptor.
- int rt_task_set_priority (RT_TASK *task, int prio)

  Change the base priority of a real-time task.
- int rt_task_set_mode (int clrmask, int setmask, int *mode_r)

  Change the current task mode.
- int rt_task_yield (void)

  Manual round-robin.
- int rt_task_unblock (RT_TASK *task)

  Unblock a real-time task.
- int rt_task_slice (RT_TASK *task, RTIME quantum)

  Set a task's round-robin quantum.
- int rt_task_inquire (RT_TASK *task, RT_TASK_INFO *info)

  Retrieve information about a real-time task.
- ssize_t rt_task_send_timed (RT_TASK *task, RT_TASK_MCB *mcb_s, RT_TASK_MCB *mcb_r, const struct timespec *abs_timeout)

  Send a message to a real-time task.
- static ssize_t rt_task_send_until (RT_TASK *task, RT_TASK_MCB *mcb_s, RT_TASK_MCB *mcb_r, RTIME timeout)

  Send a message to a real-time task (with absolute scalar timeout).
- static ssize_t rt_task_send (RT_TASK *task, RT_TASK_MCB *mcb_s, RT_TASK_MCB *mcb_r, RTIME timeout)

  Send a message to a real-time task (with relative scalar timeout).
- int rt_task_receive_timed (RT_TASK_MCB *mcb_r, const struct timespec *abs_timeout)

  Receive a message from a real-time task.
- static int rt_task_receive_until (RT_TASK_MCB *mcb_r, RTIME timeout)

  Receive a message from a real-time task (with absolute scalar timeout).
- static int rt_task_receive (RT_TASK_MCB *mcb_r, RTIME timeout)

  Receive a message from a real-time task (with relative scalar timeout).
- int rt_task_reply (int flowid, RT_TASK_MCB *mcb_s)

  Reply to a remote task message.
- int rt_task_bind (RT_TASK *task, const char *name, RTIME timeout)

  Bind to a task.
- int rt_task_unbind (RT_TASK *task)

  Unbind from a task.

5.84.1 Detailed Description

Services dealing with preemptive multi-tasking. Each Alchemy task is an independent portion of the overall application code embodied in a C procedure, which executes on its own stack context.

5.84.2 Macro Definition Documentation

5.84.2.1 #define T_FPU 0x0

Deprecated, compat only.

5.84.2.2 #define T_LOCK __THREAD_M_LOCK

Task mode bits.

Referenced by rt_task_create(), rt_task_set_mode(), and rt_task_shadow().

5.84.2.3 #define T_LOPRIO 0

Task priorities.

5.84.2.4 #define T_WARNSW __THREAD_M_WARNSW

Cobalt only, nop over Mercury.

Referenced by rt_task_create(), rt_task_set_mode(), and rt_task_shadow().

5.84.3 Function Documentation

5.84.3.1 int rt_task_bind (RT_TASK * task, const char * name, RTIME timeout)

Bind to a task.

This routine creates a new descriptor to refer to an existing Alchemy task identified by its symbolic name. If the object does not exist on entry, the caller may block until a task of the given name is created.

Parameters

task	The address of a task descriptor filled in by the operation. Contents of this memory is undefined upon failure.
name	A valid NULL-terminated name which identifies the task to bind to. This string should match the object name argument passed to rt_task_create(), or rt_task_shadow().
timeout	The number of clock ticks to wait for the registration to occur (see note). Passing TM_INFINITE causes the caller to block indefinitely until the object is registered. Passing TM_NONBLOCK causes the service to return immediately without waiting if the object is not registered on entry.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task before the retrieval has completed.
- -EWOULDBLOCK is returned if *timeout* is equal to TM_NONBLOCK and the searched object is not registered on entry.
- -ETIMEDOUT is returned if the object cannot be retrieved within the specified amount of time.
- -EPERM is returned if this service should block, but was not called from a Xenomai thread.

Valid calling contexts:

- Xenomai threads
- Any other context if *timeout* equals TM_NONBLOCK.

Note

The *timeout* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.84.3.2 int rt_task_create (RT_TASK * task, const char * name, int stksize, int prio, int mode)

Create a real-time task.

This service creates a task with access to the full set of Xenomai real-time services. If *prio* is non-zero, the new task belongs to Xenomai's real-time FIFO scheduling class, aka SCHED_FIFO. If *prio* is zero, the task belongs to the regular SCHED_OTHER class.

Creating tasks with zero priority is useful for running non real-time processes which may invoke blocking real-time services, such as pending on a semaphore, reading from a message queue or a buffer, and so on.

Once created, the task is left dormant until it is actually started by rt_task_start().

Parameters

task	The address of a task descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the task. When non-NULL and non-empty, a copy of this string is used for indexing the created task into the object registry.
stksize	The size of the stack (in bytes) for the new task. If zero is passed, a system-dependent default size will be substituted.
prio	The base priority of the new task. This value must be in the [0 .. 99] range, where 0 is the lowest effective priority.
mode	The task creation mode. The following flags can be OR'ed into this bitmask:

- T_JOINABLE allows another task to wait on the termination of the new task. rt_task_join() shall be called for this task to clean up any resources after its termination.
- T_LOCK causes the new task to lock the scheduler prior to entering the user routine specified by rt_task_start(). A call to rt_task_set_mode() from the new task is required to drop this lock.
- When running over the Cobalt core, T_WARNSW causes the SIGXCPU signal to be sent to the current task whenever it switches to the secondary mode. This feature is useful to detect unwanted migrations to the Linux domain. This flag has no effect over the Mercury core.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if either *prio*, *mode* or *stksize* are invalid.
- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the task.
- -EEXIST is returned if the *name* is conflicting with an already registered task.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Core specifics:

When running over the Cobalt core:

- calling rt_task_create() causes SCHED_FIFO tasks to switch to secondary mode.
- members of Xenomai's SCHED_FIFO class running in the primary domain have utmost priority over all Linux activities in the system, including Linux interrupt handlers.

When running over the Mercury core, the new task belongs to the regular POSIX SCHED_FIFO class.

Note

Tasks can be referred to from multiple processes which all belong to the same Xenomai session.

Examples:

cross-link.c.

References T_LOCK, and T_WARNSW.

Referenced by rt_task_spawn().

5.84.3.3 int rt_task_delete (RT_TASK * task)

Delete a real-time task.

This call terminates a task previously created by rt_task_create().

Tasks created with the T_JOINABLE flag shall be joined by a subsequent call to rt_task_join() once successfully deleted, to reclaim all resources.

Parameters

task	The descriptor address of the deleted task, or NULL for self-deletion.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is not a valid task descriptor.
- -EPERM is returned if *task* is NULL and this service was called from an invalid context. In addition, this error is always raised when this service is called from asynchronous context, such as a timer/alarm handler.

Valid calling context:

- Alchemy tasks only if *task* is NULL, any thread context otherwise.

Examples:

cross-link.c.

5.84.3.4 int rt_task_inquire (RT_TASK * task, **RT_TASK_INFO** * info)

Retrieve information about a real-time task.

Return various information about an Alchemy task. This service may also be used to probe for task existence.

Parameters

task	The descriptor address of the task. If *task* is NULL, information about the current task is returned.
info	The address of a structure the task information will be written to. Passing NULL is valid, in which case the system is only probed for existence of the specified task.

Returns

Zero is returned if the task exists. In addition, if *info* is non-NULL, it is filled in with task information.

- -EINVAL is returned if *task* is not a valid task descriptor, or if *prio* is invalid.
- -EPERM is returned if *task* is NULL and this service was called from an invalid context.

Valid calling context:

- Alchemy tasks if *task* is NULL, any otherwise.

References RT_TASK_INFO::name, RT_TASK_INFO::pid, RT_TASK_INFO::prio, and RT_TASK_INFO::stat.

5.84.3.5 int rt_task_join (RT_TASK * task)

Wait on the termination of a real-time task.

This service blocks the caller in non-real-time context until *task* has terminated. All resources are released after successful completion of this service.

The specified task must have been created by the same process that wants to join it, and the T_JOINABLE mode flag must have been set on creation to rt_task_create().

Tasks created with the T_JOINABLE flag shall be joined by a subsequent call to rt_task_join() once successfully deleted, to reclaim all resources.

Parameters

task	The descriptor address of the task to join.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is not a valid task descriptor.
- -EINVAL is returned if the task was not created with T_JOINABLE set or some other task is already waiting on the termination.
- -EDEADLK is returned if *task* refers to the caller.
- -ESRCH is returned if *task* no longer exists or refers to task created by a different process.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

After successful completion of this service, it is neither required nor valid to additionally invoke rt_task_delete() on the same task.

5.84.3.6 ssize_t rt_task_receive (RT_TASK_MCB * mcb_r, RTIME timeout) [inline], [static]

Receive a message from a real-time task (with relative scalar timeout).

This routine is a variant of rt_task_receive_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

mcb_r	The address of a message control block referring to the receive message area.
timeout	A delay expressed in clock ticks.

References rt_task_receive_timed().

5.84.3.7 int rt_task_receive_timed (RT_TASK_MCB * mcb_r, const struct timespec * abs_timeout)

Receive a message from a real-time task.

This service is part of the synchronous message passing support available to Alchemy tasks. The caller receives a variable-sized message from another task. The sender is blocked until the caller invokes rt_task_reply() to finish the transaction.

A basic message control block is used to store the location and size of the data area to receive from the client, in addition to a user-defined operation code.

Parameters

mcb_r	The address of a message control block referring to the receive message area. The fields from this control block should be set as follows:

- mcb_r->data should contain the address of a buffer large enough to collect the data sent by the remote task;
- mcb_r->size should contain the size in bytes of the buffer space pointed at by mcb_r->data. If mcb_r->size is lower than the actual size of the received message, no data copy takes place and -ENOBUFS is returned to the caller. See note.

Upon return, mcb_r->opcode will contain the operation code sent from the remote task using rt_task_send().

Parameters

abs_timeout	The number of clock ticks to wait for receiving a message (see note). Passing NULL causes the caller to block indefinitely until a remote task eventually sends a message. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return immediately without waiting if no remote task is currently waiting for sending a message.

Returns

A strictly positive value is returned upon success, representing a flow identifier for the opening transaction; this token should be passed to rt_task_reply(), in order to send back a reply to and unblock the remote task appropriately. Otherwise:

- -EPERM is returned if this service was called from an invalid context.
- -EINTR is returned if rt_task_unblock() was called for the current task before a message was received.
- -ENOBUFS is returned if *mcb_r* does not point at a message area large enough to collect the remote task's message.
- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } and no remote task is currently waiting for sending a message to the caller.

- -ETIMEDOUT is returned if no message was received within the *timeout*.

Valid calling context:

- Alchemy tasks

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_task_receive(), and rt_task_receive_until().

5.84.3.8 ssize_t rt_task_receive_until (RT_TASK_MCB * mcb_r, RTIME abs_timeout) [inline], [static]

Receive a message from a real-time task (with absolute scalar timeout).

This routine is a variant of rt_task_receive_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

mcb_r	The address of a message control block referring to the receive message area.
abs_timeout	An absolute date expressed in clock ticks.

References rt_task_receive_timed().

5.84.3.9 int rt_task_reply (int flowid, RT_TASK_MCB * mcb_s)

Reply to a remote task message.

This service is part of the synchronous message passing support available to Alchemy tasks. The caller sends a variable-sized message back to a remote task, in response to this task's initial message received by a call to rt_task_receive(). As a consequence of calling rt_task_reply(), the remote task will be unblocked from the rt_task_send() service.

A basic message control block is used to store the location and size of the data area to send back, in addition to a user-defined status code.

Parameters

flowid	The flow identifier returned by a previous call to rt_task_receive() which uniquely identifies the current transaction.
mcb_s	The address of an optional message control block referring to the message to be sent back. If *mcb_s* is NULL, the remote will be unblocked without getting any reply data. When *mcb_s* is valid, the fields from this control block should be set as follows:

- mcb_s->data should contain the address of the payload data to send to the remote task.
- mcb_s->size should contain the size in bytes of the payload data pointed at by mcb_s->data. Zero is a legitimate value, and indicates that no payload data will be transferred. In the latter case, mcb_s->data will be ignored.
- mcb_s->opcode is an opaque status code carried during the message transfer the caller can fill with any appropriate value. It will be made available "as is" to the remote task into the status code field by the rt_task_send() service. If *mcb_s* is NULL, Zero will be returned to the remote task into the status code field.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *flowid* is invalid.
- -ENXIO is returned if *flowid* does not match the expected identifier returned from the latest call of the current task to rt_task_receive(), or if the remote task stopped waiting for the reply in the meantime (e.g. the remote could have been deleted or forcibly unblocked).
- -ENOBUFS is returned if the reply data referred to by *mcb_s* is larger than the reply area mentioned by the remote task when calling rt_task_send(). In such a case, the remote task also receives -E-NOBUFS on return from rt_task_send().
- -EPERM is returned if this service was called from an invalid context.

Valid calling context:

- Alchemy tasks

5.84.3.10 int rt_task_resume (RT_TASK * task)

Resume a real-time task.

Forcibly resume the execution of a task which was previously suspended by a call to rt_task_suspend(), if the suspend nesting count decrements to zero.

Parameters

task	The descriptor address of the task to resume.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is not a valid task descriptor.

Valid calling context: any.

Note

Blocked and suspended task states are cumulative. Therefore, resuming a task currently waiting on a synchronization object (e.g. semaphore, queue) does not make it eligible for scheduling until the awaited resource is eventually acquired, or a timeout elapses.

5.84.3.11 int rt_task_same (RT_TASK * task1, RT_TASK * task2)

Compare real-time task descriptors.

This predicate returns true if *task1* and *task2* refer to the same task.

Parameters

task1	First task descriptor to compare.

task2	Second task descriptor to compare.

Returns

A non-zero value is returned if both descriptors refer to the same task, zero otherwise.

5.84.3.12 RT_TASK * rt_task_self (void)

Retrieve the current task descriptor.

Return the address of the current Alchemy task descriptor.

Returns

The address of the task descriptor referring to the current Alchemy task is returned upon success, or NULL if not called from an valid task context.

Valid calling context:

- Alchemy tasks.

5.84.3.13 ssize_t rt_task_send (RT_TASK * task, RT_TASK_MCB * mcb_s, RT_TASK_MCB * mcb_r, RTIME timeout) [inline], [static]

Send a message to a real-time task (with relative scalar timeout).

This routine is a variant of rt_task_send_timed() accepting a relative timeout specification expressed as a scalar value.

Parameters

task	The descriptor address of the recipient task.
mcb_s	The address of the message control block referring to the message to be sent.
mcb_r	The address of an optional message control block referring to the reply message area.
timeout	A delay expressed in clock ticks.

References rt_task_send_timed().

5.84.3.14 ssize_t rt_task_send_timed (RT_TASK * task, RT_TASK_MCB * mcb_s, RT_TASK_MCB * mcb_r, const struct timespec * abs_timeout)

Send a message to a real-time task.

This service is part of the synchronous message passing support available to Alchemy tasks. The caller sends a variable-sized message to another task, waiting for the remote to receive the initial message by a call to rt_task_receive(), then reply to it using rt_task_reply().

A basic message control block is used to store the location and size of the data area to send or retrieve upon reply, in addition to a user-defined operation code.

Parameters

task	The descriptor address of the recipient task.
mcb_s	The address of the message control block referring to the message to be sent. The fields from this control block should be set as follows:

- mcb_s->data should contain the address of the payload data to send to the remote task.
- mcb_s->size should contain the size in bytes of the payload data pointed at by mcb_s->data. Zero is a legitimate value, and indicates that no payload data will be transferred. In the latter case, mcb_s->data will be ignored.
- mcb_s->opcode is an opaque operation code carried during the message transfer, the caller can fill with any appropriate value. It will be made available "as is" to the remote task into the operation code field by the rt_task_receive() service.

Parameters

mcb_r	The address of an optional message control block referring to the reply message area. If *mcb_r* is NULL and a reply is sent back by the remote task, the reply message will be discarded, and -ENOBUFS will be returned to the caller. When *mcb_r* is valid, the fields from this control block should be set as follows:

- mcb_r->data should contain the address of a buffer large enough to collect the reply data from the remote task.
- mcb_r->size should contain the size in bytes of the buffer space pointed at by mcb_r->data. If mcb_r->size is lower than the actual size of the reply message, no data copy takes place and -ENOBUFS is returned to the caller.

Upon return, mcb_r->opcode will contain the status code sent back from the remote task using rt_task_reply(), or zero if unspecified.

Parameters

abs_timeout	An absolute date expressed in clock ticks, specifying a time limit to wait for the recipient task to reply to the initial message (see note). Passing NULL causes the caller to block indefinitely until a reply is received. Passing { .tv_sec = 0, .tv_nsec = 0 } causes the service to return without blocking in case the recipient task is not waiting for messages at the time of the call.

Returns

A positive value is returned upon success, representing the length (in bytes) of the reply message returned by the remote task. Zero is a success status, meaning either that *mcb_r* was NULL on entry, or that no actual message was passed to the remote call to rt_task_reply(). Otherwise:

- -EINVAL is returned if *task* is not a valid task descriptor.
- -EPERM is returned if this service was called from an invalid context.
- -ENOBUFS is returned if *mcb_r* does not point at a message area large enough to collect the remote task's reply. This includes the case where *mcb_r* is NULL on entry, despite the remote task attempts to send a reply message.
- -EWOULDBLOCK is returned if *abs_timeout* is { .tv_sec = 0, .tv_nsec = 0 } and the recipient *task* is not currently waiting for a message on the rt_task_receive() service.
- -EIDRM is returned if *task* has been deleted while waiting for a reply.
- -EINTR is returned if rt_task_unblock() was called for the current task before any reply was received from the recipient *task*.

Valid calling context:

- Xenomai threads

Note

abs_timeout is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Referenced by rt_task_send(), and rt_task_send_until().

5.84.3.15 ssize_t rt_task_send_until (RT_TASK * task, RT_TASK_MCB * mcb_s, RT_TASK_MCB * mcb_r, RTIME abs_timeout) [inline], [static]

Send a message to a real-time task (with absolute scalar timeout).

This routine is a variant of rt_task_send_timed() accepting an absolute timeout specification expressed as a scalar value.

Parameters

task	The descriptor address of the recipient task.
mcb_s	The address of the message control block referring to the message to be sent.
mcb_r	The address of an optional message control block referring to the reply message area.
abs_timeout	An absolute date expressed in clock ticks.

References rt_task_send_timed().

5.84.3.16 int rt_task_set_affinity (RT_TASK * task, const cpu_set_t * cpus)

Set CPU affinity of real-time task.

This calls makes *task* affine to the set of CPUs defined by *cpus*.

Parameters

task	The descriptor address of the task. If *task* is NULL, the CPU affinity of the current task is changed.
cpus	The set of CPUs *task* should be affine to.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is NULL but the caller is not a Xenomai task, or if *task* is non-NULL but not a valid task descriptor.
- -EINVAL is returned if *cpus* contains no processors that are currently physically on the system and permitted to the process according to any restrictions that may be imposed by the "cpuset" mechanism described in cpuset(7).

Valid calling context:

- Alchemy tasks if *task* is NULL, any otherwise.

5.84.3.17 int rt_task_set_mode (int clrmask, int setmask, int * mode_r)

Change the current task mode.

Each Alchemy task has a set of internal flags determining several operating conditions. rt_task_set_mode() takes a bitmask of mode bits to clear for disabling the corresponding modes for the current task, and another one to set for enabling them. The mode bits which were previously in effect before the change can be returned upon request.

The following bits can be part of the bitmask:

- T_LOCK causes the current task to lock the scheduler on the current CPU, preventing all further involuntary task switches on this CPU. Clearing this bit unlocks the scheduler.
- Only when running over the Cobalt core:
  - T_WARNSW causes the SIGXCPU signal to be sent to the current task whenever it switches to the secondary mode. This feature is useful to detect unwanted migrations to the Linux domain.
  - T_CONFORMING can be passed in *setmask* to switch the current Alchemy task to its preferred runtime mode. The only meaningful use of this switch is to force a real-time task back to primary mode (see note). Any other use leads to a nop.

These two last flags have no effect over the Mercury core, and are simply ignored.

Parameters

clrmask	A bitmask of mode bits to clear for the current task, before *setmask* is applied. Zero is an acceptable value which leads to a no-op.
setmask	A bitmask of mode bits to set for the current task. Zero is an acceptable value which leads to a no-op.
mode_r	If non-NULL, *mode_r* must be a pointer to a memory location which will be written upon success with the previous set of active mode bits. If NULL, the previous set of active mode bits will not be returned.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is not a valid task descriptor, or if any bit from *clrmask* or *setmask* is invalid.
- -EPERM is returned if this service was called from an invalid context.

Valid calling context:

- Alchemy tasks.

Note

Forcing the task mode using the T_CONFORMING bit from user code is almost always wrong, since the Xenomai/cobalt core handles mode switches internally when/if required. Most often, manual mode switching from applications introduces useless overhead. This mode bit is part of the API only to cover rare use cases in middleware code based on the Alchemy interface.

References T_LOCK, and T_WARNSW.

5.84.3.18 int rt_task_set_periodic (RT_TASK * task, RTIME idate, RTIME period)

Make a real-time task periodic.

Make a task periodic by programing its first release point and its period in the processor time line. *task* should then call rt_task_wait_period() to sleep until the next periodic release point in the processor timeline is reached.

Parameters

task	The descriptor address of the periodic task. If *task* is NULL, the current task is made periodic. *task* must belong the current process.
idate	The initial (absolute) date of the first release point, expressed in clock ticks (see note). If *idate* is equal to TM_NOW, the current system date is used.
period	The period of the task, expressed in clock ticks (see note). Passing TM_INFINITE stops the task's periodic timer if enabled, then returns successfully.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is NULL but the caller is not a Xenomai task, or if *task* is non-NULL but not a valid task descriptor.
- -ETIMEDOUT is returned if *idate* is different from TM_INFINITE and represents a date in the past.

Valid calling contexts:

- Alchemy tasks if *task* is NULL, any otherwise.

Core specifics:

Over Cobalt, -EINVAL is returned if *period* is different from TM_INFINITE but shorter than the scheduling latency value for the target system, as available from /proc/xenomai/latency.

Note

The *idate* and *period* values are interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Examples:

cross-link.c.

5.84.3.19 int rt_task_set_priority (RT_TASK * task, int prio)

Change the base priority of a real-time task.

The base priority of a task defines the relative importance of the work being done by each task, which gains conrol of the CPU accordingly.

Changing the base priority of a task does not affect the priority boost the target task might have obtained as a consequence of a priority inheritance undergoing.

Parameters

task	The descriptor address of the task to update. If *task* is NULL, the priority of the current task is changed.
prio	The new priority. This value must range from [T_LOPRIO .. T_HIPRIO] (inclusive) where T_LOPRIO is the lowest effective priority.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is not a valid task descriptor, or if *prio* is invalid.
- -EPERM is returned if *task* is NULL and this service was called from an invalid context.

Valid calling context:

- Alchemy tasks if *task* is NULL, any otherwise.

Note

Assigning the same priority to a running or ready task moves it to the end of its priority group, thus causing a manual round-robin.

5.84.3.20 int rt_task_shadow (RT_TASK * task, const char * name, int prio, int mode)

Turn caller into a real-time task.

Extends the calling Linux task with Xenomai capabilities, with access to the full set of Xenomai real-time services. This service is typically used for turning the main() thread of an application process into a Xenomai-enabled task.

If *prio* is non-zero, the new task moves to Xenomai's real-time FIFO scheduling class, aka SCHED_FIFO. If *prio* is zero, the task moves to the regular SCHED_OTHER class.

Running Xenomai tasks with zero priority is useful for running non real-time processes which may invoke blocking real-time services, such as pending on a semaphore, reading from a message queue or a buffer, and so on.

Once shadowed with the Xenomai extension, the calling task returns and resumes execution normally from the call site.

Parameters

task	If non-NULL, the address of a task descriptor which can be later used to identify uniquely the task, upon success of this call. If NULL, no descriptor is returned.
name	An ASCII string standing for the symbolic name of the task. When non-NULL and non-empty, a copy of this string is used for indexing the task into the object registry.
prio	The base priority of the task. This value must be in the [0 .. 99] range, where 0 is the lowest effective priority.
mode	The task shadowing mode. The following flags can be OR'ed into this bitmask:

- T_LOCK causes the current task to lock the scheduler before returning to the caller, preventing all further involuntary task switches on the current CPU. A call to rt_task_set_mode() from the current task is required to drop this lock.
- When running over the Cobalt core, T_WARNSW causes the SIGXCPU signal to be sent to the current task whenever it switches to the secondary mode. This feature is useful to detect unwanted migrations to the Linux domain. This flag has no effect over the Mercury core.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *prio* is invalid.
- -ENOMEM is returned if the system fails to get memory from the main heap in order to create the task extension.
- -EEXIST is returned if the *name* is conflicting with an already registered task.
- -EBUSY is returned if the caller is already mapped to a Xenomai task context.
- -EPERM is returned if this service was called from an invalid context.

Valid calling context:

- Regular POSIX threads

Core specifics:

When running over the Cobalt core:

- the caller always returns from this service in primary mode.

Note

Tasks can be referred to from multiple processes which all belong to the same Xenomai session.

Examples:

rtcanrecv.c, and rtcansend.c.

References T_LOCK, and T_WARNSW.

5.84.3.21 int rt_task_sleep (RTIME delay)

Delay the current real-time task (with relative delay).

This routine is a variant of rt_task_sleep_until() accepting a relative timeout specification.

Parameters

delay	A relative delay expressed in clock ticks (see note). A zero delay causes this service to return immediately to the caller with a success status.

Returns

See rt_task_sleep_until().

Note

The *delay* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Examples:

cross-link.c, and rtcansend.c.

5.84.3.22 int rt_task_sleep_until (RTIME date)

Delay the current real-time task (with absolute wakeup date).

Delay the execution of the calling task until a given date is reached. The caller is put to sleep, and does not consume any CPU time in such a state.

Parameters

date	An absolute date expressed in clock ticks, specifying a wakeup date (see note). As a special case, TM_INFINITE is an acceptable value that causes the caller to block indefinitely, until rt_task_unblock() is called against it. Otherwise, any wake up date in the past causes the task to return immediately.

Returns

Zero is returned upon success. Otherwise:

- -EINTR is returned if rt_task_unblock() was called for the current task.
- -ETIMEDOUT is returned if *date* has already elapsed.
- -EPERM is returned if this service was called from an invalid context.

Valid calling context:

- Xenomai threads

Note

The *date* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.84.3.23 int rt_task_slice (RT_TASK * task, RTIME quantum)

Set a task's round-robin quantum.

Set the time credit allotted to a task undergoing the round-robin scheduling. If *quantum* is non-zero, rt_task_slice() also refills the current quantum for the target task, otherwise, time-slicing is stopped for that task.

In other words, rt_task_slice() should be used to toggle round-robin scheduling for an Alchemy task.

Parameters

task	The descriptor address of the task to update. If *task* is NULL, the time credit of the current task is changed. *task* must belong to the current process.
quantum	The round-robin quantum for the task expressed in clock ticks (see note).

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is not a valid task descriptor, or if *prio* is invalid.
- -EPERM is returned if *task* is NULL and this service was called from an invalid context.

Valid calling context:

- Alchemy tasks if *task* is NULL, any otherwise.

Note

The *quantum* value is interpreted as a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

5.84.3.24 int rt_task_spawn (RT_TASK * task, const char * name, int stksize, int prio, int mode, void(*)(void *arg) entry, void * arg)

Create and start a real-time task.

This service spawns a task by combining calls to rt_task_create() and rt_task_start() for the new task.

Parameters

task	The address of a task descriptor which can be later used to identify uniquely the created object, upon success of this call.
name	An ASCII string standing for the symbolic name of the task. When non-NULL and non-empty, a copy of this string is used for indexing the created task into the object registry.
stksize	The size of the stack (in bytes) for the new task. If zero is passed, a system-dependent default size will be substituted.
prio	The base priority of the new task. This value must be in the [0 .. 99] range, where 0 is the lowest effective priority.
mode	The task creation mode. See rt_task_create().
entry	The address of the task entry point.
arg	A user-defined opaque argument *entry* will receive.

Returns

See rt_task_create().

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Core specifics: see rt_task_create().

References rt_task_create(), and rt_task_start().

5.84.3.25 int rt_task_start (RT_TASK * task, void(*)(void *arg) entry, void * arg)

Start a real-time task.

This call starts execution of a task previously created by rt_task_create(). This service causes the started task to leave the initial dormant state.

Parameters

task	The descriptor address of the task to be started.
entry	The address of the task entry point.
arg	A user-defined opaque argument *entry* will receive.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is not a valid task descriptor.

Valid calling context: any.

Note

Starting an already started task leads to a nop, returning a success status.

Examples:

cross-link.c.

Referenced by rt_task_spawn().

5.84.3.26 int rt_task_suspend (RT_TASK * task)

Suspend a real-time task.

Forcibly suspend the execution of a task. This task will not be eligible for scheduling until it is explicitly resumed by a call to rt_task_resume(). In other words, the suspended state caused by a call to rt_task_suspend() is cumulative with respect to the delayed and blocked states caused by other services, and is managed separately from them.

A nesting count is maintained so that rt_task_suspend() and rt_task_resume() must be used in pairs.

Receiving a Linux signal causes the suspended task to resume immediately.

Parameters

task	The descriptor address of the task to suspend. If *task* is NULL, the current task is suspended.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is NULL but the caller is not a Xenomai task, or if *task* is non-NULL but not a valid task descriptor.
- -EINTR is returned if a Linux signal has been received by the caller if suspended.
- -EPERM is returned if *task* is NULL and this service was called from an invalid context.

Valid calling context:

- Alchemy tasks if *task* is NULL, any otherwise.

Note

Blocked and suspended task states are cumulative. Therefore, suspending a task currently waiting on a synchronization object (e.g. semaphore, queue) holds its execution until it is resumed, despite the awaited resource may have been acquired, or a timeout has elapsed in the meantime.

5.84.3.27 int rt_task_unbind (RT_TASK * task)

Unbind from a task.

Parameters

task	The descriptor address of the task to unbind from.

This routine releases a previous binding to an Alchemy task. After this call has returned, the descriptor is no more valid for referencing this object.

5.84.3.28 int rt_task_unblock (RT_TASK * task)

Unblock a real-time task.

Break the task out of any wait it is currently in. This call clears all delay and/or resource wait condition for the target task.

However, rt_task_unblock() does not resume a task which has been forcibly suspended by a previous call to rt_task_suspend(). If all suspensive conditions are gone, the task becomes eligible anew for scheduling.

Parameters

task	The descriptor address of the task to unblock.

Returns

Zero is returned upon success. Otherwise:

- -EINVAL is returned if *task* is not a valid task descriptor.

Valid calling context: any.

5.84.3.29 int rt_task_wait_period (unsigned long * overruns_r)

Wait for the next periodic release point.

Delay the current task until the next periodic release point is reached. The periodic timer should have been previously started for *task* by a call to rt_task_set_periodic().

Parameters

overruns_r	If non-NULL, *overruns_r* shall be a pointer to a memory location which will be written with the count of pending overruns. This value is written to only when rt_task_wait_period() returns -ETIMEDOUT or success. The memory location remains unmodified otherwise. If NULL, this count will not be returned.

Returns

Zero is returned upon success. If *overruns_r* is non-NULL, zero is written to the pointed memory location. Otherwise:

- -EWOULDBLOCK is returned if rt_task_set_periodic() was not called for the current task.
- -EINTR is returned if rt_task_unblock() was called for the waiting task before the next periodic release point was reached. In this case, the overrun counter is also cleared.
- -ETIMEDOUT is returned if a timer overrun occurred, which indicates that a previous release point was missed by the calling task. If *overruns_r* is non-NULL, the count of pending overruns is written to the pointed memory location.
- -EPERM is returned if this service was called from an invalid context.

Valid calling context:

- Alchemy tasks.

Note

If the current release point has already been reached at the time of the call, the current task immediately returns from this service with no delay.

Examples:

cross-link.c.

5.84.3.30 int rt_task_yield (void)

Manual round-robin.

Move the current task to the end of its priority group, so that the next equal-priority task in ready state is switched in.

Returns

Zero is returned upon success. Otherwise:

- -EPERM is returned if this service was called from an invalid context.

Valid calling context:

- Xenomai threads.

5.85 Timer management services

Services for reading and spinning on the hardware timer.

Collaboration diagram for Timer management services:

Data Structures

- struct rt_timer_info

    Timer status descriptor.

Typedefs

- typedef struct rt_timer_info RT_TIMER_INFO

    Timer status descriptor.

Functions

- SRTIME rt_timer_ns2ticks (SRTIME ns)

    Convert nanoseconds to Alchemy clock ticks.
- SRTIME rt_timer_ticks2ns (SRTIME ticks)

    Convert Alchemy clock ticks to nanoseconds.
- RTIME rt_timer_read (void)

    Return the current system time.
- int rt_timer_inquire (RT_TIMER_INFO *info)

    Inquire about the Xenomai core timer.
- void rt_timer_spin (RTIME ns)

    Busy wait burning CPU cycles.

5.85.1 Detailed Description

Services for reading and spinning on the hardware timer.

5.85.2 Typedef Documentation

5.85.2.1 typedef struct **rt_timer_info RT_TIMER_INFO**

Timer status descriptor.

This structure reports various static and runtime information about the timer, returned by a call to rt_-timer_inquire().

5.85.3 Function Documentation

5.85.3.1 int rt_timer_inquire (**RT_TIMER_INFO** * info)

Inquire about the Xenomai core timer.

Return status information of the Xenomai core timer.

Parameters

info	The address of a structure the status data will be written to.

Returns

This service always returns 0.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

References rt_timer_info::date, rt_timer_info::period, and rt_timer_info::tsc.

5.85.3.2 SRTIME rt_timer_ns2ticks (SRTIME ns)

Convert nanoseconds to Alchemy clock ticks.

Convert a count of nanoseconds to Alchemy clock ticks. This routine operates on signed nanosecond values. This is the converse call to rt_timer_ticks2ns().

Parameters

ns	The count of nanoseconds to convert.

Returns

The corresponding value expressed in clock ticks of the Alchemy clock. The resolution of the Alchemy clock can be set using the –alchemy-clock-resolution option when starting the application process (defaults to 1 nanosecond).

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Examples:

cross-link.c, and rtcansend.c.

5.85.3.3 RTIME rt_timer_read (void)

Return the current system time.

Return the current time maintained by the Xenomai core clock.

Returns

The current time expressed in clock ticks (see note).

Valid calling context:

- Regular POSIX threads
- Xenomai threads

Note

The *time* value is a multiple of the Alchemy clock resolution (see –alchemy-clock-resolution option, defaults to 1 nanosecond).

Examples:

cross-link.c.

5.85.3.4 void rt_timer_spin (RTIME ns)

Busy wait burning CPU cycles.

Enter a busy waiting loop for a count of nanoseconds.

Since this service is always called with interrupts enabled, the caller might be preempted by other real-time activities, therefore the actual delay might be longer than specified.

Parameters

ns	The time to wait expressed in nanoseconds.

Valid calling context:

- Regular POSIX threads
- Xenomai threads

5.85.3.5 SRTIME rt_timer_ticks2ns (SRTIME ns)

Convert Alchemy clock ticks to nanoseconds.

Convert a count of Alchemy clock ticks to nanoseconds. This routine operates on signed nanosecond values. This is the converse call to rt_timer_ns2ticks().

Parameters

ns	The count of nanoseconds to convert.

Returns

The corresponding value expressed in nanoseconds. The resolution of the Alchemy clock can be set using the –alchemy-clock-resolution option when starting the application process (defaults to 1 nanosecond).

Valid calling context:

- Regular POSIX threads
- Xenomai threads

5.86 VxWorks® emulator

A VxWorks® emulation library on top of Xenomai.

A VxWorks® emulation library on top of Xenomai. The emulator mimicks the behavior described in the public documentation of the WIND 5.x API for the following class of services:

- taskLib, taskInfoLib, taskHookLib,
- semLib, msgQLib, wdLib, memPartLib
- intLib, tickLib, sysLib (partial)
- errnoLib, lstLib, kernelLib (partial)

5.87 pSOS® emulator

A pSOS® emulation library on top of Xenomai.

A pSOS® emulation library on top of Xenomai. The emulator mimicks the behavior described in the public documentation of the pSOS 2.x API for the following class of services:

- Tasks, Events, Queues, Semaphores
- Partitions, Regions, Timers

Chapter 6

Data Structure Documentation

6.1 a4l_channel Struct Reference

Structure describing some channel's characteristics.

Data Fields

- unsigned long flags
- unsigned long nb_bits

6.1.1 Detailed Description

Structure describing some channel's characteristics.

6.1.2 Field Documentation

6.1.2.1 unsigned long a4l_channel::flags

Channel flags to define the reference.

6.1.2.2 unsigned long a4l_channel::nb_bits

Channel resolution.

Referenced by a4l_get_chan().

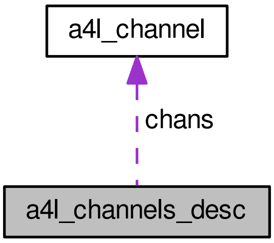
The documentation for this struct was generated from the following file:

- include/cobalt/kernel/rtdm/analogy/channel_range.h

6.2 a4l_channels_desc Struct Reference

Structure describing a channels set.

Collaboration diagram for a4l_channels_desc:



Data Fields

- unsigned long mode
- unsigned long length
- struct a4l_channel chans []

6.2.1 Detailed Description

Structure describing a channels set.

6.2.2 Field Documentation

6.2.2.1 struct **a4l_channel** a4l_channels_desc::chans[]

Channels tab

Referenced by a4l_get_chan().

6.2.2.2 unsigned long a4l_channels_desc::length

Channels count

6.2.2.3 unsigned long a4l_channels_desc::mode

Declaration mode (global or per channel)

Referenced by a4l_get_chan().

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/rtdm/analogy/channel_range.h

6.3 a4l_cmd_desc Struct Reference

Structure describing the asynchronous instruction.

Data Fields

- unsigned char idx_subd

  Subdevice to which the command will be applied.
- unsigned long flags

  Command flags.
- unsigned int start_src

  Start trigger type.
- unsigned int start_arg

  Start trigger argument.
- unsigned int scan_begin_src

  Scan begin trigger type.
- unsigned int scan_begin_arg

  Scan begin trigger argument.
- unsigned int convert_src

  Convert trigger type.
- unsigned int convert_arg

  Convert trigger argument.
- unsigned int scan_end_src

  Scan end trigger type.
- unsigned int scan_end_arg

  Scan end trigger argument.
- unsigned int stop_src

  Stop trigger type.
- unsigned int stop_arg

  Stop trigger argument.
- unsigned char nb_chan

  Count of channels related with the command.
- unsigned int * chan_descs

  Tab containing channels descriptors.
- unsigned int data_len

  Driver specific buffer size.
- sampl_t * data

  Driver specific buffer pointer.

6.3.1 Detailed Description

Structure describing the asynchronous instruction.

See Also

a4l_snd_command()

6.3.2 Field Documentation

6.3.2.1 unsigned char a4l_cmd_desc::idx_subd

Subdevice to which the command will be applied.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/analogy.h

6.4 a4l_descriptor Struct Reference

Structure containing device-information useful to users.

Data Fields

- char board_name [A4L_NAMELEN]

  Board name.
- int nb_subd

  Subdevices count.
- int idx_read_subd

  Input subdevice index.
- int idx_write_subd

  Output subdevice index.
- int fd

  File descriptor.
- unsigned int magic

  Opaque field.
- int sbsize

  Data buffer size.
- void * sbdata

  Data buffer pointer.

6.4.1 Detailed Description

Structure containing device-information useful to users.

See Also

a4l_get_desc()

6.4.2 Field Documentation

6.4.2.1 char a4l_descriptor::board_name[A4L_NAMELEN]

Board name.

6.4.2.2 int a4l_descriptor::fd

File descriptor.

Referenced by a4l_async_read(), a4l_async_write(), a4l_close(), a4l_fill_desc(), a4l_get_bufsize(), a4l_mark_bufrw(), a4l_mmap(), a4l_open(), a4l_poll(), a4l_set_bufsize(), a4l_snd_cancel(), a4l_snd_command(), a4l_snd_insn(), and a4l_snd_insnlist().

6.4.2.3 int a4l_descriptor::idx_read_subd

Input subdevice index.

Referenced by a4l_async_read().

6.4.2.4 int a4l_descriptor::idx_write_subd

Output subdevice index.

Referenced by a4l_async_write().

6.4.2.5 unsigned int a4l_descriptor::magic

Opaque field.

Referenced by a4l_fill_desc(), a4l_find_range(), a4l_get_chinfo(), a4l_get_rnginfo(), a4l_get_subdinfo(), and a4l_sys_desc().

6.4.2.6 int a4l_descriptor::nb_subd

Subdevices count.

Referenced by a4l_get_chinfo(), a4l_get_rnginfo(), and a4l_get_subdinfo().

6.4.2.7 void* a4l_descriptor::sbdata

Data buffer pointer.

Referenced by a4l_get_chinfo(), a4l_get_rnginfo(), a4l_get_subdinfo(), and a4l_sys_desc().

6.4.2.8 int a4l_descriptor::sbsize

Data buffer size.

Referenced by a4l_sys_desc().

The documentation for this struct was generated from the following file:

- include/rtdm/analogy.h

6.5 a4l_driver Struct Reference

Structure containing driver declaration data.

Data Fields

- struct list_head list

    List stuff.
- struct module * owner

    Pointer to module containing the code.
- unsigned int flags

    Type / status driver's flags.
- char * board_name

    Board name.
- int privdata_size

    Size of the driver's private data.
- int(* attach)(struct a4l_device *, struct a4l_link_desc *)

Attach procedure.

- int(* detach)(struct a4l_device *)

  Detach procedure.

6.5.1 Detailed Description

Structure containing driver declaration data.

See Also

rt_task_inquire()

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/rtdm/analogy/driver.h

6.6 a4l_instruction Struct Reference

Structure describing the synchronous instruction.

Data Fields

- unsigned int type

  Instruction type.
- unsigned int idx_subd

  Subdevice to which the instruction will be applied.
- unsigned int chan_desc

  Channel descriptor.
- unsigned int data_size

  Size of the intruction data.
- void * data

  Instruction data.

6.6.1 Detailed Description

Structure describing the synchronous instruction.

See Also

a4l_snd_insn()

6.6.2 Field Documentation

6.6.2.1 unsigned int a4l_instruction::idx_subd

Subdevice to which the instruction will be applied.

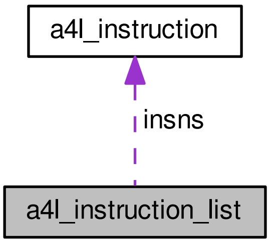
The documentation for this struct was generated from the following file:

- include/rtdm/uapi/analogy.h

6.7 a4l_instruction_list Struct Reference

Structure describing the list of synchronous instructions.

Collaboration diagram for a4l_instruction_list:



Data Fields

- unsigned int count

    Instructions count.
- a4l_insn_t * insns

    Tab containing the instructions pointers.

6.7.1 Detailed Description

Structure describing the list of synchronous instructions.

See Also

a4l_snd_insnlist()

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/analogy.h

6.8 a4l_range Struct Reference

Structure describing a (unique) range.

Data Fields

- long min
- long max
- unsigned long flags

6.8.1 Detailed Description

Structure describing a (unique) range.

6.8.2 Field Documentation

6.8.2.1 unsigned long a4l_range::flags

Range flags (unit, etc.)

6.8.2.2 long a4l_range::max

Maximal falue

6.8.2.3 long a4l_range::min

Minimal value

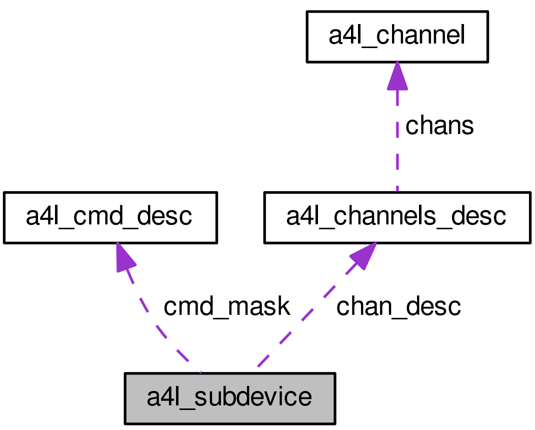
The documentation for this struct was generated from the following file:

- include/cobalt/kernel/rtdm/analogy/channel_range.h

6.9 a4l_subdevice Struct Reference

Structure describing the subdevice.

Collaboration diagram for a4l_subdevice:



Data Fields

- struct list_head list

List stuff.
- struct a4l_device * dev

  Containing device.
- unsigned int idx

  Subdevice index.
- struct a4l_buffer * buf

  Linked buffer.
- unsigned long status

  Subdevice's status.
- unsigned long flags

  Type flags.
- struct a4l_channels_desc * chan_desc

  Tab of channels descriptors pointers.
- struct a4l_rngdesc * rng_desc

  Tab of ranges descriptors pointers.
- struct a4l_cmd_desc * cmd_mask

  Command capabilities mask.
- int(* insn_read)(struct a4l_subdevice *, struct a4l_kernel_instruction *)

  Callback for the instruction "read".
- int(* insn_write)(struct a4l_subdevice *, struct a4l_kernel_instruction *)

  Callback for the instruction "write".
- int(* insn_bits)(struct a4l_subdevice *, struct a4l_kernel_instruction *)

  Callback for the instruction "bits".
- int(* insn_config)(struct a4l_subdevice *, struct a4l_kernel_instruction *)

  Callback for the configuration instruction.
- int(* do_cmd)(struct a4l_subdevice *, struct a4l_cmd_desc *)

  Callback for command handling.
- int(* do_cmdtest)(struct a4l_subdevice *, struct a4l_cmd_desc *)

  Callback for command checking.
- void(* cancel)(struct a4l_subdevice *)

  Callback for asynchronous transfer cancellation.
- void(* munge)(struct a4l_subdevice *, void *, unsigned long)

  Callback for munge operation.
- int(* trigger)(struct a4l_subdevice *, lsampl_t)

  Callback for trigger operation.
- char priv [0]

  Private data.

6.9.1 Detailed Description

Structure describing the subdevice.

See Also

a4l_add_subd()

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/rtdm/analogy/subdevice.h

6.10 atomic_long_t Struct Reference

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6.10.1 Detailed Description

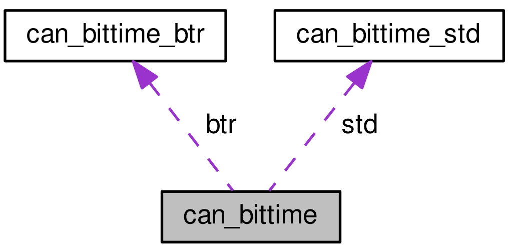
The documentation for this struct was generated from the following file:

- include/nocore/atomic.h

6.11 can_bittime Struct Reference

Custom CAN bit-time definition.

Collaboration diagram for can_bittime:



Data Fields

- can_bittime_type_t type

  Type of bit-time definition.
- struct can_bittime_std std

  Standard bit-time.
- struct can_bittime_btr btr

  Hardware-spcific BTR bit-time.

6.11.1 Detailed Description

Custom CAN bit-time definition.

Examples:

rtcanconfig.c.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/can.h

6.12 can_bittime_btr Struct Reference

Hardware-specific BTR bit-times.

Data Fields

- uint8_t btr0

  Bus timing register 0.
- uint8_t btr1

  Bus timing register 1.

6.12.1 Detailed Description

Hardware-specific BTR bit-times.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/can.h

6.13 can_bittime_std Struct Reference

Standard bit-time parameters according to Bosch.

Data Fields

- uint32_t brp

  Baud rate prescaler.
- uint8_t prop_seg

  from 1 to 8
- uint8_t phase_seg1

  from 1 to 8
- uint8_t phase_seg2

  from 1 to 8
- uint8_t sjw:7

  from 1 to 4
- uint8_t sam:1

  1 - enable triple sampling

6.13.1 Detailed Description

Standard bit-time parameters according to Bosch.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/can.h

6.14 can_filter Struct Reference

Filter for reception of CAN messages.

Data Fields

- uint32_t can_id

  CAN ID which must match with incoming IDs after passing the mask.
- uint32_t can_mask

  Mask which is applied to incoming IDs.

6.14.1 Detailed Description

Filter for reception of CAN messages.

This filter works as follows: A received CAN ID is AND'ed bitwise with `can_mask` and then compared to `can_id`. This also includes the CAN_EFF_FLAG and CAN_RTR_FLAG of CAN_xxx_FLAG. If this comparison is true, the message will be received by the socket. The logic can be inverted with the `can_id` flag CAN_INV_FILTER :

```
if (can_id & CAN_INV_FILTER) {
   if ((received_can_id & can_mask) != (can_id & ~CAN_INV_FILTER))
      accept-message;
} else {
   if ((received_can_id & can_mask) == can_id)
      accept-message;
}
```

Multiple filters can be arranged in a filter list and set with Sockopts. If one of these filters matches a CAN ID upon reception of a CAN frame, this frame is accepted.

Examples:

can-rtt.c, and rtcanrecv.c.

6.14.2 Field Documentation

6.14.2.1 uint32_t can_filter::can_id

CAN ID which must match with incoming IDs after passing the mask.

The filter logic can be inverted with the flag CAN_INV_FILTER.

Examples:

rtcanrecv.c.

6.14.2.2 uint32_t can_filter::can_mask

Mask which is applied to incoming IDs.

See CAN ID masks if exactly one CAN ID should come through.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/can.h

6.15 can_frame Struct Reference

Raw CAN frame.

Public Member Functions

- uint8_t data[8] __attribute__ ((aligned(8)))
  Payload data bytes.

Data Fields

- can_id_t can_id
  CAN ID of the frame.
- uint8_t can_dlc
  Size of the payload in bytes.

6.15.1 Detailed Description

Raw CAN frame.

Central structure for receiving and sending CAN frames.

Examples:

can-rtt.c, rtcanrecv.c, and rtcansend.c.

6.15.2 Field Documentation

6.15.2.1 **can_id_t** can_frame::can_id

CAN ID of the frame.

See CAN ID flags for special bits.

Examples:

can-rtt.c.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/can.h

6.16 RT_ALARM_INFO Struct Reference

Alarm status descriptor.

Data Fields

- unsigned long expiries

  Number of past expiries.
- char name [XNOBJECT_NAME_LEN]

  Name of alarm object.
- int active

  Active flag.

6.16.1 Detailed Description

Alarm status descriptor.

This structure reports various static and runtime information about a real-time alarm, returned by a call to rt_alarm_inquire().

The documentation for this struct was generated from the following file:

- include/alchemy/alarm.h

6.17 RT_BUFFER_INFO Struct Reference

Buffer status descriptor.

Data Fields

- int iwaiters

  Number of tasks waiting on the read side of the buffer for input data.
- int owaiters

  Number of tasks waiting on the write side of the buffer for sending out data.
- size_t totalmem

  Overall size of buffer (in bytes).
- size_t availmem

  Amount of memory currently available for holding more data.
- char name [XNOBJECT_NAME_LEN]

  Name of the buffer.

6.17.1 Detailed Description

Buffer status descriptor.

This structure reports various static and runtime information about a real-time buffer, returned by a call to rt_buffer_inquire().

The documentation for this struct was generated from the following file:

- include/alchemy/buffer.h

6.18 RT_COND_INFO Struct Reference

Condition variable status descriptor.

Data Fields

- char name [XNOBJECT_NAME_LEN]

  Name of condition variable.

6.18.1 Detailed Description

Condition variable status descriptor.

This structure reports various static and runtime information about a condition variable, returned by a call to rt_cond_inquire().

The documentation for this struct was generated from the following file:

- include/alchemy/cond.h

6.19 RT_EVENT_INFO Struct Reference

Event status descriptor.

Data Fields

- unsigned long value

  Current value of the event flag group.
- int nwaiters

  Number of tasks currently waiting for events.
- char name [XNOBJECT_NAME_LEN]

  Name of event flag group.

6.19.1 Detailed Description

Event status descriptor.

This structure reports various static and runtime information about an event flag group, returned by a call to rt_event_inquire().

The documentation for this struct was generated from the following file:

- include/alchemy/event.h

6.20 RT_HEAP_INFO Struct Reference

Heap status descriptor.

Data Fields

- int nwaiters

  Number of tasks waiting for available memory in rt_heap_alloc().
- int mode

  Creation mode flags as given to rt_heap_create().
- size_t heapsize

  Overall size of heap (in bytes).
- size_t usablemem

  Maximum amount of memory available from the heap.
- size_t usedmem

  Amount of heap memory currently consumed.
- char name [XNOBJECT_NAME_LEN]

  Name of heap.

6.20.1 Detailed Description

Heap status descriptor.

This structure reports various static and runtime information about a real-time heap, returned by a call to rt_heap_inquire().

6.20.2 Field Documentation

6.20.2.1 size_t RT_HEAP_INFO::usablemem

Maximum amount of memory available from the heap.

This value accounts for the overhead of internal data structures required to maintain the heap.

Referenced by rt_heap_inquire().

The documentation for this struct was generated from the following file:

- include/alchemy/heap.h

6.21 RT_MUTEX_INFO Struct Reference

Mutex status descriptor.

Data Fields

- RT_TASK owner

  Current mutex owner, or null if unlocked.
- char name [XNOBJECT_NAME_LEN]

  Name of mutex.

6.21.1 Detailed Description

Mutex status descriptor.

This structure reports various static and runtime information about a mutex, returned by a call to rt_mutex_inquire().

6.21.2 Field Documentation

6.21.2.1 RT_TASK RT_MUTEX_INFO::owner

Current mutex owner, or null if unlocked.

This information is in essence transient, and may not be valid anymore once used by the caller.

Referenced by rt_mutex_inquire().

The documentation for this struct was generated from the following file:

- include/alchemy/mutex.h

6.22 RT_QUEUE_INFO Struct Reference

Queue status descriptor.

Data Fields

- int nwaiters

    Number of tasks currently waiting on the queue for messages.
- int nmessages

    Number of messages pending in queue.
- int mode

    Queue mode bits, as given to rt_queue_create().
- size_t qlimit

    Maximum number of messages in queue, zero if unlimited.
- size_t poolsize

    Size of memory pool for holding message buffers (in bytes).
- size_t usedmem

    Amount of memory consumed from the buffer pool.
- char name [XNOBJECT_NAME_LEN]

    Name of message queue.

6.22.1 Detailed Description

Queue status descriptor.

This structure reports various static and runtime information about a real-time queue, returned by a call to rt_queue_inquire().

The documentation for this struct was generated from the following file:

- include/alchemy/queue.h

6.23 RT_SEM_INFO Struct Reference

Semaphore status descriptor.

Data Fields

- unsigned long count

  Current semaphore value.
- int nwaiters

  Number of tasks waiting on the semaphore.
- char name [XNOBJECT_NAME_LEN]

  Name of semaphore.

6.23.1 Detailed Description

Semaphore status descriptor.

This structure reports various static and runtime information about a semaphore, returned by a call to rt_sem_inquire().

The documentation for this struct was generated from the following file:

- include/alchemy/sem.h

6.24 RT_TASK_INFO Struct Reference

Task status descriptor.

Data Fields

- int prio

  Task priority.
- struct threadobj_stat stat

  Task status.
- char name [XNOBJECT_NAME_LEN]

  Name of task.
- pid_t pid

  Host pid.

6.24.1 Detailed Description

Task status descriptor.

This structure reports various static and runtime information about a real-time task, returned by a call to rt_task_inquire().

The documentation for this struct was generated from the following file:

- include/alchemy/task.h

6.25 rt_timer_info Struct Reference

Timer status descriptor.

Data Fields

- RTIME period

  Clock resolution in nanoseconds.

- RTIME tsc

  Current time stamp counter value.

- RTIME date

  Current monotonic date, based on the time stamp counter value.

6.25.1 Detailed Description

Timer status descriptor.

This structure reports various static and runtime information about the timer, returned by a call to rt_timer_inquire().

6.25.2 Field Documentation

6.25.2.1 RTIME rt_timer_info::date

Current monotonic date, based on the time stamp counter value.

The date is expressed in clock ticks, therefore depends on the Alchemy clock resolution applicable to the current process.

Referenced by rt_timer_inquire().

6.25.2.2 RTIME rt_timer_info::tsc

Current time stamp counter value.

The source of this information is hardware-dependent, and does not depend on the per-process clock settings. Consecutive readings from a single CPU are guaranteed to be monotonically incrementing, however readings may not be synchronized on multi-core hardware if the time stamp counter is local to each CPU. Therefore, whether consecutive readings from different CPUs are consistent and monotonically incrementing depends on the underlying TSC source.

Referenced by rt_timer_inquire().

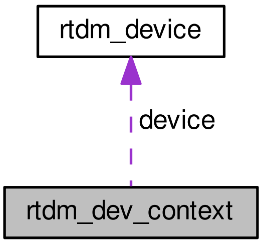
The documentation for this struct was generated from the following file:

- include/alchemy/timer.h

6.26 rtdm_dev_context Struct Reference

Device context.

Collaboration diagram for rtdm_dev_context:



Data Fields

- struct rtdm_device * device

  Set of active device operation handlers.
- struct rtdm_devctx_reserved reserved

  Data stored by RTDM inside a device context (internal use only)
- char dev_private [0]

  Begin of driver defined context data structure.

6.26.1 Detailed Description

Device context.

A device context structure is associated with every open device instance. RTDM takes care of its creation and destruction and passes it to the operation handlers when being invoked.

Drivers can attach arbitrary data immediately after the official structure. The size of this data is provided via rtdm_device.context_size during device registration.

6.26.2 Field Documentation

6.26.2.1 struct **rtdm_device*** rtdm_dev_context::device

Set of active device operation handlers.

Reference to owning device

Referenced by rtdm_fd_device().

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/rtdm/driver.h

6.27 rtdm_device Struct Reference

RTDM device.

Data Fields

- struct rtdm_dev_reserved reserved

  Data stored by RTDM inside a registered device (internal use only)
- int struct_version

  Revision number of this structure, see Driver Versioning defines.
- int device_flags

  Device flags, see Device Flags for details.
- size_t context_size

  Size of driver defined appendix to struct rtdm_dev_context.
- char device_name [RTDM_MAX_DEVNAME_LEN+1]

  Named device identification (orthogonal to Linux device name space)
- int protocol_family

  Protocol device identification: protocol family (PF_xxx)
- int socket_type

  Protocol device identification: socket type (SOCK_xxx)
- rtdm_open_handler_t open

  Named device instance creation for real-time contexts.
- rtdm_socket_handler_t socket

  Protocol socket creation for real-time contexts.
- struct rtdm_fd_ops ops

  Default operations on newly opened device instance.
- int device_class

  Device class ID, see RTDM_CLASS_xxx.
- int device_sub_class

  Device sub-class, see RTDM_SUBCLASS_xxx definition in the Device Profiles.
- int profile_version

  Supported device profile version.
- const char * driver_name

  Informational driver name (reported via /proc)
- int driver_version

  Driver version, see Driver Versioning defines.
- const char * peripheral_name

  Informational peripheral name the device is attached to (reported via /proc)
- const char * provider_name

  Informational driver provider name (reported via /proc)
- const char * proc_name

  Name of /proc entry for the device, must not be NULL.
- int device_id

  Driver definable device ID.
- void * device_data

  Driver definable device data.

6.27.1 Detailed Description

RTDM device.

This structure specifies a RTDM device. As some fields, especially the reserved area, will be modified by RTDM during runtime, the structure must not reside in write-protected memory.

6.27.2 Field Documentation

6.27.2.1 **rtdm_open_handler_t** rtdm_device::open

Named device instance creation for real-time contexts.

Referenced by rtdm_dev_register().

6.27.2.2 **rtdm_socket_handler_t** rtdm_device::socket

Protocol socket creation for real-time contexts.

Referenced by rtdm_dev_register().

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/rtdm/driver.h

6.28 rtdm_device_info Struct Reference

Device information.

Data Fields

- int device_flags

  Device flags, see Device Flags for details.
- int device_class

  Device class ID, see RTDM_CLASS_xxx.
- int device_sub_class

  Device sub-class, either RTDM_SUBCLASS_GENERIC or a RTDM_SUBCLASS_xxx definition of the related Device Profile.
- int profile_version

  Supported device profile version.

6.28.1 Detailed Description

Device information.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/rtdm.h

6.29 rtipc_port_label Struct Reference

Port label information structure.

Data Fields

- char label [XNOBJECT_NAME_LEN]

  Port label string, null-terminated.

6.29.1 Detailed Description

Port label information structure.

Examples:

bufp-label.c, iddp-label.c, and xddp-label.c.

6.29.2 Field Documentation

6.29.2.1 char rtipc_port_label::label[XNOBJECT_NAME_LEN]

Port label string, null-terminated.

Referenced by rt_pipe_create().

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/ipc.h

6.30 rtser_config Struct Reference

Serial device configuration.

Data Fields

- int config_mask
  mask specifying valid fields, see RTSER_SET_xxx
- int baud_rate
  baud rate, default RTSER_DEF_BAUD
- int parity
  number of parity bits, see RTSER_xxx_PARITY
- int data_bits
  number of data bits, see RTSER_xxx_BITS
- int stop_bits
  number of stop bits, see RTSER_xxx_STOPB
- int handshake
  handshake mechanisms, see RTSER_xxx_HAND
- int fifo_depth
  reception FIFO interrupt threshold, see RTSER_FIFO_xxx
- nanosecs_rel_t rx_timeout
  reception timeout, see RTSER_TIMEOUT_xxx for special values
- nanosecs_rel_t tx_timeout
  transmission timeout, see RTSER_TIMEOUT_xxx for special values
- nanosecs_rel_t event_timeout
  event timeout, see RTSER_TIMEOUT_xxx for special values
- int timestamp_history
  enable timestamp history, see RTSER_xxx_TIMESTAMP_HISTORY
- int event_mask
  event mask to be used with RTSER_RTIOC_WAIT_EVENT, see RTSER_EVENT_xxx
- int rs485
  enable RS485 mode, see RTSER_RS485_xxx

6.30.1 Detailed Description

Serial device configuration.

Examples:

cross-link.c.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/serial.h

6.31 rtser_event Struct Reference

Additional information about serial device events.

Data Fields

- int events
  signalled events, see RTSER_EVENT_xxx
- int rx_pending
  number of pending input characters
- nanosecs_abs_t last_timestamp
  last interrupt timestamp
- nanosecs_abs_t rxpend_timestamp
  reception timestamp of oldest character in input queue

6.31.1 Detailed Description

Additional information about serial device events.

Examples:

cross-link.c.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/serial.h

6.32 rtser_status Struct Reference

Serial device status.

Data Fields

- int line_status
  line status register, see RTSER_LSR_xxx
- int modem_status
  modem status register, see RTSER_MSR_xxx

6.32.1 Detailed Description

Serial device status.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/serial.h

6.33 sockaddr_can Struct Reference

Socket address structure for the CAN address family.

Data Fields

- sa_family_t can_family
  CAN address family, must be `AF_CAN`.
- int can_ifindex
  Interface index of CAN controller.

6.33.1 Detailed Description

Socket address structure for the CAN address family.

Examples:

can-rtt.c, rtcanrecv.c, and rtcansend.c.

6.33.2 Field Documentation

6.33.2.1 int sockaddr_can::can_ifindex

Interface index of CAN controller.

See SIOCGIFINDEX.

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/can.h

6.34 sockaddr_ipc Struct Reference

Socket address structure for the RTIPC address family.

Data Fields

- sa_family_t sipc_family
  RTIPC address family, must be `AF_RTIPC`.
- rtipc_port_t sipc_port
  Port number.

6.34.1 Detailed Description

Socket address structure for the RTIPC address family.

Examples:

bufp-label.c, bufp-readwrite.c, iddp-label.c, iddp-sendrecv.c, xddp-echo.c, xddp-label.c, and xddp-stream.c.

6.34.2 Field Documentation

6.34.2.1 **rtipc_port_t** sockaddr_ipc::sipc_port

Port number.

Referenced by rt_pipe_create().

The documentation for this struct was generated from the following file:

- include/rtdm/uapi/ipc.h

6.35 xnsched Struct Reference

Scheduling information structure.

Data Fields

- unsigned long status
- unsigned long lflags
- struct xnthread * curr
- int cpu
- cpumask_t resched
- struct xnsched_rt rt
- volatile unsigned inesting
- struct xntimer htimer
- struct xntimer rrbtimer

6.35.1 Detailed Description

Scheduling information structure.

6.35.2 Field Documentation

6.35.2.1 int xnsched::cpu

Mask of CPUs needing rescheduling.

6.35.2.2 struct xnthread* xnsched::curr

Owner CPU id.

Referenced by xnthread_set_slice(), and xnthread_suspend().

6.35.2.3 struct xntimer xnsched::htimer

Round-robin timer.

Referenced by program_htick_shot(), switch_htick_mode(), and xnclock_tick().

6.35.2.4 volatile unsigned xnsched::inesting

Host timer.

6.35.2.5 unsigned long xnsched::lflags

Current thread.

Referenced by xnclock_tick(), xnsched_run(), and xnthread_suspend().

6.35.2.6 cpumask_t xnsched::resched

Context of built-in real-time class.

6.35.2.7 struct xntimer xnsched::rrbtimer

Root thread control block.

Referenced by xnthread_set_slice().

6.35.2.8 struct xnsched_rt xnsched::rt

Interrupt nesting level.

6.35.2.9 unsigned long xnsched::status

< Scheduler specific status bitmask. Scheduler specific local flags bitmask.

Referenced by xnclock_tick(), and xnsched_run().

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/sched.h

6.36 xnvfile_lock_ops Struct Reference

Vfile locking operations.

Data Fields

- int(* get)(struct xnvfile *vfile)
- void(* put)(struct xnvfile *vfile)

6.36.1 Detailed Description

Vfile locking operations.

This structure describes the operations to be provided for implementing locking support on vfiles. They apply to both snapshot-driven and regular vfiles.

6.36.2 Field Documentation

6.36.2.1 int(* xnvfile_lock_ops::get)(struct xnvfile *vfile)

This handler should grab the desired lock.

Parameters

vfile	A pointer to the virtual file which needs locking.

Returns

zero should be returned if the call succeeds. Otherwise, a negative error code can be returned; upon error, the current vfile operation is aborted, and the user-space caller is passed back the error value.

6.36.2.2 void(* xnvfile_lock_ops::put)(struct xnvfile *vfile)

This handler should release the lock previously grabbed by the get() handler.

Parameters

vfile	A pointer to the virtual file which currently holds the lock to release.

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/vfile.h

6.37 xnvfile_regular_iterator Struct Reference

Regular vfile iterator.

Data Fields

- loff_t pos

  Current record position while iterating.
- struct seq_file * seq

  Backlink to the host sequential file supporting the vfile.
- struct xnvfile_regular * vfile

  Backlink to the vfile being read.
- char private [0]

  Start of private area.

6.37.1 Detailed Description

Regular vfile iterator.

This structure defines an iterator over a regular vfile.

6.37.2 Field Documentation

6.37.2.1 loff_t xnvfile_regular_iterator::pos

Current record position while iterating.

6.37.2.2 char xnvfile_regular_iterator::private[0]

Start of private area.

Use xnvfile_iterator_priv() to address it.

6.37.2.3 struct seq_file* xnvfile_regular_iterator::seq

Backlink to the host sequential file supporting the vfile.

6.37.2.4 struct xnvfile_regular* xnvfile_regular_iterator::vfile

Backlink to the vfile being read.

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/vfile.h

6.38 xnvfile_regular_ops Struct Reference

Regular vfile operation descriptor.

Data Fields

- int(* rewind)(struct xnvfile_regular_iterator *it)
- void *(* begin)(struct xnvfile_regular_iterator *it)
- void *(* next)(struct xnvfile_regular_iterator *it)
- void(* end)(struct xnvfile_regular_iterator *it)
- int(* show)(struct xnvfile_regular_iterator *it, void *data)
- ssize_t(* store)(struct xnvfile_input *input)

6.38.1 Detailed Description

Regular vfile operation descriptor.

This structure describes the operations available with a regular vfile. It defines handlers for sending back formatted kernel data upon a user-space read request, and for obtaining user data upon a user-space write request.

6.38.2 Field Documentation

6.38.2.1 void∗(∗ xnvfile_regular_ops::begin)(struct **xnvfile_regular_iterator** ∗it)

This handler should prepare for iterating over the records upon a read request, starting from the specified position.

Parameters

it	A pointer to the current vfile iterator. On entry, it->pos is set to the (0-based) position of the first record to output. This handler may be called multiple times with different position requests.

Returns

A pointer to the first record to format and output, to be passed to the show() handler as its *data* parameter, if the call succeeds. Otherwise:

- NULL in case no record is available, in which case the read operation will terminate immediately with no output.
- VFILE_SEQ_START, a special value indicating that the show() handler should receive a NULL data pointer first, in order to output a header.
- ERR_PTR(errno), where errno is a negative error code; upon error, the current operation will be aborted immediately.

Note

This handler is optional; if none is given in the operation descriptor (i.e. NULL value), the show() handler() will be called only once for a read operation, with a NULL *data* parameter. This particular setting is convenient for simple regular vfiles having a single, fixed record to output.

6.38.2.2 void(∗ xnvfile_regular_ops::end)(struct **xnvfile_regular_iterator** ∗it)

This handler is called after all records have been output.

Parameters

it	A pointer to the current vfile iterator.

Note

This handler is optional and the pointer may be NULL.

6.38.2.3 void∗(∗ xnvfile_regular_ops::next)(struct **xnvfile_regular_iterator** ∗it)

This handler should return the address of the next record to format and output by the show()handler".

Parameters

it	A pointer to the current vfile iterator. On entry, it->pos is set to the (0-based) position of the next record to output.

Returns

A pointer to the next record to format and output, to be passed to the show() handler as its *data* parameter, if the call succeeds. Otherwise:

- NULL in case no record is available, in which case the read operation will terminate immediately with no output.
- ERR_PTR(errno), where errno is a negative error code; upon error, the current operation will be aborted immediately.

Note

This handler is optional; if none is given in the operation descriptor (i.e. NULL value), the read operation will stop after the first invocation of the show() handler.

6.38.2.4 int(* xnvfile_regular_ops::rewind)(struct **xnvfile_regular_iterator** *it)

This handler is called only once, when the virtual file is opened, before the begin() handler is invoked.

Parameters

it	A pointer to the vfile iterator which will be used to read the file contents.

Returns

Zero should be returned upon success. Otherwise, a negative error code aborts the operation, and is passed back to the reader.

Note

This handler is optional. It should not be used to allocate resources but rather to perform consistency checks, since no closure call is issued in case the open sequence eventually fails.

6.38.2.5 int(* xnvfile_regular_ops::show)(struct **xnvfile_regular_iterator** *it, void *data)

This handler should format and output a record.

xnvfile_printf(), xnvfile_write(), xnvfile_puts() and xnvfile_putc() are available to format and/or emit the output. All routines take the iterator argument *it* as their first parameter.

Parameters

it	A pointer to the current vfile iterator.
data	A pointer to the record to format then output. The first call to the handler may receive a NULL *data* pointer, depending on the presence and/or return of a hander; the show handler should test this special value to output any header that fits, prior to receiving more calls with actual records.

Returns

zero if the call succeeds, also indicating that the handler should be called for the next record if any. Otherwise:

- A negative error code. This will abort the output phase, and return this status to the reader.
- VFILE_SEQ_SKIP, a special value indicating that the current record should be skipped and will not be output.

6.38.2.6 ssize_t(* xnvfile_regular_ops::store)(struct xnvfile_input *input)

This handler receives data written to the vfile, likely for updating some kernel setting, or triggering any other action which fits. This is the only handler which deals with the write-side of a vfile. It is called when writing to the /proc entry of the vfile from a user-space process.

The input data is described by a descriptor passed to the handler, which may be subsequently passed to parsing helper routines. For instance, xnvfile_get_string() will accept the input descriptor for returning the written data as a null-terminated character string. On the other hand, xnvfile_get_integer() will attempt to return a long integer from the input data.

Parameters

input	A pointer to an input descriptor. It refers to an opaque data from the handler's standpoint.

Returns

the number of bytes read from the input descriptor if the call succeeds. Otherwise, a negative error code. Return values from parsing helper routines are commonly passed back to the caller by the store() handler.

Note

This handler is optional, and may be omitted for read-only vfiles.

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/vfile.h

6.39 xnvfile_rev_tag Struct Reference

Snapshot revision tag.

Data Fields

- int rev

  Current revision number.

6.39.1 Detailed Description

Snapshot revision tag.

This structure defines a revision tag to be used with snapshot-driven vfiles.

6.39.2 Field Documentation

6.39.2.1 int xnvfile_rev_tag::rev

Current revision number.

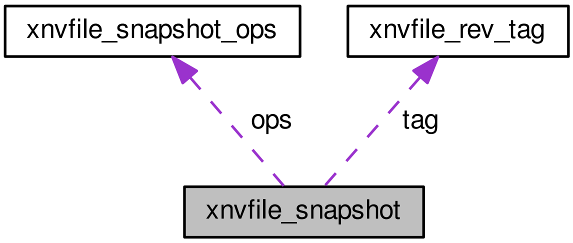
The documentation for this struct was generated from the following file:

- include/cobalt/kernel/vfile.h

6.40 xnvfile_snapshot Struct Reference

Snapshot vfile descriptor.

Collaboration diagram for xnvfile_snapshot:



6.40.1 Detailed Description

Snapshot vfile descriptor.

This structure describes a snapshot-driven vfile. Reading from such a vfile involves a preliminary data collection phase under lock protection, and a subsequent formatting and output phase of the collected data records. Locking is done in a way that does not increase worst-case latency, regardless of the number of records to be collected for output.

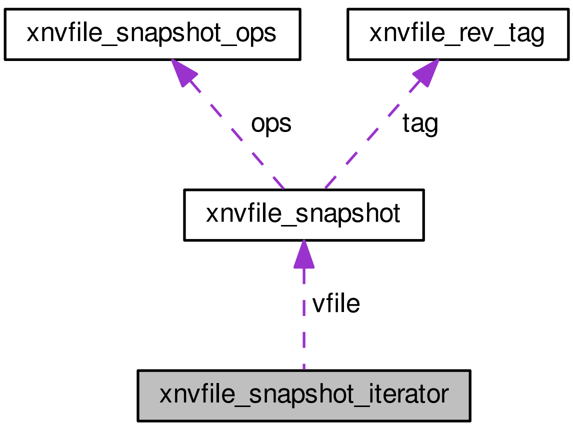
The documentation for this struct was generated from the following file:

- include/cobalt/kernel/vfile.h

6.41 xnvfile_snapshot_iterator Struct Reference

Snapshot-driven vfile iterator.

Collaboration diagram for xnvfile_snapshot_iterator:



Data Fields

- int nrdata

    Number of collected records.
- caddr_t databuf

    Address of record buffer.
- struct seq_file * seq

    Backlink to the host sequential file supporting the vfile.
- struct xnvfile_snapshot * vfile

    Backlink to the vfile being read.
- void(* endfn)(struct xnvfile_snapshot_iterator *it, void *buf)

    Buffer release handler.
- char private [0]

    Start of private area.

6.41.1 Detailed Description

Snapshot-driven vfile iterator.

This structure defines an iterator over a snapshot-driven vfile.

6.41.2 Field Documentation

6.41.2.1 caddr_t xnvfile_snapshot_iterator::databuf

Address of record buffer.

6.41.2.2 void(* xnvfile_snapshot_iterator::endfn)(struct **xnvfile_snapshot_iterator** *it, void *buf)

Buffer release handler.

6.41.2.3 int xnvfile_snapshot_iterator::nrdata

Number of collected records.

6.41.2.4 char xnvfile_snapshot_iterator::private[0]

Start of private area.

Use xnvfile_iterator_priv() to address it.

6.41.2.5 struct seq_file* xnvfile_snapshot_iterator::seq

Backlink to the host sequential file supporting the vfile.

6.41.2.6 struct **xnvfile_snapshot*** xnvfile_snapshot_iterator::vfile

Backlink to the vfile being read.

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/vfile.h

6.42 xnvfile_snapshot_ops Struct Reference

Snapshot vfile operation descriptor.

Data Fields

- int(* rewind)(struct xnvfile_snapshot_iterator *it)
- void *(* begin)(struct xnvfile_snapshot_iterator *it)
- void(* end)(struct xnvfile_snapshot_iterator *it, void *buf)
- int(* next)(struct xnvfile_snapshot_iterator *it, void *data)
- int(* show)(struct xnvfile_snapshot_iterator *it, void *data)
- ssize_t(* store)(struct xnvfile_input *input)

6.42.1 Detailed Description

Snapshot vfile operation descriptor.

This structure describes the operations available with a snapshot-driven vfile. It defines handlers for returning a printable snapshot of some Xenomai object contents upon a user-space read request, and for updating this object upon a user-space write request.

6.42.2 Field Documentation

6.42.2.1 void*(* xnvfile_snapshot_ops::begin)(struct **xnvfile_snapshot_iterator** *it)

This handler should allocate the snapshot buffer to hold records during the data collection phase. When specified, all records collected via the next()handler" will be written to a cell from the memory area returned by begin().

Parameters

it	A pointer to the current snapshot iterator.

Returns

A pointer to the record buffer, if the call succeeds. Otherwise:

- NULL in case of allocation error. This will abort the data collection, and return -ENOMEM to the reader.
- VFILE_SEQ_EMPTY, a special value indicating that no record will be output. In such a case, the next() handler will not be called, and the data collection will stop immediately. However, the show() handler will still be called once, with a NULL data pointer (i.e. header display request).

Note

This handler is optional; if none is given, an internal allocation depending on the value returned by the rewind() handler can be obtained.

6.42.2.2 void(∗ xnvfile_snapshot_ops::end)(struct **xnvfile_snapshot_iterator** ∗it, void ∗buf)

This handler releases the memory buffer previously obtained from begin(). It is usually called after the snapshot data has been output by show(), but it may also be called before rewinding the vfile after a revision change, to release the dropped buffer.

Parameters

it	A pointer to the current snapshot iterator.
buf	A pointer to the buffer to release.

Note

This routine is optional and the pointer may be NULL. It is not needed upon internal buffer allocation; see the description of the rewind()handler".

6.42.2.3 int(∗ xnvfile_snapshot_ops::next)(struct **xnvfile_snapshot_iterator** ∗it, void ∗data)

This handler fetches the next record, as part of the snapshot data to be sent back to the reader via the show().

Parameters

it	A pointer to the current snapshot iterator.
data	A pointer to the record to fill in.

Returns

a strictly positive value, if the call succeeds and leaves a valid record into *data*, which should be passed to the show() handler() during the formatting and output phase. Otherwise:

- A negative error code. This will abort the data collection, and return this status to the reader.
- VFILE_SEQ_SKIP, a special value indicating that the current record should be skipped. In such a case, the *data* pointer is not advanced to the next position before the next() handler is called anew.

Note

This handler is called with the vfile lock held. Before each invocation of this handler, the vfile core checks whether the revision tag has been touched, in which case the data collection is restarted from scratch. A data collection phase succeeds whenever all records can be fetched via the next() handler, while the revision tag remains unchanged, which indicates that a consistent snapshot of the object state was taken.

6.42.2.4 int(* xnvfile_snapshot_ops::rewind)(struct **xnvfile_snapshot_iterator** *it)

This handler (re-)initializes the data collection, moving the seek pointer at the first record. When the file revision tag is touched while collecting data, the current reading is aborted, all collected data dropped, and the vfile is eventually rewound.

Parameters

it	A pointer to the current snapshot iterator. Two useful information can be retrieved from this iterator in this context:

- it->vfile is a pointer to the descriptor of the virtual file being rewound.
- xnvfile_iterator_priv(it) returns a pointer to the private data area, available from the descriptor, which size is vfile->privsz. If the latter size is zero, the returned pointer is meaningless and should not be used.

Returns

A negative error code aborts the data collection, and is passed back to the reader. Otherwise:

- a strictly positive value is interpreted as the total number of records which will be returned by the next() handler during the data collection phase. If no begin() handler is provided in the operation descriptor, this value is used to allocate the snapshot buffer internally. The size of this buffer would then be vfile->datasz * value.
- zero leaves the allocation to the begin() handler if present, or indicates that no record is to be output in case such handler is not given.

Note

This handler is optional; a NULL value indicates that nothing needs to be done for rewinding the vfile. It is called with the vfile lock held.

6.42.2.5 int(* xnvfile_snapshot_ops::show)(struct **xnvfile_snapshot_iterator** *it, void *data)

This handler should format and output a record from the collected data.

xnvfile_printf(), xnvfile_write(), xnvfile_puts() and xnvfile_putc() are available to format and/or emit the output. All routines take the iterator argument *it* as their first parameter.

Parameters

it	A pointer to the current snapshot iterator.

data	A pointer to the record to format then output. The first call to the handler is always passed a NULL *data* pointer; the show handler should test this special value to output any header that fits, prior to receiving more calls with actual records.

Returns

zero if the call succeeds, also indicating that the handler should be called for the next record if any. Otherwise:

- A negative error code. This will abort the output phase, and return this status to the reader.
- VFILE_SEQ_SKIP, a special value indicating that the current record should be skipped and will not be output.

6.42.2.6 ssize_t(* xnvfile_snapshot_ops::store)(struct xnvfile_input *input)

This handler receives data written to the vfile, likely for updating the associated Xenomai object's state, or triggering any other action which fits. This is the only handler which deals with the write-side of a vfile. It is called when writing to the /proc entry of the vfile from a user-space process.

The input data is described by a descriptor passed to the handler, which may be subsequently passed to parsing helper routines. For instance, xnvfile_get_string() will accept the input descriptor for returning the written data as a null-terminated character string. On the other hand, xnvfile_get_integer() will attempt to return a long integer from the input data.

Parameters

input	A pointer to an input descriptor. It refers to an opaque data from the handler's standpoint.

Returns

the number of bytes read from the input descriptor if the call succeeds. Otherwise, a negative error code. Return values from parsing helper routines are commonly passed back to the caller by the store() handler.

Note

This handler is optional, and may be omitted for read-only vfiles.

Referenced by xnvfile_init_snapshot().

The documentation for this struct was generated from the following file:

- include/cobalt/kernel/vfile.h

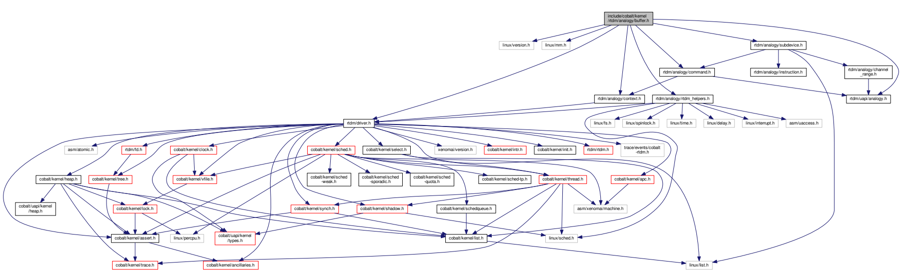
Chapter 7

File Documentation

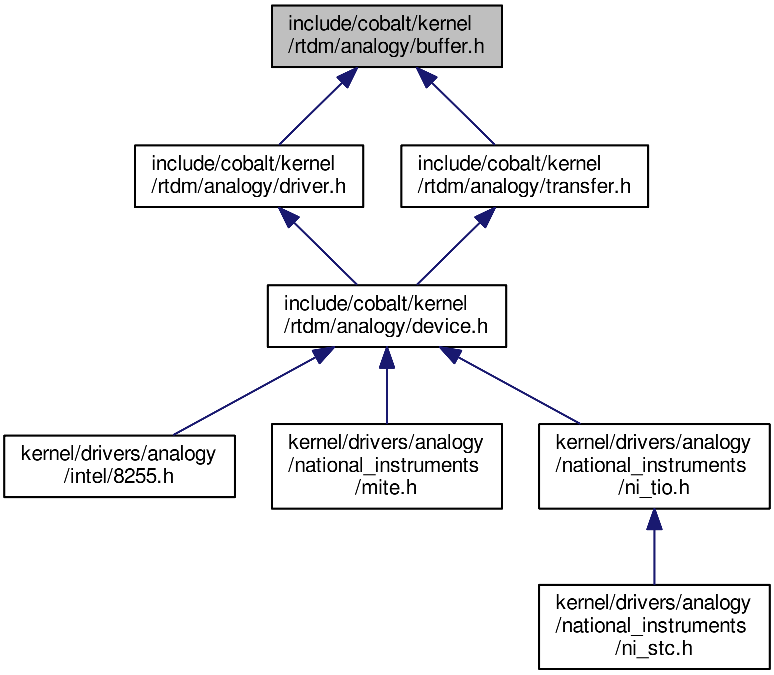
7.1 include/cobalt/kernel/rtdm/analogy/buffer.h File Reference

Analogy for Linux, buffer related features.

Include dependency graph for buffer.h:



This graph shows which files directly or indirectly include this file:



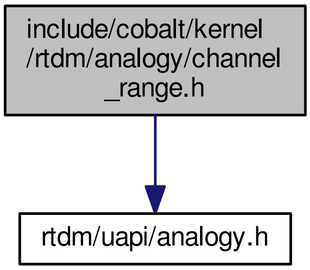
7.1.1 Detailed Description

Analogy for Linux, buffer related features. Copyright (C) 1997-2000 David A. Schleef ds@schleef.org Copyright (C) 2008 Alexis Berlemont alexis.berlemont@free.fr

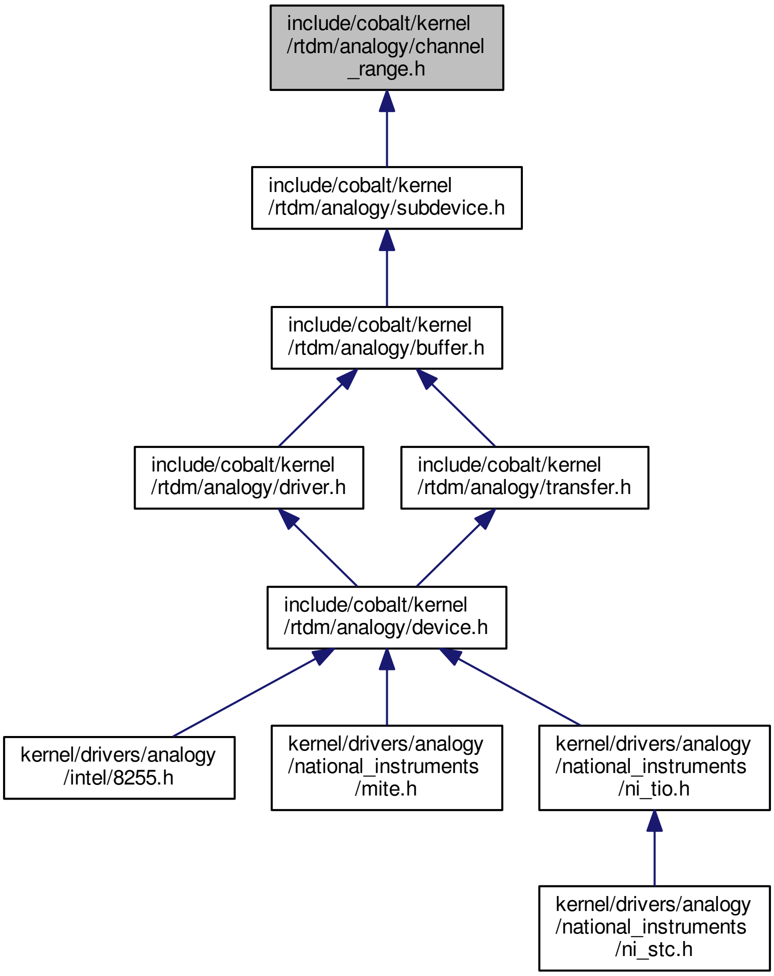
7.2 include/cobalt/kernel/rtdm/analogy/channel_range.h File Reference

Analogy for Linux, channel, range related features.

Include dependency graph for channel_range.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct a4l_channel

  Structure describing some channel's characteristics.
- struct a4l_channels_desc

  Structure describing a channels set.
- struct a4l_range

  Structure describing a (unique) range.

Macros

- #define A4L_CHAN_GLOBAL 0x10

  Internal use flag (must not be used by driver developer)
- #define A4L_RNG_GLOBAL 0x8

  Internal use flag (must not be used by driver developer)
- #define RANGE(x, y)

  Macro to declare a (unique) range with no unit defined.
- #define RANGE_V(x, y)

  Macro to declare a (unique) range in Volt.
- #define RANGE_mA(x, y)

  Macro to declare a (unique) range in milliAmpere.
- #define RANGE_ext(x, y)

  Macro to declare a (unique) range in some external reference.
- #define A4L_RNG_GLOBAL_RNGDESC 0

  Constant to define a ranges descriptor as global (inter-channel)
- #define A4L_RNG_PERCHAN_RNGDESC 1

  Constant to define a ranges descriptor as specific for a channel.
- #define RNG_GLOBAL(x)

  Macro to declare a ranges global descriptor in one line.

Channel reference

Flags to define the channel's reference

- #define A4L_CHAN_AREF_GROUND 0x1

  Ground reference.
- #define A4L_CHAN_AREF_COMMON 0x2

  Common reference.
- #define A4L_CHAN_AREF_DIFF 0x4

  Differential reference.
- #define A4L_CHAN_AREF_OTHER 0x8

  Misc reference.

Channels declaration mode

Constant to define whether the channels in a descriptor are identical

- #define A4L_CHAN_GLOBAL_CHANDESC 0

  Global declaration, the set contains channels with similar characteristics.
- #define A4L_CHAN_PERCHAN_CHANDESC 1

  Per channel declaration, the decriptor gathers differents channels.

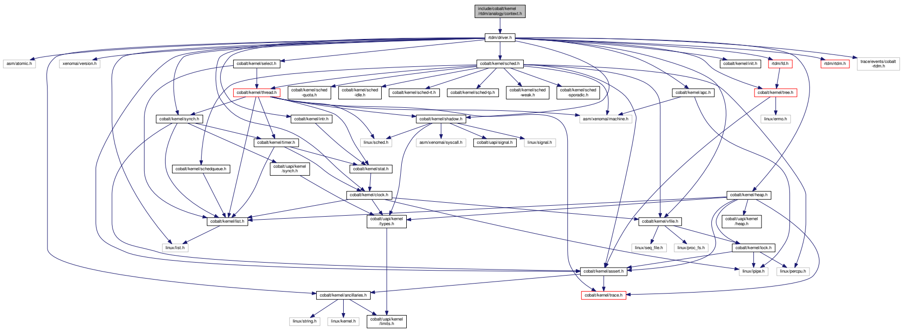
7.2.1 Detailed Description

Analogy for Linux, channel, range related features. Copyright (C) 1997-2000 David A. Schleef ds@schleef.org Copyright (C) 2008 Alexis Berlemont alexis.berlemont@free.fr

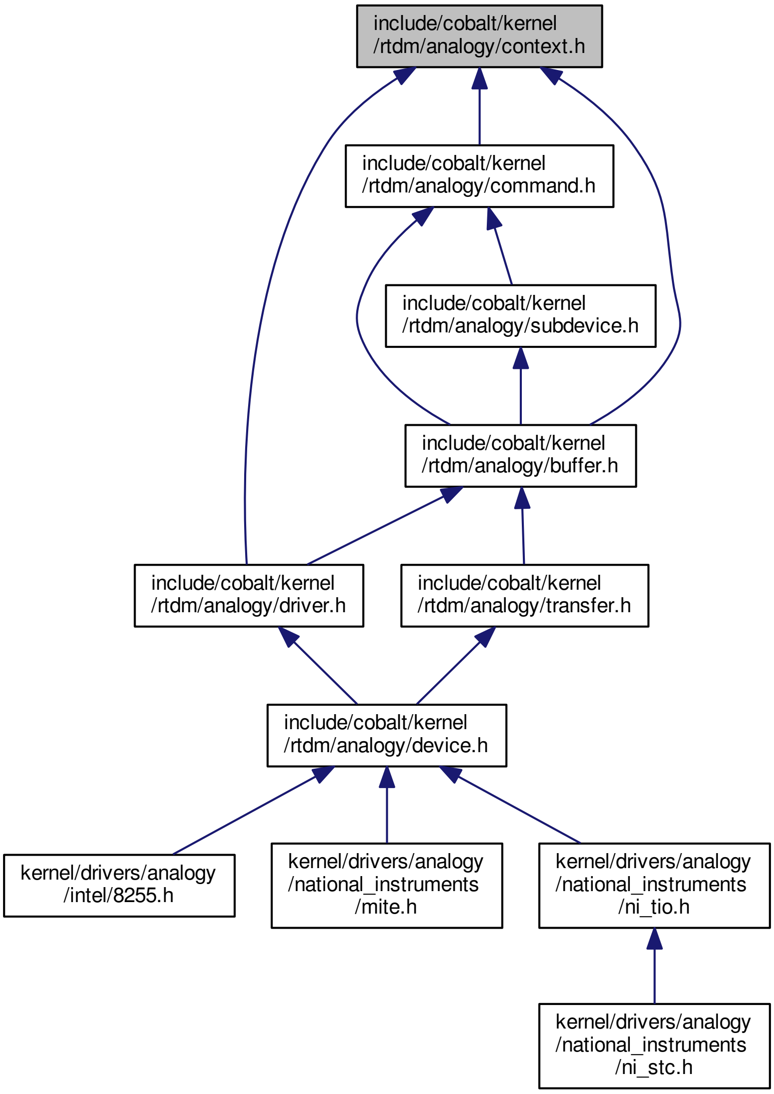
7.3 include/cobalt/kernel/rtdm/analogy/context.h File Reference

Analogy for Linux, context structure / macros declarations.

Include dependency graph for context.h:



This graph shows which files directly or indirectly include this file:



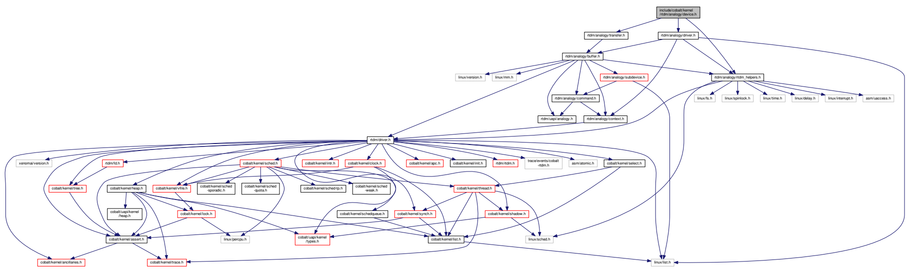
7.3.1 Detailed Description

Analogy for Linux, context structure / macros declarations. Copyright (C) 1997-2000 David A. Schleef ds@schleef.org Copyright (C) 2008 Alexis Berlemont alexis.berlemont@free.fr

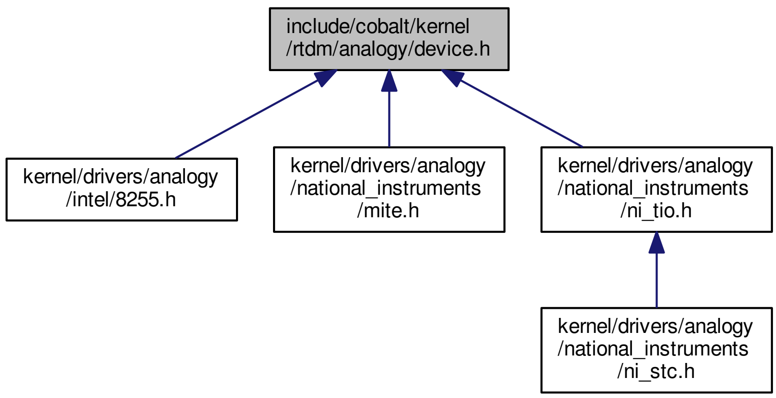
7.4 include/cobalt/kernel/rtdm/analogy/device.h File Reference

Analogy for Linux, device related features.

Include dependency graph for device.h:



This graph shows which files directly or indirectly include this file:



7.4.1 Detailed Description

Analogy for Linux, device related features. Copyright (C) 1997-2000 David A. Schleef ds@schleef.org Copyright (C) 2008 Alexis Berlemont alexis.berlemont@free.fr

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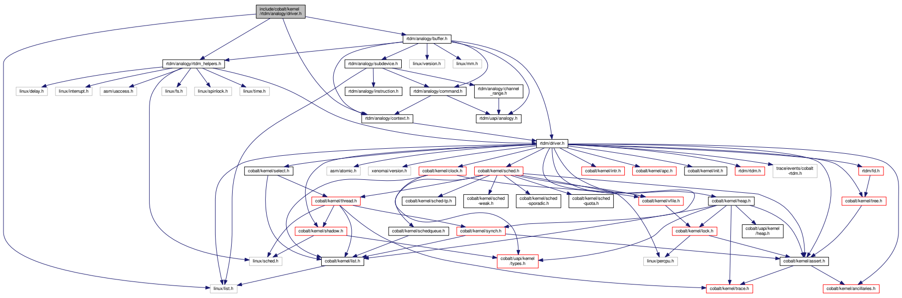
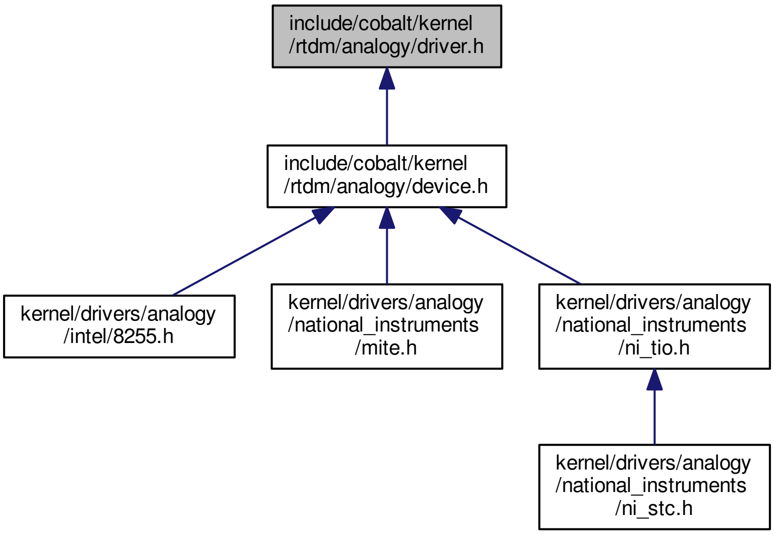
7.5 include/cobalt/kernel/rtdm/analogy/driver.h File Reference

Analogy for Linux, driver facilities.

Include dependency graph for driver.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct a4l_driver

    Structure containing driver declaration data.

7.5.1 Detailed Description

Analogy for Linux, driver facilities. Copyright (C) 1997-2000 David A. Schleef ds@schleef.org Copyright (C) 2008 Alexis Berlemont alexis.berlemont@free.fr

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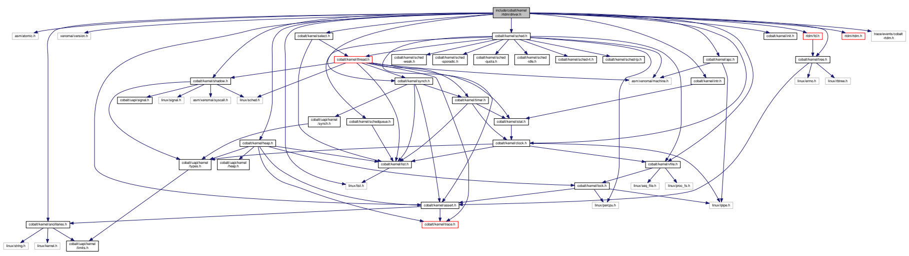
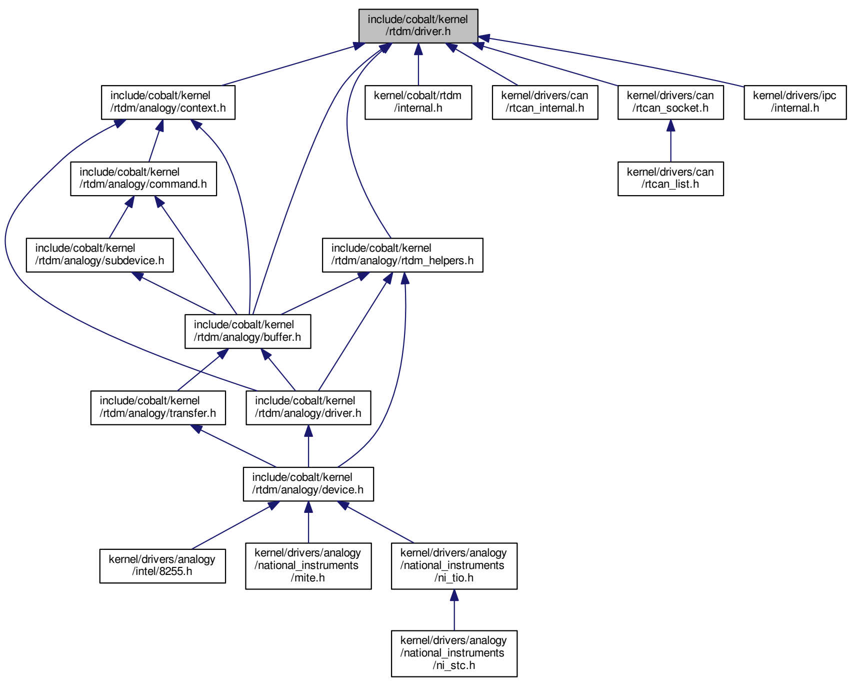
7.6 include/cobalt/kernel/rtdm/driver.h File Reference

Real-Time Driver Model for Xenomai, driver API header.

Include dependency graph for driver.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct rtdm_dev_context

    Device context.

- struct rtdm_device
  RTDM device.

Macros

- #define cobalt_atomic_enter(context)
  Enter atomic section (dual kernel only)
- #define cobalt_atomic_leave(context)
  Leave atomic section (dual kernel only)
- #define RTDM_EXECUTE_ATOMICALLY(code_block)
  Execute code block atomically (DEPRECATED)
- #define RTDM_LOCK_UNLOCKED(__name) IPIPE_SPIN_LOCK_UNLOCKED
  Static lock initialisation.
- #define rtdm_lock_irqsave(context) splhigh(context)
  Disable preemption locally.
- #define rtdm_lock_irqrestore(context) splexit(context)
  Restore preemption state.
- #define rtdm_irq_get_arg(irq_handle, type) ((type *)irq_handle->cookie)
  Retrieve IRQ handler argument.

Device Flags

Static flags describing a RTDM device

- #define RTDM_EXCLUSIVE 0x0001
  If set, only a single instance of the device can be requested by an application.
- #define RTDM_NAMED_DEVICE 0x0010
  If set, the device is addressed via a clear-text name.
- #define RTDM_PROTOCOL_DEVICE 0x0020
  If set, the device is addressed via a combination of protocol ID and socket type.
- #define RTDM_DEVICE_TYPE_MASK 0x00F0
  Mask selecting the device type.

Driver Versioning

Current revisions of RTDM structures, encoding of driver versions. See API Versioning for the interface revision.

- #define RTDM_DEVICE_STRUCT_VER 6
  Version of struct rtdm_device.
- #define RTDM_CONTEXT_STRUCT_VER 4
  Version of struct rtdm_dev_context.
- #define RTDM_SECURE_DEVICE 0x80000000
  Flag indicating a secure variant of RTDM (not supported here)
- #define RTDM_DRIVER_VER(major, minor, patch) (((major & 0xFF) << 16) | ((minor & 0xFF) << 8) | (patch & 0xFF))
  Version code constructor for driver revisions.
- #define RTDM_DRIVER_MAJOR_VER(ver) (((ver) >> 16) & 0xFF)
  Get major version number from driver revision code.
- #define RTDM_DRIVER_MINOR_VER(ver) (((ver) >> 8) & 0xFF)
  Get minor version number from driver revision code.
- #define RTDM_DRIVER_PATCH_VER(ver) ((ver) & 0xFF)
  Get patch version number from driver revision code.

RTDM_IRQTYPE_xxx

Interrupt registrations flags

- #define RTDM_IRQTYPE_SHARED XN_ISR_SHARED

  Enable IRQ-sharing with other real-time drivers.
- #define RTDM_IRQTYPE_EDGE XN_ISR_EDGE

  Mark IRQ as edge-triggered, relevant for correct handling of shared edge-triggered IRQs.

RTDM_IRQ_xxx

Return flags of interrupt handlers

- #define RTDM_IRQ_NONE XN_ISR_NONE

  Unhandled interrupt.
- #define RTDM_IRQ_HANDLED XN_ISR_HANDLED

  Denote handled interrupt.

Task Priority Range

Maximum and minimum task priorities

- #define **RTDM_TASK_LOWEST_PRIORITY** 0
- #define **RTDM_TASK_HIGHEST_PRIORITY** 99

Task Priority Modification

Raise or lower task priorities by one level

- #define **RTDM_TASK_RAISE_PRIORITY** (+1)
- #define **RTDM_TASK_LOWER_PRIORITY** (-1)

Typedefs

- typedef ipipe_spinlock_t rtdm_lock_t

  Lock variable.
- typedef unsigned long rtdm_lockctx_t

  Variable to save the context while holding a lock.
- typedef int(* rtdm_irq_handler_t)(rtdm_irq_t *irq_handle)

  Interrupt handler.
- typedef void(* rtdm_nrtsig_handler_t)(rtdm_nrtsig_t nrt_sig, void *arg)

  Non-real-time signal handler.
- typedef void(* rtdm_timer_handler_t)(rtdm_timer_t *timer)

  Timer handler.
- typedef void(* rtdm_task_proc_t)(void *arg)

  Real-time task procedure.

Operation Handler Prototypes

- typedef int(* rtdm_open_handler_t)(struct rtdm_fd *fd, int oflag)

  Named device open handler.
- typedef int(* rtdm_socket_handler_t)(struct rtdm_fd *fd, int protocol)

  Socket creation handler for protocol devices.

Enumerations

RTDM_SELECTTYPE_xxx

Event types select can bind to

- enum rtdm_selecttype { RTDM_SELECTTYPE_READ = XNSELECT_READ, RTDM_SELECTTYPE_WRITE = XNSELECT_WRITE, RTDM_SELECTTYPE_EXCEPT = XNSELECT_EXCEPT }

RTDM_TIMERMODE_xxx

Timer operation modes

- enum rtdm_timer_mode { RTDM_TIMERMODE_RELATIVE = XN_RELATIVE, RTDM_TIMERMODE_ABSOLUTE = XN_ABSOLUTE, RTDM_TIMERMODE_REALTIME = XN_REALTIME }

Functions

- static void * rtdm_fd_to_private (struct rtdm_fd *fd)

  Locate the driver private area associated to a device context structure.
- static struct rtdm_fd * rtdm_private_to_fd (void *dev_private)

  Locate a device file descriptor structure from its driver private area.
- static bool rtdm_fd_is_user (struct rtdm_fd *fd)

  Tell whether the passed file descriptor belongs to an application.
- static struct rtdm_device * rtdm_fd_device (struct rtdm_fd *fd)

  Locate a device structure from a file descriptor.
- int rtdm_dev_register (struct rtdm_device *device)

  Register a RTDM device.
- int rtdm_dev_unregister (struct rtdm_device *device, unsigned int poll_delay)

  Unregisters a RTDM device.
- void rtdm_toseq_init (rtdm_toseq_t *timeout_seq, nanosecs_rel_t timeout)

  Initialise a timeout sequence.
- static void rtdm_lock_init (rtdm_lock_t *lock)

  Dynamic lock initialisation.
- static void rtdm_lock_get (rtdm_lock_t *lock)

  Acquire lock from non-preemptible contexts.
- static void rtdm_lock_put (rtdm_lock_t *lock)

  Release lock without preemption restoration.
- static void rtdm_lock_put_irqrestore (rtdm_lock_t *lock, rtdm_lockctx_t context)

  Release lock and restore preemption state.
- int rtdm_irq_request (rtdm_irq_t *irq_handle, unsigned int irq_no, rtdm_irq_handler_t handler, unsigned long flags, const char *device_name, void *arg)

  Register an interrupt handler.
- void rtdm_timer_destroy (rtdm_timer_t *timer)

  Destroy a timer.
- int rtdm_timer_start (rtdm_timer_t *timer, nanosecs_abs_t expiry, nanosecs_rel_t interval, enum rtdm_timer_mode mode)

  Start a timer.
- void rtdm_timer_stop (rtdm_timer_t *timer)

  Stop a timer.
- int rtdm_task_init (rtdm_task_t *task, const char *name, rtdm_task_proc_t task_proc, void *arg, int priority, nanosecs_rel_t period)

Initialise and start a real-time task.

- void rtdm_task_busy_sleep (nanosecs_rel_t delay)

  Busy-wait a specified amount of time.
- void rtdm_event_init (rtdm_event_t *event, unsigned long pending)

  Initialise an event.
- int rtdm_event_wait (rtdm_event_t *event)

  Wait on event occurrence.
- int rtdm_event_timedwait (rtdm_event_t *event, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_-seq)

  Wait on event occurrence with timeout.
- void rtdm_event_signal (rtdm_event_t *event)

  Signal an event occurrence.
- void rtdm_event_clear (rtdm_event_t *event)

  Clear event state.
- void rtdm_event_pulse (rtdm_event_t *event)

  Signal an event occurrence to currently listening waiters.
- void rtdm_event_destroy (rtdm_event_t *event)

  Destroy an event.
- void rtdm_sem_init (rtdm_sem_t *sem, unsigned long value)

  Initialise a semaphore.
- int rtdm_sem_down (rtdm_sem_t *sem)

  Decrement a semaphore.
- int rtdm_sem_timeddown (rtdm_sem_t *sem, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)

  Decrement a semaphore with timeout.
- void rtdm_sem_up (rtdm_sem_t *sem)

  Increment a semaphore.
- void rtdm_sem_destroy (rtdm_sem_t *sem)

  Destroy a semaphore.
- void rtdm_mutex_init (rtdm_mutex_t *mutex)

  Initialise a mutex.
- int rtdm_mutex_lock (rtdm_mutex_t *mutex)

  Request a mutex.
- int rtdm_mutex_timedlock (rtdm_mutex_t *mutex, nanosecs_rel_t timeout, rtdm_toseq_t *timeout-_seq)

  Request a mutex with timeout.
- void rtdm_mutex_unlock (rtdm_mutex_t *mutex)

  Release a mutex.
- void rtdm_mutex_destroy (rtdm_mutex_t *mutex)

  Destroy a mutex.
- int rtdm_ratelimit (struct rtdm_ratelimit_state *rs, const char *func)

  Enforces a rate limit.

7.6.1 Detailed Description

Real-Time Driver Model for Xenomai, driver API header.

Note

7.6.2 Typedef Documentation

7.6.2.1 typedef int(* rtdm_open_handler_t)(struct rtdm_fd *fd, int oflag)

Named device open handler.

Parameters

in	*fd*	File descriptor structure associated with opened device instance
in	*oflag*	Open flags as passed by the user

Returns

0 on success. On failure return either -ENOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, or another negative error code.

See Also

`open()` in IEEE Std 1003.1, http://www.opengroup.org/onlinepubs/009695399

7.6.2.2 typedef int(* rtdm_socket_handler_t)(struct rtdm_fd *fd, int protocol)

Socket creation handler for protocol devices.

Parameters

in	*fd*	File descriptor structure associated with opened device instance
in	*protocol*	Protocol number as passed by the user

Returns

0 on success. On failure return either -ENOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, or another negative error code.

See Also

`socket()` in IEEE Std 1003.1, http://www.opengroup.org/onlinepubs/009695399

7.6.3 Function Documentation

7.6.3.1 static struct **rtdm_device*** rtdm_fd_device (struct rtdm_fd * fd) [static]

Locate a device structure from a file descriptor.

Parameters

in	*fd*	File descriptor

Returns

The address of the device structure to which this file descriptor is attached.

References rtdm_dev_context::device.

7.6.3.2 static bool rtdm_fd_is_user (struct rtdm_fd * fd) [inline], [static]

Tell whether the passed file descriptor belongs to an application.

Parameters

in	*fd*	File descriptor

Returns

true if passed file descriptor belongs to an application, false otherwise.

7.6.3.3 static void* rtdm_fd_to_private (struct rtdm_fd * fd) [inline], [static]

Locate the driver private area associated to a device context structure.

Parameters

in	*fd*	File descriptor structure associated with opened device instance

Returns

The address of the private driver area associated to *file* descriptor.

References rtdm_dev_context::dev_private.

7.6.3.4 static struct rtdm_fd* rtdm_private_to_fd (void * dev_private) [static]

Locate a device file descriptor structure from its driver private area.

Parameters

in	*dev_private*	Address of a private context area

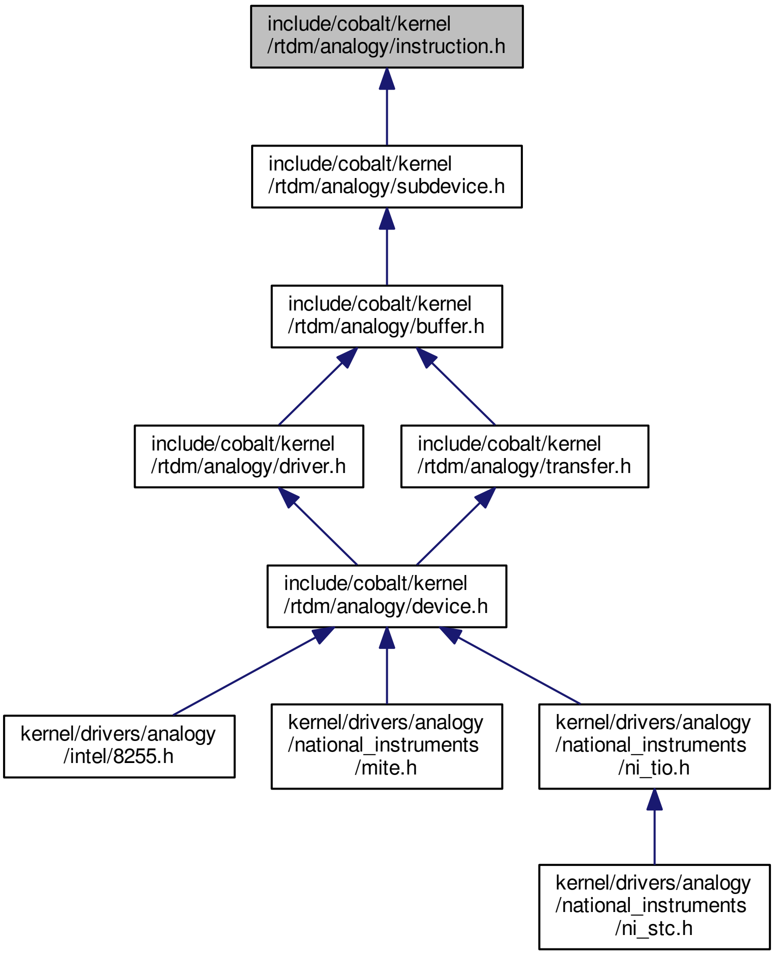
Returns

The address of the file descriptor structure defining *dev_private*.

7.7 include/cobalt/kernel/rtdm/analogy/instruction.h File Reference

Analogy for Linux, instruction related features.

This graph shows which files directly or indirectly include this file:



7.7.1 Detailed Description

Analogy for Linux, instruction related features.

Note

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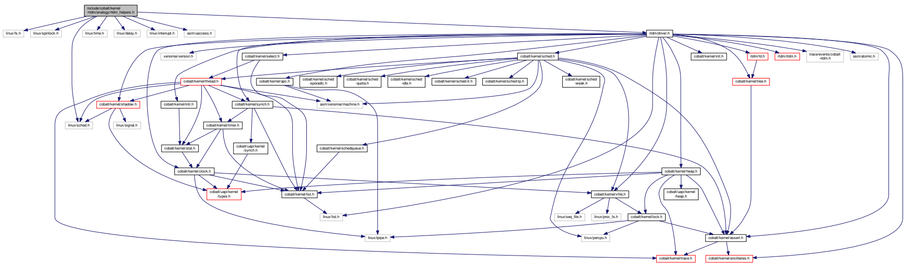
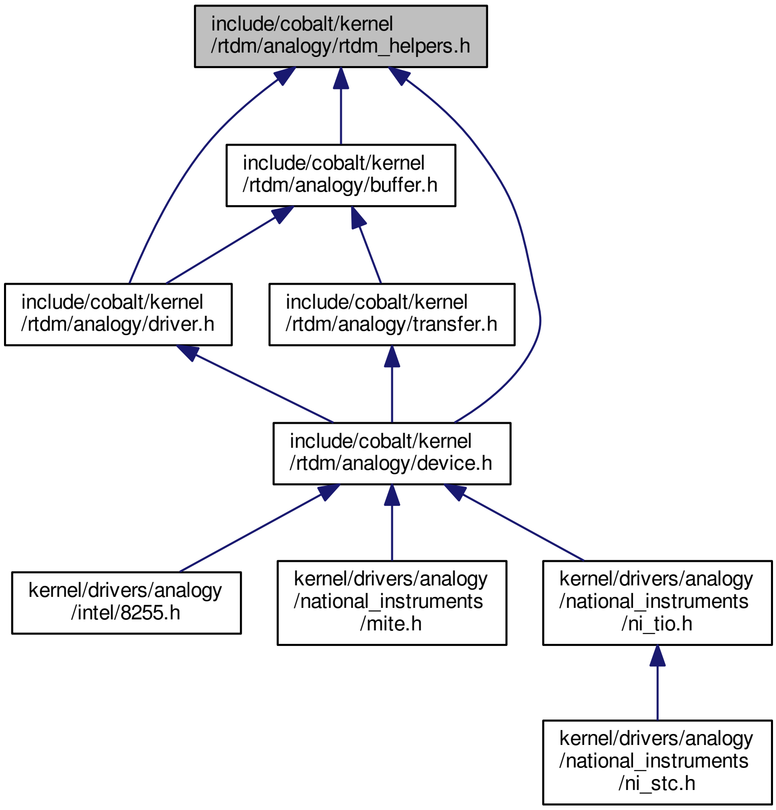
7.8 include/cobalt/kernel/rtdm/analogy/rtdm_helpers.h File Reference

Analogy for Linux, Operation system facilities.

Include dependency graph for rtdm_helpers.h:



This graph shows which files directly or indirectly include this file:



7.8.1 Detailed Description

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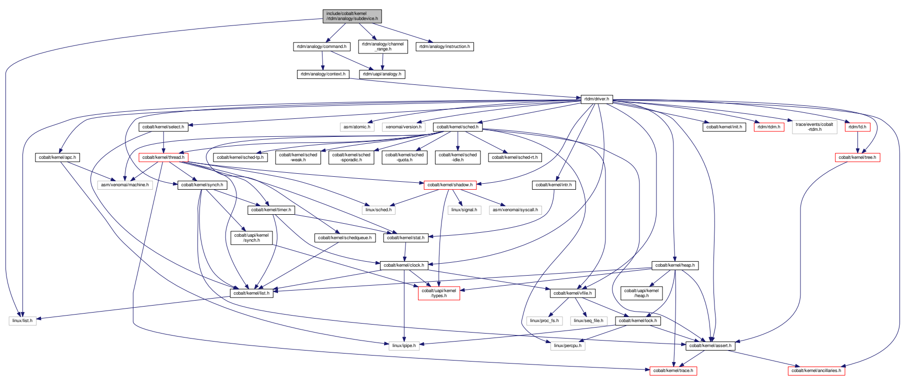
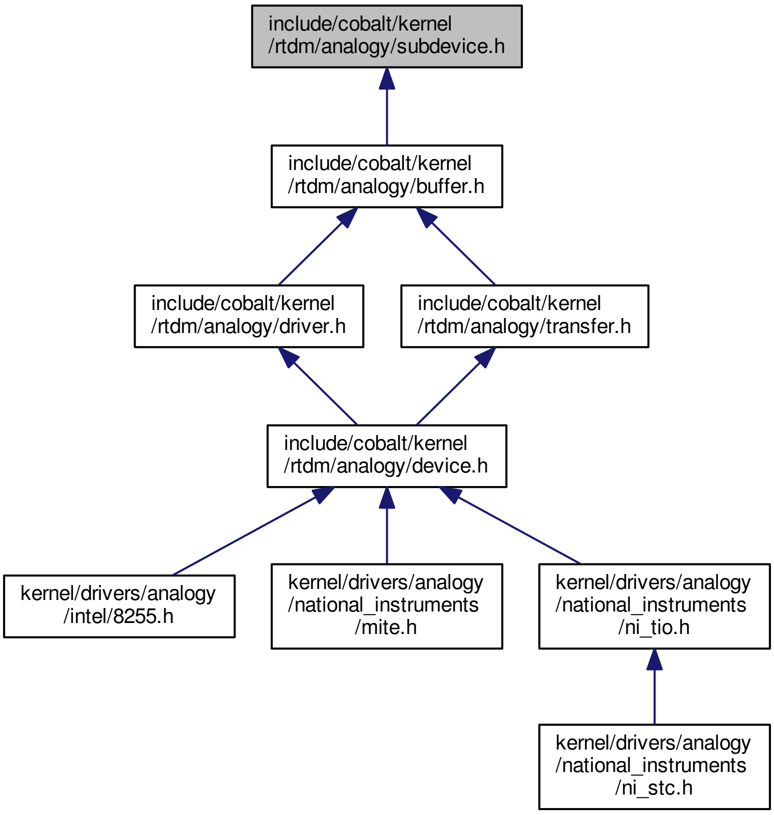
7.9 include/cobalt/kernel/rtdm/analogy/subdevice.h File Reference

Analogy for Linux, subdevice related features.

Include dependency graph for subdevice.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct a4l_subdevice

    Structure describing the subdevice.

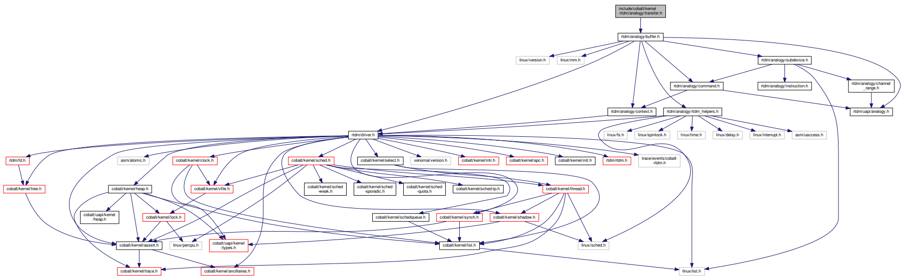
7.9.1 Detailed Description

Analogy for Linux, subdevice related features. Copyright (C) 1997-2000 David A. Schleef ds@schleef.-org Copyright (C) 2008 Alexis Berlemont alexis.berlemont@free.fr

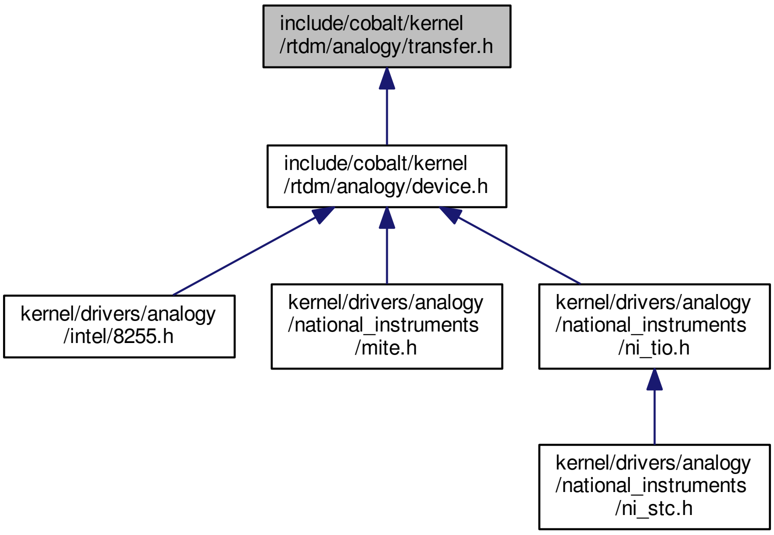
7.10 include/cobalt/kernel/rtdm/analogy/transfer.h File Reference

Analogy for Linux, transfer related features.

Include dependency graph for transfer.h:



This graph shows which files directly or indirectly include this file:



7.10.1 Detailed Description

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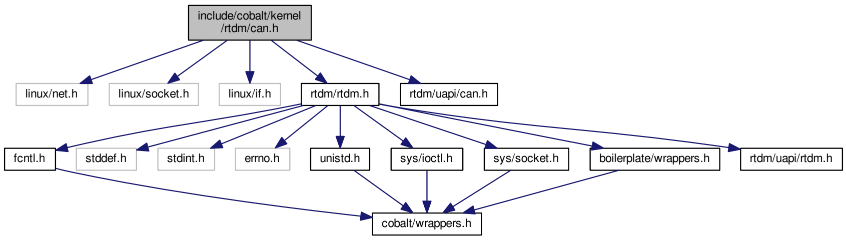
7.11 include/cobalt/kernel/rtdm/can.h File Reference

Include dependency graph for can.h:



7.11.1 Detailed Description

Note

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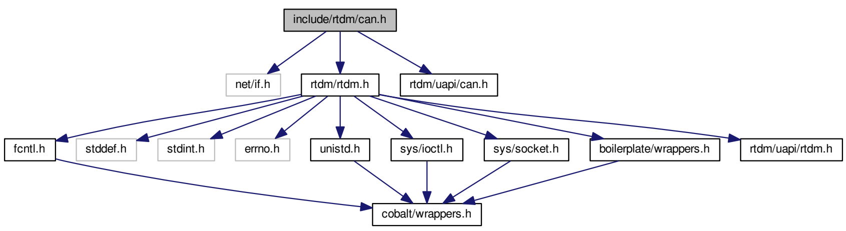
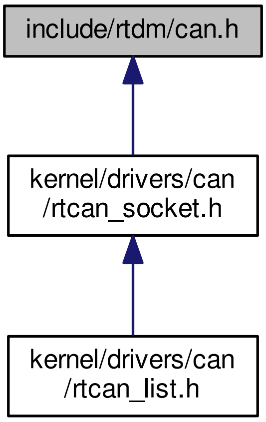
7.12 include/rtdm/can.h File Reference

Include dependency graph for can.h:



This graph shows which files directly or indirectly include this file:



7.12.1 Detailed Description

Note

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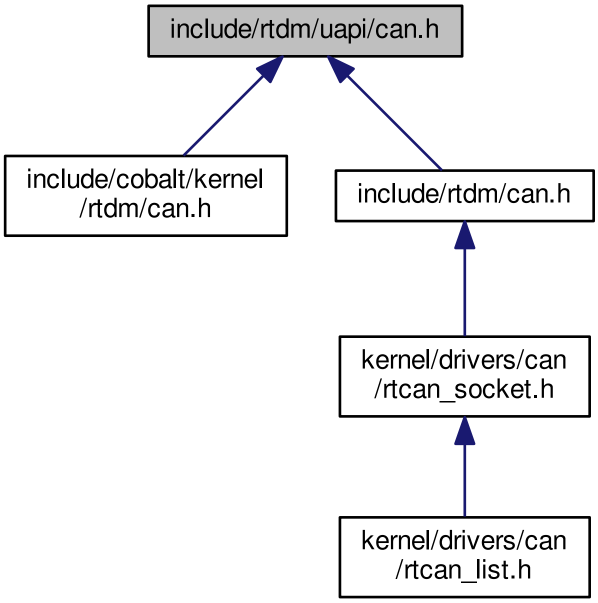
7.13 include/rtdm/uapi/can.h File Reference

Real-Time Driver Model for RT-Socket-CAN, CAN device profile header.

This graph shows which files directly or indirectly include this file:



Data Structures

- struct can_bittime_std

  Standard bit-time parameters according to Bosch.
- struct can_bittime_btr

  Hardware-specific BTR bit-times.
- struct can_bittime

  Custom CAN bit-time definition.
- struct can_filter

  Filter for reception of CAN messages.
- struct sockaddr_can

  Socket address structure for the CAN address family.
- struct can_frame

  Raw CAN frame.

Macros

- #define AF_CAN 29

  CAN address family.
- #define PF_CAN AF_CAN

  CAN protocol family.
- #define SOL_CAN_RAW 103

  CAN socket levels.

CAN ID masks

Bit masks for masking CAN IDs

- #define CAN_EFF_MASK 0x1FFFFFFF
  Bit mask for extended CAN IDs.
- #define CAN_SFF_MASK 0x000007FF
  Bit mask for standard CAN IDs.

CAN ID flags

Flags within a CAN ID indicating special CAN frame attributes

- #define CAN_EFF_FLAG 0x80000000
  Extended frame.
- #define CAN_RTR_FLAG 0x40000000
  Remote transmission frame.
- #define CAN_ERR_FLAG 0x20000000
  Error frame (see Errors), not valid in struct can_filter.
- #define CAN_INV_FILTER CAN_ERR_FLAG
  Invert CAN filter definition, only valid in struct can_filter.

Particular CAN protocols

Possible protocols for the PF_CAN protocol family

Currently only the RAW protocol is supported.

- #define CAN_RAW 1
  Raw protocol of `PF_CAN`, applicable to socket type `SOCK_RAW`.

CAN controller modes

Special CAN controllers modes, which can be or'ed together.

Note

These modes are hardware-dependent. Please consult the hardware manual of the CAN controller for more detailed information.

- #define CAN_CTRLMODE_LISTENONLY 0x1
- #define CAN_CTRLMODE_LOOPBACK 0x2
- #define CAN_CTRLMODE_3_SAMPLES 0x4

Timestamp switches

Arguments to pass to RTCAN_RTIOC_TAKE_TIMESTAMP

- #define RTCAN_TAKE_NO_TIMESTAMPS 0
  Switch off taking timestamps.
- #define RTCAN_TAKE_TIMESTAMPS 1
  Do take timestamps.

RAW socket options

Setting and getting CAN RAW socket options.

- #define CAN_RAW_FILTER 0x1
  CAN filter definition.
- #define CAN_RAW_ERR_FILTER 0x2
  CAN error mask.
- #define CAN_RAW_LOOPBACK 0x3
  CAN TX loopback.
- #define CAN_RAW_RECV_OWN_MSGS 0x4

CAN receive own messages.

IOCTLs

CAN device IOCTLs

- #define SIOCGIFINDEX defined_by_kernel_header_file
  Get CAN interface index by name.
- #define SIOCSCANBAUDRATE _IOW(RTIOC_TYPE_CAN, 0x01, struct ifreq)
  Set baud rate.
- #define SIOCGCANBAUDRATE _IOWR(RTIOC_TYPE_CAN, 0x02, struct ifreq)
  Get baud rate.
- #define SIOCSCANCUSTOMBITTIME _IOW(RTIOC_TYPE_CAN, 0x03, struct ifreq)
  Set custom bit time parameter.
- #define SIOCGCANCUSTOMBITTIME _IOWR(RTIOC_TYPE_CAN, 0x04, struct ifreq)
  Get custom bit-time parameters.
- #define SIOCSCANMODE _IOW(RTIOC_TYPE_CAN, 0x05, struct ifreq)
  Set operation mode of CAN controller.
- #define SIOCGCANSTATE _IOWR(RTIOC_TYPE_CAN, 0x06, struct ifreq)
  Get current state of CAN controller.
- #define SIOCSCANCTRLMODE _IOW(RTIOC_TYPE_CAN, 0x07, struct ifreq)
  Set special controller modes.
- #define SIOCGCANCTRLMODE _IOWR(RTIOC_TYPE_CAN, 0x08, struct ifreq)
  Get special controller modes.
- #define RTCAN_RTIOC_TAKE_TIMESTAMP _IOW(RTIOC_TYPE_CAN, 0x09, int)
  Enable or disable storing a high precision timestamp upon reception of a CAN frame.
- #define RTCAN_RTIOC_RCV_TIMEOUT _IOW(RTIOC_TYPE_CAN, 0x0A, nanosecs_rel_t)
  Specify a reception timeout for a socket.
- #define RTCAN_RTIOC_SND_TIMEOUT _IOW(RTIOC_TYPE_CAN, 0x0B, nanosecs_rel_t)
  Specify a transmission timeout for a socket.

Error mask

Error class (mask) in `can_id` field of struct can_frame to be used with CAN_RAW_ERR_FILTER.

Note: *Error reporting is hardware dependent and most CAN controllers report less detailed error conditions than the SJA1000.*

Note: *In case of a bus-off error condition (CAN_ERR_BUSOFF), the CAN controller is **not** restarted automatically. It is the application's responsibility to react appropriately, e.g. calling CAN_MODE_S-TART.*

Note: *Bus error interrupts (CAN_ERR_BUSERROR) are enabled when an application is calling a Recv function on a socket listening on bus errors (using CAN_RAW_ERR_FILTER). After one bus error has occured, the interrupt will be disabled to allow the application time for error processing and to efficiently avoid bus error interrupt flooding.*

- #define CAN_ERR_TX_TIMEOUT 0x00000001U
  TX timeout (netdevice driver)
- #define CAN_ERR_LOSTARB 0x00000002U
  Lost arbitration (see data[0])
- #define CAN_ERR_CRTL 0x00000004U
  Controller problems (see data[1])
- #define CAN_ERR_PROT 0x00000008U
  Protocol violations (see data[2], data[3])
- #define CAN_ERR_TRX 0x00000010U
  Transceiver status (see data[4])
- #define CAN_ERR_ACK 0x00000020U
  Received no ACK on transmission.
- #define CAN_ERR_BUSOFF 0x00000040U
  Bus off.

- #define CAN_ERR_BUSERROR 0x00000080U
  Bus error (may flood!)
- #define CAN_ERR_RESTARTED 0x00000100U
  Controller restarted.
- #define CAN_ERR_MASK 0x1FFFFFFFU
  Omit EFF, RTR, ERR flags.

Arbitration lost error

Error in the data[0] field of struct can_frame.

- #define CAN_ERR_LOSTARB_UNSPEC 0x00
  unspecified

Controller problems

Error in the data[1] field of struct can_frame.

- #define CAN_ERR_CRTL_UNSPEC 0x00
  unspecified
- #define CAN_ERR_CRTL_RX_OVERFLOW 0x01
  RX buffer overflow.
- #define CAN_ERR_CRTL_TX_OVERFLOW 0x02
  TX buffer overflow.
- #define CAN_ERR_CRTL_RX_WARNING 0x04
  reached warning level for RX errors
- #define CAN_ERR_CRTL_TX_WARNING 0x08
  reached warning level for TX errors
- #define CAN_ERR_CRTL_RX_PASSIVE 0x10
  reached passive level for RX errors
- #define CAN_ERR_CRTL_TX_PASSIVE 0x20
  reached passive level for TX errors

Protocol error type

Error in the data[2] field of struct can_frame.

- #define CAN_ERR_PROT_UNSPEC 0x00
  unspecified
- #define CAN_ERR_PROT_BIT 0x01
  single bit error
- #define CAN_ERR_PROT_FORM 0x02
  frame format error
- #define CAN_ERR_PROT_STUFF 0x04
  bit stuffing error
- #define CAN_ERR_PROT_BIT0 0x08
  unable to send dominant bit
- #define CAN_ERR_PROT_BIT1 0x10
  unable to send recessive bit
- #define CAN_ERR_PROT_OVERLOAD 0x20
  bus overload
- #define CAN_ERR_PROT_ACTIVE 0x40
  active error announcement
- #define CAN_ERR_PROT_TX 0x80
  error occured on transmission

Protocol error location

Error in the data[4] field of struct can_frame.

- #define CAN_ERR_PROT_LOC_UNSPEC 0x00
  unspecified
- #define CAN_ERR_PROT_LOC_SOF 0x03
  start of frame
- #define CAN_ERR_PROT_LOC_ID28_21 0x02
  ID bits 28 - 21 (SFF: 10 - 3)
- #define CAN_ERR_PROT_LOC_ID20_18 0x06
  ID bits 20 - 18 (SFF: 2 - 0)
- #define CAN_ERR_PROT_LOC_SRTR 0x04
  substitute RTR (SFF: RTR)
- #define CAN_ERR_PROT_LOC_IDE 0x05
  identifier extension
- #define CAN_ERR_PROT_LOC_ID17_13 0x07
  ID bits 17-13.
- #define CAN_ERR_PROT_LOC_ID12_05 0x0F
  ID bits 12-5.
- #define CAN_ERR_PROT_LOC_ID04_00 0x0E
  ID bits 4-0.
- #define CAN_ERR_PROT_LOC_RTR 0x0C
  RTR.
- #define CAN_ERR_PROT_LOC_RES1 0x0D
  reserved bit 1
- #define CAN_ERR_PROT_LOC_RES0 0x09
  reserved bit 0
- #define CAN_ERR_PROT_LOC_DLC 0x0B
  data length code
- #define CAN_ERR_PROT_LOC_DATA 0x0A
  data section
- #define CAN_ERR_PROT_LOC_CRC_SEQ 0x08
  CRC sequence.
- #define CAN_ERR_PROT_LOC_CRC_DEL 0x18
  CRC delimiter.
- #define CAN_ERR_PROT_LOC_ACK 0x19
  ACK slot.
- #define CAN_ERR_PROT_LOC_ACK_DEL 0x1B
  ACK delimiter.
- #define CAN_ERR_PROT_LOC_EOF 0x1A
  end of frame
- #define CAN_ERR_PROT_LOC_INTERM 0x12
  intermission
- #define CAN_ERR_TRX_UNSPEC 0x00
  0000 0000
- #define CAN_ERR_TRX_CANH_NO_WIRE 0x04
  0000 0100
- #define CAN_ERR_TRX_CANH_SHORT_TO_BAT 0x05
  0000 0101
- #define CAN_ERR_TRX_CANH_SHORT_TO_VCC 0x06
  0000 0110
- #define CAN_ERR_TRX_CANH_SHORT_TO_GND 0x07
  0000 0111
- #define CAN_ERR_TRX_CANL_NO_WIRE 0x40
  0100 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_BAT 0x50
  0101 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_VCC 0x60
  0110 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_GND 0x70
  0111 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_CANH 0x80
  1000 0000

Typedefs

- typedef uint32_t can_id_t

  Type of CAN id (see CAN_xxx_MASK and CAN_xxx_FLAG)
- typedef can_id_t can_err_mask_t

  Type of CAN error mask.
- typedef uint32_t can_baudrate_t

  Baudrate definition in bits per second.
- typedef enum CAN_BITTIME_TYPE can_bittime_type_t

  See CAN_BITTIME_TYPE.
- typedef enum CAN_MODE can_mode_t

  See CAN_MODE.
- typedef int can_ctrlmode_t

  See CAN_CTRLMODE.
- typedef enum CAN_STATE can_state_t

  See CAN_STATE.
- typedef struct can_filter can_filter_t

  Filter for reception of CAN messages.
- typedef struct can_frame can_frame_t

  Raw CAN frame.

Enumerations

- enum CAN_BITTIME_TYPE { CAN_BITTIME_STD, CAN_BITTIME_BTR }

  Supported CAN bit-time types.

CAN operation modes

Modes into which CAN controllers can be set

- enum CAN_MODE { CAN_MODE_STOP = 0, CAN_MODE_START, CAN_MODE_SLEEP }

CAN controller states

States a CAN controller can be in.

- enum CAN_STATE {
  CAN_STATE_ERROR_ACTIVE = 0, CAN_STATE_ACTIVE = 0, CAN_STATE_ERROR_WARNING = 1, CAN_STATE_BUS_WARNING = 1,
  CAN_STATE_ERROR_PASSIVE = 2, CAN_STATE_BUS_PASSIVE = 2, CAN_STATE_BUS_OFF, CAN_STATE_SCANNING_BAUDRATE,
  CAN_STATE_STOPPED, CAN_STATE_SLEEPING }

7.13.1 Detailed Description

Real-Time Driver Model for RT-Socket-CAN, CAN device profile header.

Note

Copyright (C) 2006 Wolfgang Grandegger wg@grandegger.com
Copyright (C) 2005, 2006 Sebastian Smolorz Sebastian.Smolorz@stud.uni-hannover.de

This RTDM CAN device profile header is based on:

include/linux/can.h, include/linux/socket.h, net/can/pf_can.h in linux-can.patch, a CAN socket framework for Linux

Copyright (C) 2004, 2005, Robert Schwebel, Benedikt Spranger, Marc Kleine-Budde, Pengutronix

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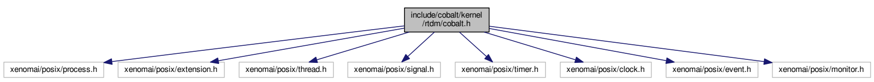
7.14 include/cobalt/kernel/rtdm/cobalt.h File Reference

This file is part of the Xenomai project.

Include dependency graph for cobalt.h:



7.14.1 Detailed Description

This file is part of the Xenomai project.

Note

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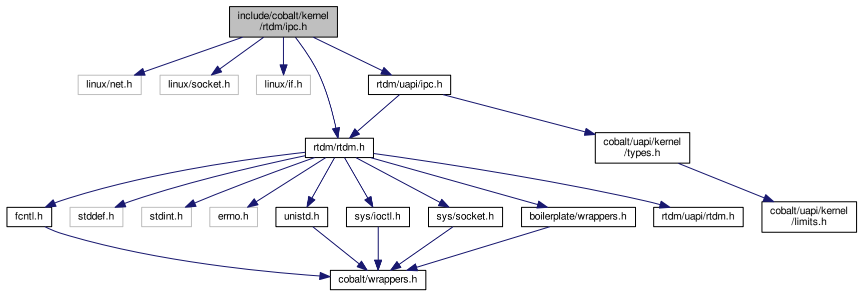
7.15 include/cobalt/kernel/rtdm/ipc.h File Reference

This file is part of the Xenomai project.

Include dependency graph for ipc.h:



7.15.1 Detailed Description

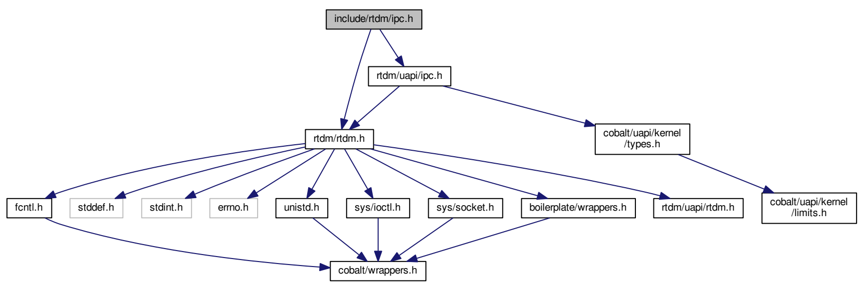
This file is part of the Xenomai project.

Note

7.16 include/rtdm/ipc.h File Reference

This file is part of the Xenomai project.

Include dependency graph for ipc.h:



7.16.1 Detailed Description

This file is part of the Xenomai project.

Note

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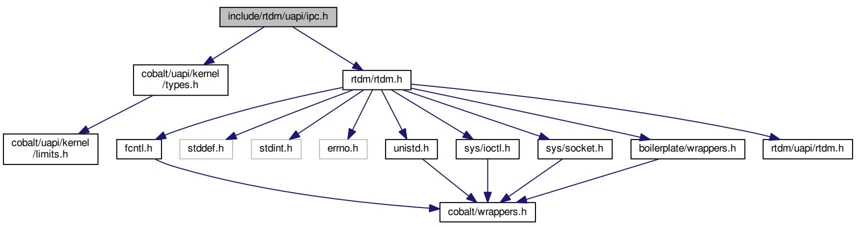
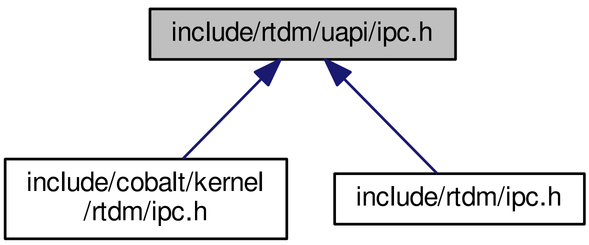
7.17 include/rtdm/uapi/ipc.h File Reference

This file is part of the Xenomai project.

Include dependency graph for ipc.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct rtipc_port_label

  Port label information structure.
- struct sockaddr_ipc

  Socket address structure for the RTIPC address family.

Macros

XDDP socket options

Setting and getting XDDP socket options.

- #define XDDP_LABEL 1
  XDDP label assignment.
- #define XDDP_POOLSZ 2
  XDDP local pool size configuration.
- #define XDDP_BUFSZ 3
  XDDP streaming buffer size configuration.
- #define XDDP_MONITOR 4
  XDDP monitoring callback.

XDDP events

Specific events occurring on XDDP channels, which can be monitored via the XDDP_MONITOR socket option.

- #define XDDP_EVTIN 1
  Monitor writes to the non real-time endpoint.
- #define XDDP_EVTOUT 2
  Monitor reads from the non real-time endpoint.
- #define XDDP_EVTDOWN 3
  Monitor close from the non real-time endpoint.
- #define XDDP_EVTNOBUF 4
  Monitor memory shortage for non real-time datagrams.

IDDP socket options

Setting and getting IDDP socket options.

- #define IDDP_LABEL 1
  IDDP label assignment.
- #define IDDP_POOLSZ 2
  IDDP local pool size configuration.

BUFP socket options

Setting and getting BUFP socket options.

- #define BUFP_LABEL 1
  BUFP label assignment.
- #define BUFP_BUFSZ 2
  BUFP buffer size configuration.

Socket level options

Setting and getting supported standard socket level options.

- #define SO_SNDTIMEO defined_by_kernel_header_file
  IPCPROTO_IDDP and IPCPROTO_BUFP protocols support the standard SO_SNDTIMEO socket option, from the `SOL_SOCKET` level.
- #define SO_RCVTIMEO defined_by_kernel_header_file
  All RTIPC protocols support the standard SO_RCVTIMEO socket option, from the `SOL_SOCKET` level.

Typedefs

- typedef int16_t rtipc_port_t
  Port number type for the RTIPC address family.

Enumerations

RTIPC protocol list

protocols for the PF_RTIPC protocol family

- enum { IPCPROTO_IPC = 0, IPCPROTO_XDDP = 1, IPCPROTO_IDDP = 2, IPCPROTO_BUFP = 3 }

Functions

Supported operations

Standard socket operations supported by the RTIPC protocols.

- int socket__AF_RTIPC (int domain=AF_RTIPC, int type=SOCK_DGRAM, int protocol)
  Create an endpoint for communication in the AF_RTIPC domain.
- int close__AF_RTIPC (int sockfd)
  Close a RTIPC socket descriptor.
- int bind__AF_RTIPC (int sockfd, const struct sockaddr_ipc *addr, socklen_t addrlen)
  Bind a RTIPC socket to a port.
- int connect__AF_RTIPC (int sockfd, const struct sockaddr_ipc *addr, socklen_t addrlen)
  Initiate a connection on a RTIPC socket.
- int setsockopt__AF_RTIPC (int sockfd, int level, int optname, const void *optval, socklen_t optlen)
  Set options on RTIPC sockets.
- int getsockopt__AF_RTIPC (int sockfd, int level, int optname, void *optval, socklen_t *optlen)
  Get options on RTIPC sockets.
- ssize_t sendmsg__AF_RTIPC (int sockfd, const struct msghdr *msg, int flags)
  Send a message on a RTIPC socket.
- ssize_t recvmsg__AF_RTIPC (int sockfd, struct msghdr *msg, int flags)
  Receive a message from a RTIPC socket.
- int getsockname__AF_RTIPC (int sockfd, struct sockaddr_ipc *addr, socklen_t *addrlen)
  Get socket name.
- int getpeername__AF_RTIPC (int sockfd, struct sockaddr_ipc *addr, socklen_t *addrlen)
  Get socket peer.

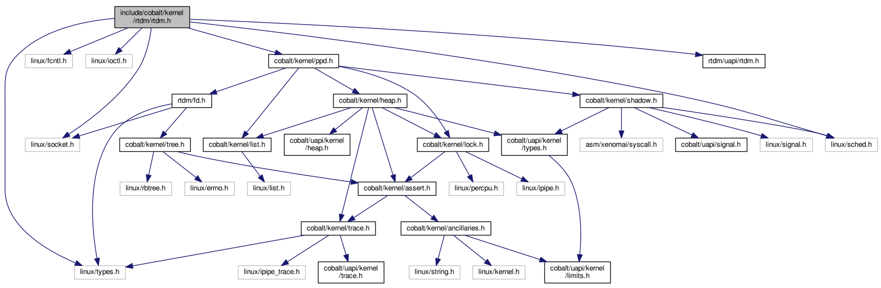
7.17.1 Detailed Description

This file is part of the Xenomai project.

Note

7.18 include/cobalt/kernel/rtdm/rtdm.h File Reference

Include dependency graph for rtdm.h:



7.18.1 Detailed Description

Note

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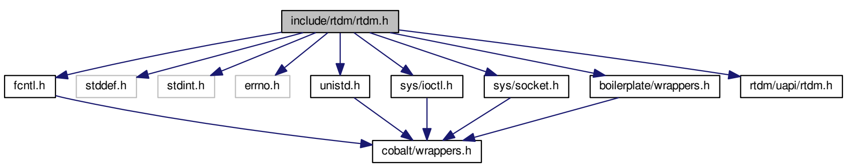
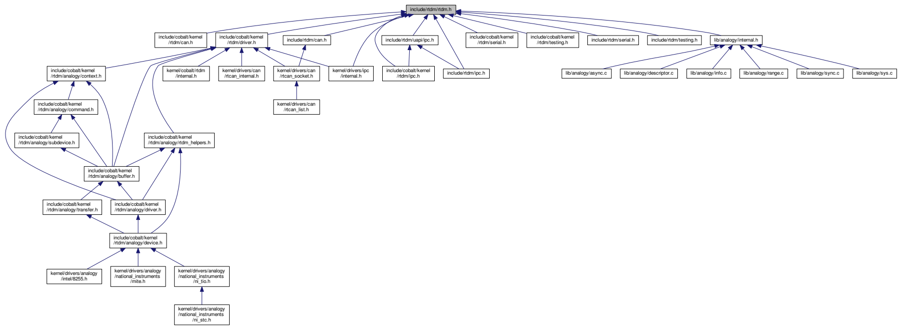
7.19 include/rtdm/rtdm.h File Reference

Include dependency graph for rtdm.h:



This graph shows which files directly or indirectly include this file:



7.19.1 Detailed Description

Note

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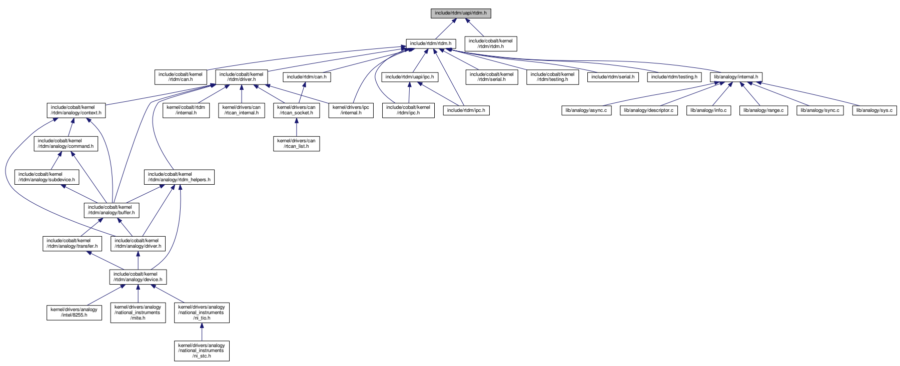
7.20 include/rtdm/uapi/rtdm.h File Reference

Real-Time Driver Model for Xenomai, user API header.

This graph shows which files directly or indirectly include this file:



Data Structures

- struct rtdm_device_info

Device information.

Macros

API Versioning

- #define RTDM_API_VER 9
  Common user and driver API version.
- #define RTDM_API_MIN_COMPAT_VER 9
  Minimum API revision compatible with the current release.

RTDM_TIMEOUT_xxx

Special timeout values

- #define RTDM_TIMEOUT_INFINITE 0
  Block forever.
- #define RTDM_TIMEOUT_NONE (-1)
  Any negative timeout means non-blocking.

RTDM_CLASS_xxx

Device classes

- #define **RTDM_CLASS_PARPORT** 1
- #define **RTDM_CLASS_SERIAL** 2
- #define **RTDM_CLASS_CAN** 3
- #define **RTDM_CLASS_NETWORK** 4
- #define **RTDM_CLASS_RTMAC** 5
- #define **RTDM_CLASS_TESTING** 6
- #define **RTDM_CLASS_RTIPC** 7
- #define **RTDM_CLASS_COBALT** 8
- #define **RTDM_CLASS_EXPERIMENTAL** 224
- #define **RTDM_CLASS_MAX** 255

Device Naming

Maximum length of device names (excluding the final null character)

- #define **RTDM_MAX_DEVNAME_LEN** 31

RTDM_PURGE_xxx_BUFFER

Flags selecting buffers to be purged

- #define **RTDM_PURGE_RX_BUFFER** 0x0001
- #define **RTDM_PURGE_TX_BUFFER** 0x0002

Common IOCTLs

The following IOCTLs are common to all device rtdm_profiles.

- #define RTIOC_DEVICE_INFO _IOR(RTIOC_TYPE_COMMON, 0x00, struct rtdm_device_-info)
  Retrieve information about a device or socket.
- #define RTIOC_PURGE _IOW(RTIOC_TYPE_COMMON, 0x10, int)
  Purge internal device or socket buffers.

Typedefs

- typedef uint64_t nanosecs_abs_t

    RTDM type for representing absolute dates.
- typedef int64_t nanosecs_rel_t

    RTDM type for representing relative intervals.
- typedef struct rtdm_device_info rtdm_device_info_t

    Device information.

7.20.1 Detailed Description

Real-Time Driver Model for Xenomai, user API header.

Note

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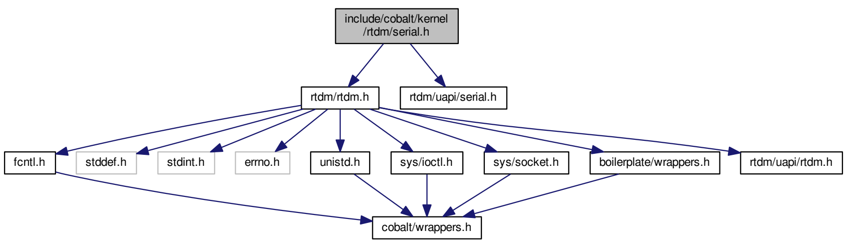
7.21 include/cobalt/kernel/rtdm/serial.h File Reference

Include dependency graph for serial.h:



7.21.1 Detailed Description

Note

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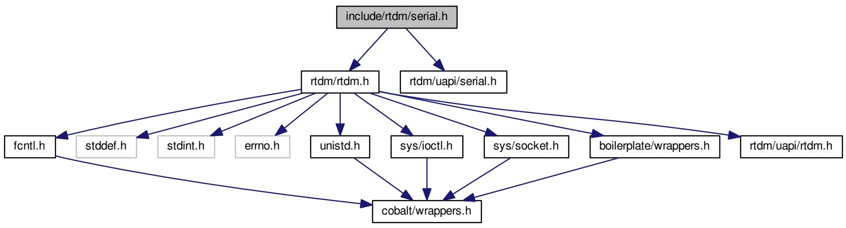
7.22 include/rtdm/serial.h File Reference

Real-Time Driver Model for Xenomai, serial device profile header.

Include dependency graph for serial.h:



7.22.1 Detailed Description

Real-Time Driver Model for Xenomai, serial device profile header.

Note

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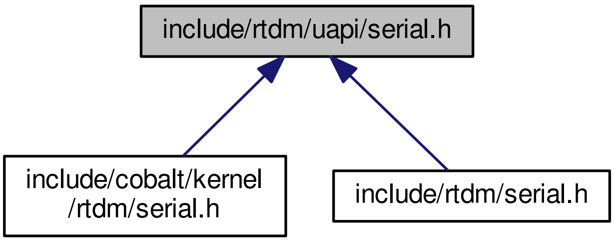
7.23 include/rtdm/uapi/serial.h File Reference

Real-Time Driver Model for Xenomai, serial device profile header.

This graph shows which files directly or indirectly include this file:



Data Structures

- struct rtser_config

    Serial device configuration.
- struct rtser_status

    Serial device status.
- struct rtser_event

    Additional information about serial device events.

Macros

- #define RTSER_RTIOC_BREAK_CTL _IOR(RTIOC_TYPE_SERIAL, 0x06, int)

    Set or clear break on UART output line.

RTSER_DEF_BAUD

Default baud rate

- #define **RTSER_DEF_BAUD** 9600

RTSER_xxx_PARITY

Number of parity bits

- #define **RTSER_NO_PARITY** 0x00
- #define **RTSER_ODD_PARITY** 0x01
- #define **RTSER_EVEN_PARITY** 0x03
- #define **RTSER_DEF_PARITY** RTSER_NO_PARITY

RTSER_xxx_BITS

Number of data bits

- #define **RTSER_5_BITS** 0x00
- #define **RTSER_6_BITS** 0x01
- #define **RTSER_7_BITS** 0x02
- #define **RTSER_8_BITS** 0x03
- #define **RTSER_DEF_BITS** RTSER_8_BITS

RTSER_xxx_STOPB

Number of stop bits

- #define RTSER_1_STOPB 0x00

  valid only in combination with 5 data bits
- #define RTSER_1_5_STOPB 0x01

  valid only in combination with 5 data bits
- #define RTSER_2_STOPB 0x01

  valid only in combination with 5 data bits
- #define RTSER_DEF_STOPB RTSER_1_STOPB

  valid only in combination with 5 data bits

RTSER_xxx_HAND

Handshake mechanisms

- #define **RTSER_NO_HAND** 0x00
- #define **RTSER_RTSCTS_HAND** 0x01
- #define **RTSER_DEF_HAND** RTSER_NO_HAND

RTSER_RS485_xxx

RS485 mode with automatic RTS handling

- #define **RTSER_RS485_DISABLE** 0x00
- #define **RTSER_RS485_ENABLE** 0x01
- #define **RTSER_DEF_RS485** RTSER_RS485_DISABLE

RTSER_FIFO_xxx

Reception FIFO interrupt threshold

- #define **RTSER_FIFO_DEPTH_1** 0x00
- #define **RTSER_FIFO_DEPTH_4** 0x40
- #define **RTSER_FIFO_DEPTH_8** 0x80
- #define **RTSER_FIFO_DEPTH_14** 0xC0
- #define **RTSER_DEF_FIFO_DEPTH** RTSER_FIFO_DEPTH_1

RTSER_TIMEOUT_xxx

Special timeout values, see also RTDM_TIMEOUT_xxx

- #define **RTSER_TIMEOUT_INFINITE** RTDM_TIMEOUT_INFINITE
- #define **RTSER_TIMEOUT_NONE** RTDM_TIMEOUT_NONE
- #define **RTSER_DEF_TIMEOUT** RTDM_TIMEOUT_INFINITE

RTSER_xxx_TIMESTAMP_HISTORY

Timestamp history control

- #define **RTSER_RX_TIMESTAMP_HISTORY** 0x01
- #define **RTSER_DEF_TIMESTAMP_HISTORY** 0x00

RTSER_EVENT_xxx

Events bits

- #define **RTSER_EVENT_RXPEND** 0x01
- #define **RTSER_EVENT_ERRPEND** 0x02
- #define **RTSER_EVENT_MODEMHI** 0x04
- #define **RTSER_EVENT_MODEMLO** 0x08
- #define **RTSER_EVENT_TXEMPTY** 0x10
- #define **RTSER_DEF_EVENT_MASK** 0x00

RTSER_SET_xxx

Configuration mask bits

- #define **RTSER_SET_BAUD** 0x0001
- #define **RTSER_SET_PARITY** 0x0002
- #define **RTSER_SET_DATA_BITS** 0x0004
- #define **RTSER_SET_STOP_BITS** 0x0008
- #define **RTSER_SET_HANDSHAKE** 0x0010
- #define **RTSER_SET_FIFO_DEPTH** 0x0020
- #define **RTSER_SET_TIMEOUT_RX** 0x0100
- #define **RTSER_SET_TIMEOUT_TX** 0x0200
- #define **RTSER_SET_TIMEOUT_EVENT** 0x0400
- #define **RTSER_SET_TIMESTAMP_HISTORY** 0x0800
- #define **RTSER_SET_EVENT_MASK** 0x1000
- #define **RTSER_SET_RS485** 0x2000

RTSER_LSR_xxx

Line status bits

- #define **RTSER_LSR_DATA** 0x01
- #define **RTSER_LSR_OVERRUN_ERR** 0x02
- #define **RTSER_LSR_PARITY_ERR** 0x04
- #define **RTSER_LSR_FRAMING_ERR** 0x08
- #define **RTSER_LSR_BREAK_IND** 0x10
- #define **RTSER_LSR_THR_EMTPY** 0x20
- #define **RTSER_LSR_TRANSM_EMPTY** 0x40
- #define **RTSER_LSR_FIFO_ERR** 0x80
- #define **RTSER_SOFT_OVERRUN_ERR** 0x0100

RTSER_MSR_xxx

Modem status bits

- #define **RTSER_MSR_DCTS** 0x01
- #define **RTSER_MSR_DDSR** 0x02
- #define **RTSER_MSR_TERI** 0x04
- #define **RTSER_MSR_DDCD** 0x08
- #define **RTSER_MSR_CTS** 0x10
- #define **RTSER_MSR_DSR** 0x20
- #define **RTSER_MSR_RI** 0x40
- #define **RTSER_MSR_DCD** 0x80

RTSER_MCR_xxx

Modem control bits

- #define **RTSER_MCR_DTR** 0x01
- #define **RTSER_MCR_RTS** 0x02
- #define **RTSER_MCR_OUT1** 0x04
- #define **RTSER_MCR_OUT2** 0x08
- #define **RTSER_MCR_LOOP** 0x10

Sub-Classes of RTDM_CLASS_SERIAL

- #define **RTDM_SUBCLASS_16550A** 0

IOCTLs

Serial device IOCTLs

- #define RTSER_RTIOC_GET_CONFIG _IOR(RTIOC_TYPE_SERIAL, 0x00, struct rtser_-config)

  Get serial device configuration.

- #define RTSER_RTIOC_SET_CONFIG _IOW(RTIOC_TYPE_SERIAL, 0x01, struct rtser_-config)
  Set serial device configuration.
- #define RTSER_RTIOC_GET_STATUS _IOR(RTIOC_TYPE_SERIAL, 0x02, struct rtser_-status)
  Get serial device status.
- #define RTSER_RTIOC_GET_CONTROL _IOR(RTIOC_TYPE_SERIAL, 0x03, int)
  Get serial device's modem contol register.
- #define RTSER_RTIOC_SET_CONTROL _IOW(RTIOC_TYPE_SERIAL, 0x04, int)
  Set serial device's modem contol register.
- #define RTSER_RTIOC_WAIT_EVENT _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_-event)
  Wait on serial device events according to previously set mask.

RTSER_BREAK_xxx

Break control

- #define RTSER_BREAK_CLR 0x00
  Serial device configuration.
- #define RTSER_BREAK_SET 0x01
  Serial device configuration.
- #define RTIOC_TYPE_SERIAL RTDM_CLASS_SERIAL
  Serial device configuration.
- typedef struct rtser_config rtser_config_t
  Serial device configuration.
- typedef struct rtser_status rtser_status_t
  Serial device status.
- typedef struct rtser_event rtser_event_t
  Additional information about serial device events.

7.23.1 Detailed Description

Real-Time Driver Model for Xenomai, serial device profile header.

Note

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7.23.2 Macro Definition Documentation

7.23.2.1 #define RTSER_RTIOC_BREAK_CTL _IOR(**RTIOC_TYPE_SERIAL**, 0x06, int)

Set or clear break on UART output line.

Parameters

in	*arg*	RTSER_BREAK_SET or RTSER_BREAK_CLR (int)

Returns

0 on success, otherwise negative error code

Tags

task-unrestricted

Note

A set break condition may also be cleared on UART line reconfiguration.

7.23.2.2 #define RTSER_RTIOC_GET_CONFIG _IOR(**RTIOC_TYPE_SERIAL**, 0x00, struct rtser_config)

Get serial device configuration.

Parameters

out	*arg*	Pointer to configuration buffer (struct rtser_config)

Returns

0 on success, otherwise negative error code

Tags

task-unrestricted

7.23.2.3 #define RTSER_RTIOC_GET_CONTROL _IOR(**RTIOC_TYPE_SERIAL**, 0x03, int)

Get serial device's modem contol register.

Parameters

out	*arg*	Pointer to variable receiving the content (int, see RTSER_MCR_xxx)

Returns

0 on success, otherwise negative error code

Tags

task-unrestricted

7.23.2.4 #define RTSER_RTIOC_GET_STATUS _IOR(**RTIOC_TYPE_SERIAL**, 0x02, struct rtser_status)

Get serial device status.

Parameters

out	*arg*	Pointer to status buffer (struct rtser_status)

Returns

0 on success, otherwise negative error code

Tags

task-unrestricted

Note

The error states `RTSER_LSR_OVERRUN_ERR`, `RTSER_LSR_PARITY_ERR`, `RTSER_LSR_FRAMING_ERR`, and `RTSER_SOFT_OVERRUN_ERR` that may have occured during previous read accesses to the device will be saved for being reported via this IOCTL. Upon return from `RTSER_RTIOC_GET_STATUS`, the saved state will be cleared.

7.23.2.5 #define RTSER_RTIOC_SET_CONFIG _IOW(**RTIOC_TYPE_SERIAL**, 0x01, struct rtser_config)

Set serial device configuration.

Parameters

in	*arg*	Pointer to configuration buffer (struct rtser_config)

Returns

0 on success, otherwise:

- -EPERM is returned if the caller's context is invalid, see note below.
- -ENOMEM is returned if a new history buffer for timestamps cannot be allocated.

Tags

task-unrestricted

Note

If rtser_config contains a valid timestamp_history and the addressed device has been opened in non-real-time context, this IOCTL must be issued in non-real-time context as well. Otherwise, this command will fail.

Examples:

cross-link.c.

7.23.2.6 #define RTSER_RTIOC_SET_CONTROL _IOW(**RTIOC_TYPE_SERIAL**, 0x04, int)

Set serial device's modem contol register.

Parameters

in	*arg*	New control register content (int, see RTSER_MCR_xxx)

Returns

0 on success, otherwise negative error code

Tags

task-unrestricted

7.23.2.7 #define RTSER_RTIOC_WAIT_EVENT _IOR(**RTIOC_TYPE_SERIAL**, 0x05, struct rtser_event)

Wait on serial device events according to previously set mask.

Parameters

out	*arg*	Pointer to event information buffer (struct rtser_event)

Returns

0 on success, otherwise:

- -EBUSY is returned if another task is already waiting on events of this device.
- -EBADF is returned if the file descriptor is invalid or the device has just been closed.

Tags

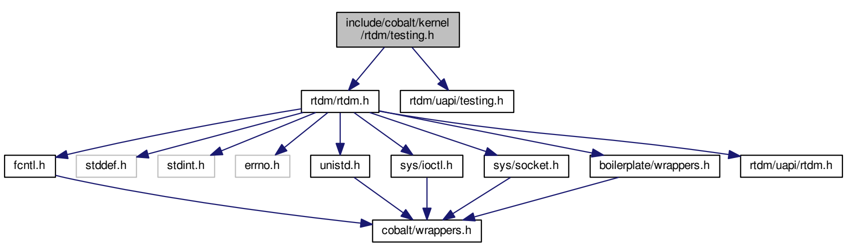
mode-unrestricted

Examples:

cross-link.c.

7.24 include/cobalt/kernel/rtdm/testing.h File Reference

Include dependency graph for testing.h:



7.24.1 Detailed Description

Note

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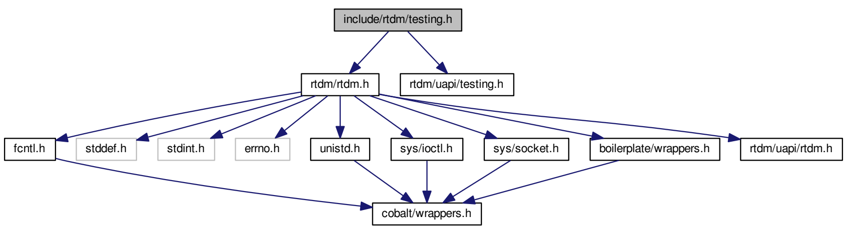
7.25 include/rtdm/testing.h File Reference

Real-Time Driver Model for Xenomai, testing device profile header.

Include dependency graph for testing.h:



7.25.1 Detailed Description

Real-Time Driver Model for Xenomai, testing device profile header.

Note

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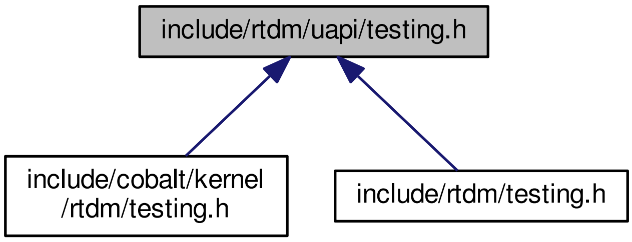
7.26 include/rtdm/uapi/testing.h File Reference

Real-Time Driver Model for Xenomai, testing device profile header.

This graph shows which files directly or indirectly include this file:



Macros

Sub-Classes of RTDM_CLASS_TESTING

- #define RTDM_SUBCLASS_TIMERBENCH 0
  subclass name: "timerbench"
- #define RTDM_SUBCLASS_IRQBENCH 1
  subclass name: "irqbench"
- #define RTDM_SUBCLASS_SWITCHTEST 2
  subclass name: "switchtest"
- #define RTDM_SUBCLASS_RTDMTEST 3
  subclase name: "rtdm"

IOCTLs

Testing device IOCTLs

- #define **RTTST_RTIOC_INTERM_BENCH_RES** _IOWR(RTIOC_TYPE_TESTING, 0x00, struct rttst_interm_bench_res)
- #define **RTTST_RTIOC_TMBENCH_START** _IOW(RTIOC_TYPE_TESTING, 0x10, struct rttst_tmbench_config)
- #define **RTTST_RTIOC_TMBENCH_STOP** _IOWR(RTIOC_TYPE_TESTING, 0x11, struct rttst_overall_bench_res)
- #define **RTTST_RTIOC_IRQBENCH_START** _IOW(RTIOC_TYPE_TESTING, 0x20, struct rttst_irqbench_config)
- #define **RTTST_RTIOC_IRQBENCH_STOP** _IO(RTIOC_TYPE_TESTING, 0x21)
- #define **RTTST_RTIOC_IRQBENCH_GET_STATS** _IOR(RTIOC_TYPE_TESTING, 0x22, struct rttst_irqbench_stats)
- #define **RTTST_RTIOC_IRQBENCH_WAIT_IRQ** _IO(RTIOC_TYPE_TESTING, 0x23)
- #define **RTTST_RTIOC_IRQBENCH_REPLY_IRQ** _IO(RTIOC_TYPE_TESTING, 0x24)
- #define **RTTST_RTIOC_SWTEST_SET_TASKS_COUNT** _IOW(RTIOC_TYPE_TESTING, 0x30, unsigned long)
- #define **RTTST_RTIOC_SWTEST_SET_CPU** _IOW(RTIOC_TYPE_TESTING, 0x31, unsigned long)
- #define **RTTST_RTIOC_SWTEST_REGISTER_UTASK** _IOW(RTIOC_TYPE_TESTING, 0x32, struct rttst_swtest_task)
- #define **RTTST_RTIOC_SWTEST_CREATE_KTASK** _IOWR(RTIOC_TYPE_TESTING, 0x33, struct rttst_swtest_task)
- #define **RTTST_RTIOC_SWTEST_PEND** _IOR(RTIOC_TYPE_TESTING, 0x34, struct rttst_-swtest_task)

- #define **RTTST_RTIOC_SWTEST_SWITCH_TO** _IOR(RTIOC_TYPE_TESTING, 0x35, struct rttst_swtest_dir)
- #define **RTTST_RTIOC_SWTEST_GET_SWITCHES_COUNT** _IOR(RTIOC_TYPE_TESTING, 0x36, unsigned long)
- #define **RTTST_RTIOC_SWTEST_GET_LAST_ERROR** _IOR(RTIOC_TYPE_TESTING, 0x37, struct rttst_swtest_error)
- #define **RTTST_RTIOC_SWTEST_SET_PAUSE** _IOW(RTIOC_TYPE_TESTING, 0x38, unsigned long)
- #define **RTTST_RTIOC_RTDM_DEFER_CLOSE** _IOW(RTIOC_TYPE_TESTING, 0x40, unsigned long)

7.26.1 Detailed Description

Real-Time Driver Model for Xenomai, testing device profile header.

Note

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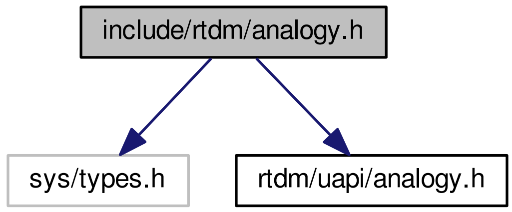
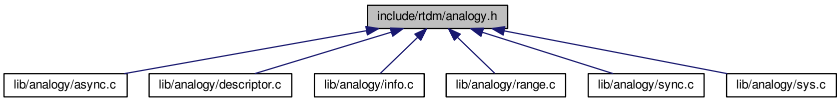
7.27 include/rtdm/analogy.h File Reference

Analogy for Linux, library facilities.

Include dependency graph for analogy.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct a4l_descriptor

  Structure containing device-information useful to users.

Macros

ANALOGY_xxx_DESC

Constants used as argument so as to define the description depth to recover

- #define A4L_BSC_DESC 0x0

  BSC stands for basic descriptor (device data)
- #define A4L_CPLX_DESC 0x1

  CPLX stands for complex descriptor (subdevice + channel + range data)

7.27.1 Detailed Description

Analogy for Linux, library facilities.

Note

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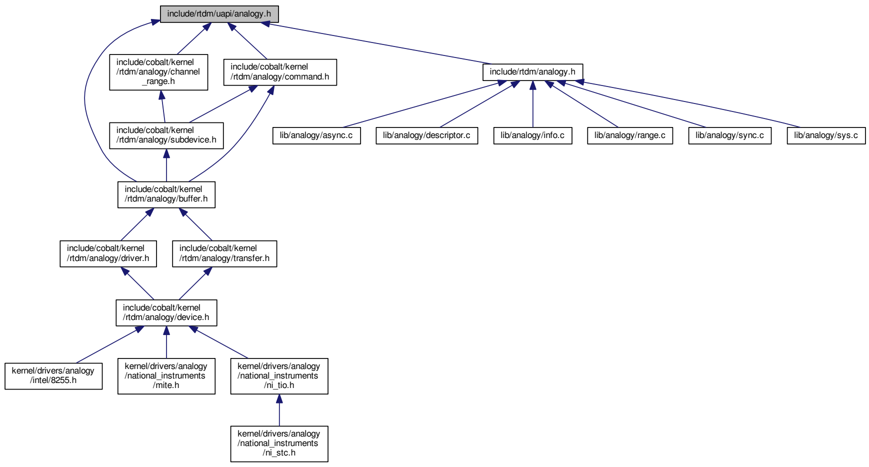
7.28 include/rtdm/uapi/analogy.h File Reference

Analogy for Linux, UAPI bits.

This graph shows which files directly or indirectly include this file:



Data Structures

- struct a4l_cmd_desc

    Structure describing the asynchronous instruction.
- struct a4l_instruction

    Structure describing the synchronous instruction.
- struct a4l_instruction_list

    Structure describing the list of synchronous instructions.

Macros

- #define A4L_RNG_FACTOR 1000000

    Constant for internal use only (must not be used by driver developer).
- #define A4L_RNG_VOLT_UNIT 0x0

    Volt unit range flag.
- #define A4L_RNG_MAMP_UNIT 0x1

    MilliAmpere unit range flag.
- #define A4L_RNG_NO_UNIT 0x2

    No unit range flag.
- #define A4L_RNG_EXT_UNIT 0x4

    External unit range flag.
- #define A4L_RNG_UNIT(x)

    Macro to retrieve the range unit from the range flags.
- #define A4L_INSN_WAIT_MAX 100000

    Maximal wait duration.

ANALOGY_CMD_xxx

Common command flags definitions

- #define A4L_CMD_SIMUL 0x1

    Do not execute the command, just check it.
- #define A4L_CMD_BULK 0x2

Perform data recovery / transmission in bulk mode.
- #define A4L_CMD_WRITE 0x4

  Perform a command which will write data to the device.

TRIG_xxx

Command triggers flags definitions

- #define TRIG_NONE 0x00000001

  Never trigger.
- #define TRIG_NOW 0x00000002

  Trigger now + N ns.
- #define TRIG_FOLLOW 0x00000004

  Trigger on next lower level trig.
- #define TRIG_TIME 0x00000008

  Trigger at time N ns.
- #define TRIG_TIMER 0x00000010

  Trigger at rate N ns.
- #define TRIG_COUNT 0x00000020

  Trigger when count reaches N.
- #define TRIG_EXT 0x00000040

  Trigger on external signal N.
- #define TRIG_INT 0x00000080

  Trigger on analogy-internal signal N.
- #define TRIG_OTHER 0x00000100

  Driver defined trigger.
- #define TRIG_WAKE_EOS 0x0020

  Wake up on end-of-scan.
- #define TRIG_ROUND_MASK 0x00030000

  Trigger not implemented yet.
- #define TRIG_ROUND_NEAREST 0x00000000

  Trigger not implemented yet.
- #define TRIG_ROUND_DOWN 0x00010000

  Trigger not implemented yet.
- #define TRIG_ROUND_UP 0x00020000

  Trigger not implemented yet.
- #define TRIG_ROUND_UP_NEXT 0x00030000

  Trigger not implemented yet.

Channel macros

Specific precompilation macros and constants useful for the channels descriptors tab located in the command structure

- #define CHAN(a) ((a) & 0xffff)

  Channel indication macro.
- #define RNG(a) (((a) & 0xff) << 16)

  Range definition macro.
- #define AREF(a) (((a) & 0xf) << 24)

  Reference definition macro.
- #define FLAGS(a) ((a) & CR_FLAGS_MASK)

  Flags definition macro.
- #define PACK(a, b, c) (CHAN(a) | RNG(b) | AREF(c))

  Channel + range + reference definition macro.
- #define PACK_FLAGS(a, b, c, d) (CHAN(a) | RNG(b) | AREF(c) | FLAGS(d))

  Channel + range + reference + flags definition macro.
- #define AREF_GROUND 0x00

Analog reference is analog ground.
- #define AREF_COMMON 0x01
  Analog reference is analog common.
- #define AREF_DIFF 0x02
  Analog reference is differential.
- #define AREF_OTHER 0x03
  Analog reference is undefined.

Subdevices types

Flags to define the subdevice type

- #define A4L_SUBD_UNUSED (A4L_SUBD_MASK_SPECIAL|0x1)
  Unused subdevice.
- #define A4L_SUBD_AI (A4L_SUBD_MASK_READ|0x2)
  Analog input subdevice.
- #define A4L_SUBD_AO (A4L_SUBD_MASK_WRITE|0x4)
  Analog output subdevice.
- #define A4L_SUBD_DI (A4L_SUBD_MASK_READ|0x8)
  Digital input subdevice.
- #define A4L_SUBD_DO (A4L_SUBD_MASK_WRITE|0x10)
  Digital output subdevice.
- #define A4L_SUBD_DIO (A4L_SUBD_MASK_SPECIAL|0x20)
  Digital input/output subdevice.
- #define A4L_SUBD_COUNTER (A4L_SUBD_MASK_SPECIAL|0x40)
  Counter subdevice.
- #define A4L_SUBD_TIMER (A4L_SUBD_MASK_SPECIAL|0x80)
  Timer subdevice.
- #define A4L_SUBD_MEMORY (A4L_SUBD_MASK_SPECIAL|0x100)
  Memory, EEPROM, DPRAM.
- #define A4L_SUBD_CALIB (A4L_SUBD_MASK_SPECIAL|0x200)
  Calibration subdevice DACs.
- #define A4L_SUBD_PROC (A4L_SUBD_MASK_SPECIAL|0x400)
  Processor, DSP.
- #define A4L_SUBD_SERIAL (A4L_SUBD_MASK_SPECIAL|0x800)
  Serial IO subdevice.
- #define A4L_SUBD_TYPES
  Mask which gathers all the types.

Subdevice features

Flags to define the subdevice's capabilities

- #define A4L_SUBD_CMD 0x1000
  The subdevice can handle command (i.e it can perform asynchronous acquisition)
- #define A4L_SUBD_MMAP 0x8000
  The subdevice support mmap operations (technically, any driver can do it; however, the developer might want that his driver must be accessed through read / write.

Subdevice status

Flags to define the subdevice's status

- #define A4L_SUBD_BUSY_NR 0
  The subdevice is busy, a synchronous or an asynchronous acquisition is occuring.
- #define A4L_SUBD_BUSY (1 << A4L_SUBD_BUSY_NR)
  The subdevice is busy, a synchronous or an asynchronous acquisition is occuring.
- #define A4L_SUBD_CLEAN_NR 1

The subdevice is about to be cleaned in the middle of the detach procedure.
- #define A4L_SUBD_CLEAN (1 << A4L_SUBD_CLEAN_NR)

  The subdevice is busy, a synchronous or an asynchronous acquisition is occuring.

Instruction type

Flags to define the type of instruction

- #define A4L_INSN_READ (0 | A4L_INSN_MASK_READ)

  Read instruction.
- #define A4L_INSN_WRITE (1 | A4L_INSN_MASK_WRITE)

  Write instruction.
- #define A4L_INSN_BITS

  "Bits" instruction
- #define A4L_INSN_CONFIG

  Configuration instruction.
- #define A4L_INSN_GTOD

  Get time instruction.
- #define A4L_INSN_WAIT

  Wait instruction.
- #define A4L_INSN_INTTRIG

  Trigger instruction (to start asynchronous acquisition)

Configuration instruction type

Values to define the type of configuration instruction

- #define **A4L_INSN_CONFIG_DIO_INPUT** 0
- #define **A4L_INSN_CONFIG_DIO_OUTPUT** 1
- #define **A4L_INSN_CONFIG_DIO_OPENDRAIN** 2
- #define **A4L_INSN_CONFIG_ANALOG_TRIG** 16
- #define **A4L_INSN_CONFIG_ALT_SOURCE** 20
- #define **A4L_INSN_CONFIG_DIGITAL_TRIG** 21
- #define **A4L_INSN_CONFIG_BLOCK_SIZE** 22
- #define **A4L_INSN_CONFIG_TIMER_1** 23
- #define **A4L_INSN_CONFIG_FILTER** 24
- #define **A4L_INSN_CONFIG_CHANGE_NOTIFY** 25
- #define **A4L_INSN_CONFIG_SERIAL_CLOCK** 26
- #define **A4L_INSN_CONFIG_BIDIRECTIONAL_DATA** 27
- #define **A4L_INSN_CONFIG_DIO_QUERY** 28
- #define **A4L_INSN_CONFIG_PWM_OUTPUT** 29
- #define **A4L_INSN_CONFIG_GET_PWM_OUTPUT** 30
- #define **A4L_INSN_CONFIG_ARM** 31
- #define **A4L_INSN_CONFIG_DISARM** 32
- #define **A4L_INSN_CONFIG_GET_COUNTER_STATUS** 33
- #define **A4L_INSN_CONFIG_RESET** 34
- #define **A4L_INSN_CONFIG_GPCT_SINGLE_PULSE_GENERATOR** 1001 /* Use CTR as single pulsegenerator */
- #define **A4L_INSN_CONFIG_GPCT_PULSE_TRAIN_GENERATOR** 1002 /* Use CTR as pulsetraingenerator */
- #define **A4L_INSN_CONFIG_GPCT_QUADRATURE_ENCODER** 1003 /* Use the counter as encoder */
- #define **A4L_INSN_CONFIG_SET_GATE_SRC** 2001 /* Set gate source */
- #define **A4L_INSN_CONFIG_GET_GATE_SRC** 2002 /* Get gate source */
- #define **A4L_INSN_CONFIG_SET_CLOCK_SRC** 2003 /* Set master clock source */
- #define **A4L_INSN_CONFIG_GET_CLOCK_SRC** 2004 /* Get master clock source */
- #define **A4L_INSN_CONFIG_SET_OTHER_SRC** 2005 /* Set other source */
- #define **A4L_INSN_CONFIG_SET_COUNTER_MODE** 4097
- #define **A4L_INSN_CONFIG_SET_ROUTING** 4099
- #define **A4L_INSN_CONFIG_GET_ROUTING** 4109

Counter status bits

Status bits for INSN_CONFIG_GET_COUNTER_STATUS

- #define **A4L_COUNTER_ARMED** 0x1
- #define **A4L_COUNTER_COUNTING** 0x2
- #define **A4L_COUNTER_TERMINAL_COUNT** 0x4

IO direction

Values to define the IO polarity

- #define **A4L_INPUT** 0
- #define **A4L_OUTPUT** 1
- #define **A4L_OPENDRAIN** 2

Events types

Values to define the Analogy events. They might used to send some specific events through the instruction interface.

- #define **A4L_EV_START** 0x00040000
- #define **A4L_EV_SCAN_BEGIN** 0x00080000
- #define **A4L_EV_CONVERT** 0x00100000
- #define **A4L_EV_SCAN_END** 0x00200000
- #define **A4L_EV_STOP** 0x00400000

7.28.1 Detailed Description

Analogy for Linux, UAPI bits.

Note

7.28.2 Macro Definition Documentation

7.28.2.1 #define A4L_RNG_FACTOR 1000000

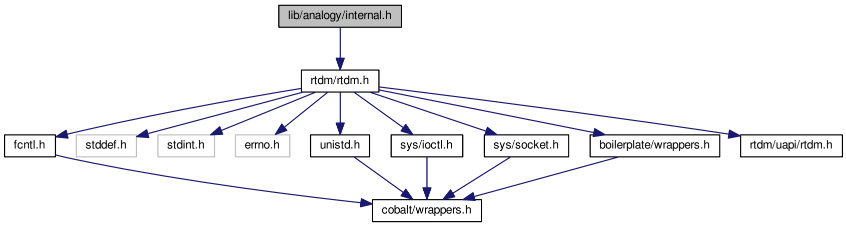
Constant for internal use only (must not be used by driver developer).

Referenced by a4l_dtoraw(), a4l_find_range(), a4l_ftoraw(), a4l_rawtod(), and a4l_rawtof().

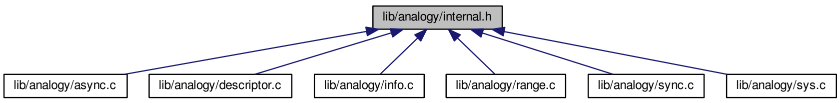
7.29 lib/analogy/internal.h File Reference

Analogy for Linux, internal declarations.

Include dependency graph for internal.h:



This graph shows which files directly or indirectly include this file:



7.29.1 Detailed Description

Analogy for Linux, internal declarations.

Note

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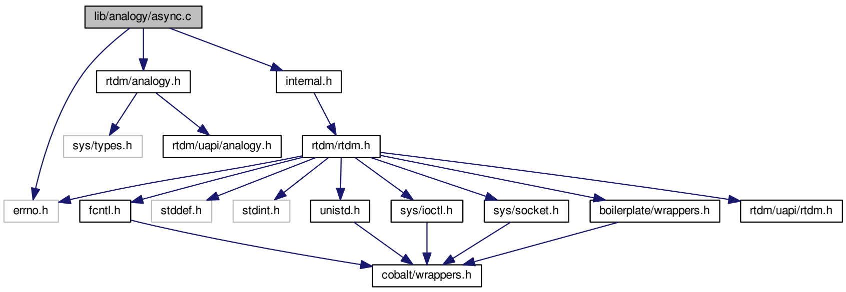
7.30 lib/analogy/async.c File Reference

Analogy for Linux, command, transfer, etc.

Include dependency graph for async.c:



Functions

- int a4l_snd_command (a4l_desc_t *dsc, a4l_cmd_t *cmd)

  Send a command to an Analoy device.
- int a4l_snd_cancel (a4l_desc_t *dsc, unsigned int idx_subd)

  Cancel an asynchronous acquisition.
- int a4l_set_bufsize (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long size)

  Change the size of the asynchronous buffer.
- int a4l_get_bufsize (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long *size)

  Get the size of the asynchronous buffer.
- int a4l_mark_bufrw (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long cur, unsigned long *new)

  Update the asynchronous buffer state.
- int a4l_poll (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long ms_timeout)

  Get the available data count.
- int a4l_mmap (a4l_desc_t *dsc, unsigned int idx_subd, unsigned long size, void **ptr)

  Map the asynchronous ring-buffer into a user-space.
- int a4l_async_read (a4l_desc_t *dsc, void *buf, size_t nbyte, unsigned long ms_timeout)

  Perform asynchronous read operation on the analog input subdevice.
- int a4l_async_write (a4l_desc_t *dsc, void *buf, size_t nbyte, unsigned long ms_timeout)

  Perform asynchronous write operation on the analog input subdevice.

7.30.1 Detailed Description

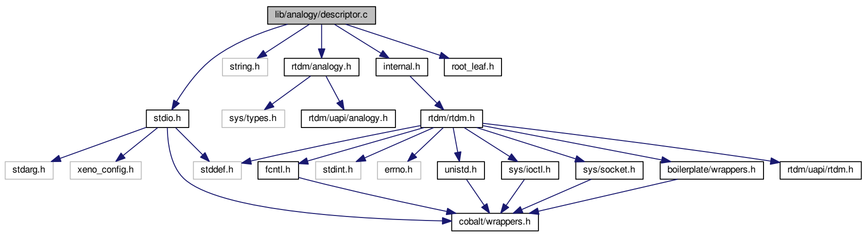
Analogy for Linux, command, transfer, etc. related features

Note

7.31 lib/analogy/descriptor.c File Reference

Analogy for Linux, descriptor related features.

Include dependency graph for descriptor.c:



Functions

- int a4l_sys_desc (int fd, a4l_desc_t *dsc, int pass)

  Get a descriptor on an attached device.
- int a4l_open (a4l_desc_t *dsc, const char *fname)

  Open an Analogy device and basically fill the descriptor.
- int a4l_close (a4l_desc_t *dsc)

  Close the Analogy device related with the descriptor.
- int a4l_fill_desc (a4l_desc_t *dsc)

  Fill the descriptor with subdevices, channels and ranges data.
- int a4l_get_subdinfo (a4l_desc_t *dsc, unsigned int subd, a4l_sbinfo_t **info)

  Get an information structure on a specified subdevice.
- int a4l_get_chinfo (a4l_desc_t *dsc, unsigned int subd, unsigned int chan, a4l_chinfo_t **info)

  Get an information structure on a specified channel.
- int a4l_get_rnginfo (a4l_desc_t *dsc, unsigned int subd, unsigned int chan, unsigned int rng, a4l_-rnginfo_t **info)

  Get an information structure on a specified range.

7.31.1 Detailed Description

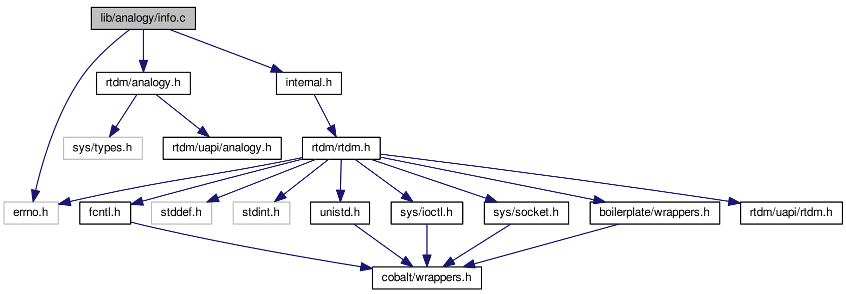
Analogy for Linux, descriptor related features.

Note

7.32 lib/analogy/info.c File Reference

Analogy for Linux, device, subdevice, etc.

Include dependency graph for info.c:



7.32.1 Detailed Description

Analogy for Linux, device, subdevice, etc. related features

Note

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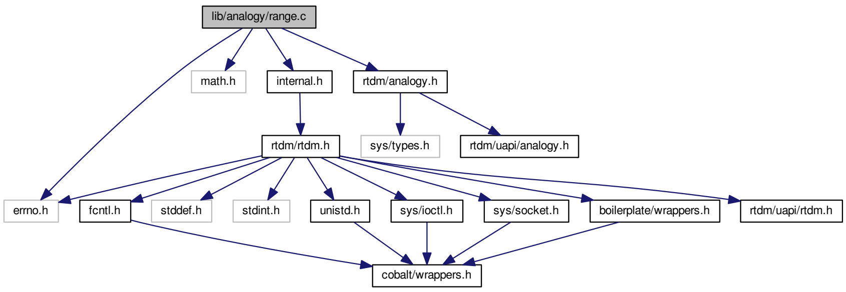
7.33 lib/analogy/range.c File Reference

Analogy for Linux, range related features.

Include dependency graph for range.c:



Functions

- int a4l_sizeof_chan (a4l_chinfo_t *chan)

  Get the size in memory of an acquired element.
- int a4l_sizeof_subd (a4l_sbinfo_t *subd)

  Get the size in memory of a digital acquired element.
- int a4l_find_range (a4l_desc_t *dsc, unsigned int idx_subd, unsigned int idx_chan, unsigned long unit, double min, double max, a4l_rnginfo_t **rng)

  Find the must suitable range.
- int a4l_rawtoul (a4l_chinfo_t *chan, unsigned long *dst, void *src, int cnt)

  Unpack raw data (from the driver) into unsigned long values.
- int a4l_rawtof (a4l_chinfo_t *chan, a4l_rnginfo_t *rng, float *dst, void *src, int cnt)

  Convert raw data (from the driver) to float-typed samples.
- int a4l_rawtod (a4l_chinfo_t *chan, a4l_rnginfo_t *rng, double *dst, void *src, int cnt)

  Convert raw data (from the driver) to double-typed samples.
- int a4l_ultoraw (a4l_chinfo_t *chan, void *dst, unsigned long *src, int cnt)

  Pack unsigned long values into raw data (for the driver)
- int a4l_ftoraw (a4l_chinfo_t *chan, a4l_rnginfo_t *rng, void *dst, float *src, int cnt)

  Convert float-typed samples to raw data (for the driver)
- int a4l_dtoraw (a4l_chinfo_t *chan, a4l_rnginfo_t *rng, void *dst, double *src, int cnt)

  Convert double-typed samples to raw data (for the driver)

7.33.1 Detailed Description

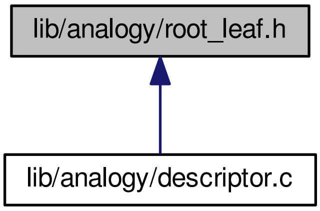
Analogy for Linux, range related features.

Note

7.34 lib/analogy/root_leaf.h File Reference

Analogy for Linux, root / leaf system.

This graph shows which files directly or indirectly include this file:



7.34.1 Detailed Description

Analogy for Linux, root / leaf system.

Note

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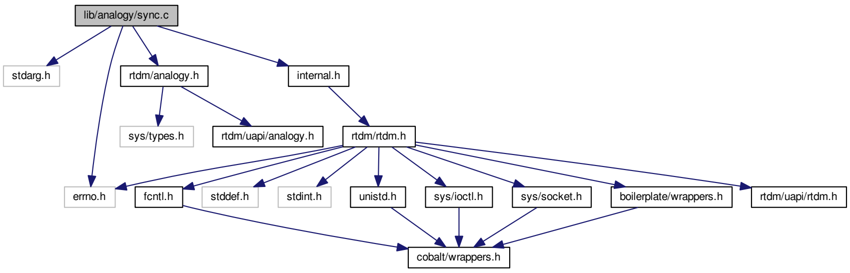
7.35 lib/analogy/sync.c File Reference

Analogy for Linux, instruction related features.

Include dependency graph for sync.c:



Functions

- int a4l_snd_insnlist (a4l_desc_t *dsc, a4l_insnlst_t *arg)

  Perform a list of synchronous acquisition misc operations.
- int a4l_snd_insn (a4l_desc_t *dsc, a4l_insn_t *arg)

  Perform a synchronous acquisition misc operation.
- int a4l_sync_write (a4l_desc_t *dsc, unsigned int idx_subd, unsigned int chan_desc, unsigned int ns_delay, void *buf, size_t nbyte)

  Perform a synchronous acquisition write operation.
- int a4l_sync_read (a4l_desc_t *dsc, unsigned int idx_subd, unsigned int chan_desc, unsigned int ns_delay, void *buf, size_t nbyte)

  Perform a synchronous acquisition read operation.
- int a4l_sync_dio (a4l_desc_t *dsc, unsigned int idx_subd, void *mask, void *buf)

  Perform a synchronous acquisition digital acquisition.
- int a4l_config_subd (a4l_desc_t *dsc, unsigned int idx_subd, unsigned int type,...)

  Configure a subdevice.

7.35.1 Detailed Description

Analogy for Linux, instruction related features.

Note

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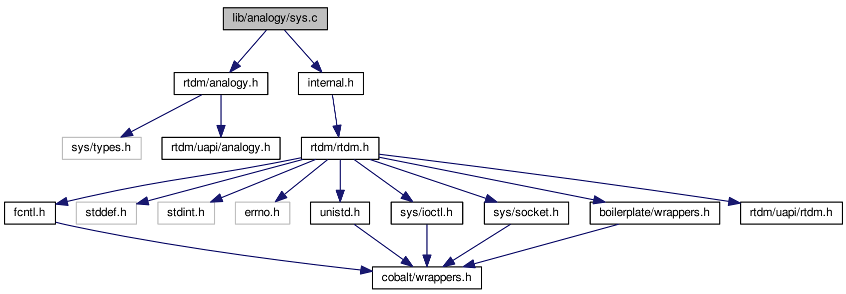
7.36 lib/analogy/sys.c File Reference

Analogy for Linux, descriptor related features.

Include dependency graph for sys.c:



Functions

- int a4l_sys_open (const char *fname)
  Open an Analogy device.
- int a4l_sys_close (int fd)
  Close an Analogy device.
- int a4l_sys_read (int fd, void *buf, size_t nbyte)
  Read from an Analogy device.
- int a4l_sys_write (int fd, void *buf, size_t nbyte)
  Write to an Analogy device.
- int a4l_sys_attach (int fd, a4l_lnkdesc_t *arg)
  Attach an Analogy device to a driver.
- int a4l_sys_detach (int fd)
  Detach an Analogy device from a driver.
- int a4l_sys_bufcfg (int fd, unsigned int idx_subd, unsigned long size)
  Configure the buffer size.

7.36.1 Detailed Description

Analogy for Linux, descriptor related features.

Note

Chapter 8

Example Documentation

8.1 bufp-label.c

```c
/*
 * BUFP-based client/server demo, using the read(2)/write(2)
 * system calls to exchange data over a socket.
 *
 * In this example, two sockets are created.  A server thread (reader)
 * is bound to a real-time port and receives a stream of bytes sent to
 * this port from a client thread (writer).
 *
 * See Makefile in this directory for build directives.
 */
#include <sys/mman.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <signal.h>
#include <string.h>
#include <pthread.h>
#include <errno.h>
#include <rtdm/ipc.h>

pthread_t svtid, cltid;

#define BUFP_PORT_LABEL  "bufp-demo"

static const char *msg[] = {
    "Surfing With The Alien",
    "Lords of Karma",
    "Banana Mango",
    "Psycho Monkey",
    "Luminous Flesh Giants",
    "Moroccan Sunset",
    "Satch Boogie",
    "Flying In A Blue Dream",
    "Ride",
    "Summer Song",
    "Speed Of Light",
    "Crystal Planet",
    "Raspberry Jam Delta-V",
    "Champagne?",
    "Clouds Race Across The Sky",
    "Engines Of Creation"
};

static void fail(const char *reason)
{
        perror(reason);
        exit(EXIT_FAILURE);
}

static void *server(void *arg)
{
        struct rtipc_port_label plabel;
        struct sockaddr_ipc saddr;
        char buf[128];
        size_t bufsz;
        int ret, s;

        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_BUFP);
        if (s < 0)
```

```
                fail("socket");

        /*
         * Set a 16k buffer for the server endpoint. This
         * configuration must be done prior to binding the socket to a
         * port.
         */
        bufsz = 16384; /* bytes */
        ret = setsockopt(s, SOL_BUFP, BUFP_BUFSZ,
                         &bufsz, sizeof(bufsz));
        if (ret)
                fail("setsockopt");

        /*
         * Set a port label. This name will be registered when
         * binding, in addition to the port number (if given).
         */
        strcpy(plabel.label, BUFP_PORT_LABEL);
        ret = setsockopt(s, SOL_BUFP, BUFP_LABEL,
                         &plabel, sizeof(plabel));
        if (ret)
                fail("setsockopt");

        /*
         * Bind the socket to the port. Assign that port a label, so
         * that peers may use a descriptive information to locate
         * it. Labeled ports will appear in the
         * /proc/xenomai/registry/rtipc/bufp directory once the socket
         * is bound.
         *
         * saddr.sipc_port specifies the port number to use. If -1 is
         * passed, the BUFP driver will auto-select an idle port.
         */
        saddr.sipc_family = AF_RTIPC;
        saddr.sipc_port = -1;
        ret = bind(s, (struct sockaddr *)&saddr, sizeof(saddr));
        if (ret)
                fail("bind");

        for (;;) {
                ret = read(s, buf, sizeof(buf));
                if (ret < 0) {
                        close(s);
                        fail("read");
                }
                rt_printf("%s: received %d bytes, \"%.*s\"\n",
                          __FUNCTION__, ret, ret, buf);
        }

        return NULL;
}

static void *client(void *arg)
{
        struct rtipc_port_label plabel;
        struct sockaddr_ipc svsaddr;
        int ret, s, n = 0, len;
        struct timespec ts;

        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_BUFP);
        if (s < 0)
                fail("socket");

        /*
         * Set the port label. This name will be used to find the peer
         * when connecting, instead of the port number. The label must
         * be set _after_ the socket is bound to the port, so that
         * BUFP does not try to register this label for the client
         * port as well (like the server thread did).
         */
        strcpy(plabel.label, BUFP_PORT_LABEL);
        ret = setsockopt(s, SOL_BUFP, BUFP_LABEL,
                         &plabel, sizeof(plabel));
        if (ret)
                fail("setsockopt");

        memset(&svsaddr, 0, sizeof(svsaddr));
        svsaddr.sipc_family = AF_RTIPC;
        svsaddr.sipc_port = -1; /* Tell BUFP to search by label. */
        ret = connect(s, (struct sockaddr *)&svsaddr, sizeof(svsaddr));
        if (ret)
                fail("connect");

        for (;;) {
                len = strlen(msg[n]);
                ret = write(s, msg[n], len);
                if (ret < 0) {
```

```
                        close(s);
                        fail("write");
                }
                rt_printf("%s: sent %d bytes, \"%.*s\"\n",
                          __FUNCTION__, ret, ret, msg[n]);
                n = (n + 1) % (sizeof(msg) / sizeof(msg[0]));
                /*
                 * We run in full real-time mode (i.e. primary mode),
                 * so we have to let the system breathe between two
                 * iterations.
                 */
                ts.tv_sec = 0;
                ts.tv_nsec = 500000000; /* 500 ms */
                clock_nanosleep(CLOCK_REALTIME, 0, &ts, NULL);
        }

        return NULL;
}

static void cleanup_upon_sig(int sig)
{
        pthread_cancel(svtid);
        pthread_cancel(cltid);
        signal(sig, SIG_DFL);
        pthread_join(svtid, NULL);
        pthread_join(cltid, NULL);
}

int main(int argc, char **argv)
{
        struct sched_param svparam = {.sched_priority = 71 };
        struct sched_param clparam = {.sched_priority = 70 };
        pthread_attr_t svattr, clattr;
        sigset_t mask, oldmask;

        mlockall(MCL_CURRENT | MCL_FUTURE);

        sigemptyset(&mask);
        sigaddset(&mask, SIGINT);
        signal(SIGINT, cleanup_upon_sig);
        sigaddset(&mask, SIGTERM);
        signal(SIGTERM, cleanup_upon_sig);
        sigaddset(&mask, SIGHUP);
        signal(SIGHUP, cleanup_upon_sig);
        pthread_sigmask(SIG_BLOCK, &mask, &oldmask);

        /*
         * This is a real-time compatible printf() package from
         * Xenomai's RT Development Kit (RTDK), that does NOT cause
         * any transition to secondary mode.
         */
        rt_print_auto_init(1);

        pthread_attr_init(&svattr);
        pthread_attr_setdetachstate(&svattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&svattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&svattr, SCHED_FIFO);
        pthread_attr_setschedparam(&svattr, &svparam);

        errno = pthread_create(&svtid, &svattr, &server, NULL);
        if (errno)
                fail("pthread_create");

        pthread_attr_init(&clattr);
        pthread_attr_setdetachstate(&clattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&clattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&clattr, SCHED_FIFO);
        pthread_attr_setschedparam(&clattr, &clparam);

        errno = pthread_create(&cltid, &clattr, &client, NULL);
        if (errno)
                fail("pthread_create");

        sigsuspend(&oldmask);

        return 0;
}
```

8.2 bufp-readwrite.c

```
/*
 * BUFP-based client/server demo, using the read(2)/write(2)
 * system calls to exchange data over a socket.
```

```
 *
 * In this example, two sockets are created.  A server thread (reader)
 * is bound to a real-time port and receives a stream of bytes sent to
 * this port from a client thread (writer).
 *
 * See Makefile in this directory for build directives.
 */
#include <sys/mman.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <signal.h>
#include <string.h>
#include <pthread.h>
#include <errno.h>
#include <rtdm/ipc.h>

pthread_t svtid, cltid;

#define BUFP_SVPORT 12

static const char *msg[] = {
    "Surfing With The Alien",
    "Lords of Karma",
    "Banana Mango",
    "Psycho Monkey",
    "Luminous Flesh Giants",
    "Moroccan Sunset",
    "Satch Boogie",
    "Flying In A Blue Dream",
    "Ride",
    "Summer Song",
    "Speed Of Light",
    "Crystal Planet",
    "Raspberry Jam Delta-V",
    "Champagne?",
    "Clouds Race Across The Sky",
    "Engines Of Creation"
};

static void fail(const char *reason)
{
        perror(reason);
        exit(EXIT_FAILURE);
}

static void *server(void *arg)
{
        struct sockaddr_ipc saddr;
        char buf[128];
        size_t bufsz;
        int ret, s;

        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_BUFP);
        if (s < 0)
                fail("socket");

        /*
         * Set a 16k buffer for the server endpoint. This
         * configuration must be done prior to binding the socket to a
         * port.
         */
        bufsz = 16384; /* bytes */
        ret = setsockopt(s, SOL_BUFP, BUFP_BUFSZ,
                         &bufsz, sizeof(bufsz));
        if (ret)
                fail("setsockopt");

        saddr.sipc_family = AF_RTIPC;
        saddr.sipc_port = BUFP_SVPORT;
        ret = bind(s, (struct sockaddr *)&saddr, sizeof(saddr));
        if (ret)
                fail("bind");

        for (;;) {
                ret = read(s, buf, sizeof(buf));
                if (ret < 0) {
                        close(s);
                        fail("read");
                }
                rt_printf("%s: received %d bytes, \"%.*s\"\n",
                          __FUNCTION__, ret, ret, buf);
        }

        return NULL;
}
```

```
static void *client(void *arg)
{
	struct sockaddr_ipc svsaddr;
	int ret, s, n = 0, len;
	struct timespec ts;

	s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_BUFP);
	if (s < 0)
		fail("socket");

	memset(&svsaddr, 0, sizeof(svsaddr));
	svsaddr.sipc_family = AF_RTIPC;
	svsaddr.sipc_port = BUFP_SVPORT;
	ret = connect(s, (struct sockaddr *)&svsaddr, sizeof(svsaddr));
	if (ret)
		fail("connect");

	for (;;) {
		len = strlen(msg[n]);
		ret = write(s, msg[n], len);
		if (ret < 0) {
			close(s);
			fail("write");
		}
		rt_printf("%s: sent %d bytes, \"%.*s\"\n",
			  __FUNCTION__, ret, ret, msg[n]);
		n = (n + 1) % (sizeof(msg) / sizeof(msg[0]));
		/*
		 * We run in full real-time mode (i.e. primary mode),
		 * so we have to let the system breathe between two
		 * iterations.
		 */
		ts.tv_sec = 0;
		ts.tv_nsec = 500000000; /* 500 ms */
		clock_nanosleep(CLOCK_REALTIME, 0, &ts, NULL);
	}

	return NULL;
}

static void cleanup_upon_sig(int sig)
{
	pthread_cancel(svtid);
	pthread_cancel(cltid);
	signal(sig, SIG_DFL);
	pthread_join(svtid, NULL);
	pthread_join(cltid, NULL);
}

int main(int argc, char **argv)
{
	struct sched_param svparam = {.sched_priority = 71 };
	struct sched_param clparam = {.sched_priority = 70 };
	pthread_attr_t svattr, clattr;
	sigset_t mask, oldmask;

	mlockall(MCL_CURRENT | MCL_FUTURE);

	sigemptyset(&mask);
	sigaddset(&mask, SIGINT);
	signal(SIGINT, cleanup_upon_sig);
	sigaddset(&mask, SIGTERM);
	signal(SIGTERM, cleanup_upon_sig);
	sigaddset(&mask, SIGHUP);
	signal(SIGHUP, cleanup_upon_sig);
	pthread_sigmask(SIG_BLOCK, &mask, &oldmask);

	/*
	 * This is a real-time compatible printf() package from
	 * Xenomai's RT Development Kit (RTDK), that does NOT cause
	 * any transition to secondary mode.
	 */
	rt_print_auto_init(1);

	pthread_attr_init(&svattr);
	pthread_attr_setdetachstate(&svattr, PTHREAD_CREATE_JOINABLE);
	pthread_attr_setinheritsched(&svattr, PTHREAD_EXPLICIT_SCHED);
	pthread_attr_setschedpolicy(&svattr, SCHED_FIFO);
	pthread_attr_setschedparam(&svattr, &svparam);

	errno = pthread_create(&svtid, &svattr, &server, NULL);
	if (errno)
		fail("pthread_create");

	pthread_attr_init(&clattr);
	pthread_attr_setdetachstate(&clattr, PTHREAD_CREATE_JOINABLE);
	pthread_attr_setinheritsched(&clattr, PTHREAD_EXPLICIT_SCHED);
```

```
        pthread_attr_setschedpolicy(&clattr, SCHED_FIFO);
        pthread_attr_setschedparam(&clattr, &clparam);

        errno = pthread_create(&cltid, &clattr, &client, NULL);
        if (errno)
                fail("pthread_create");

        sigsuspend(&oldmask);

        return 0;
}
```

8.3 can-rtt.c

```
/*
 * Round-Trip-Time Test - sends and receives messages and measures the
 *                        time in between.
 *
 * Copyright (C) 2006 Wolfgang Grandegger <wg@grandegger.com>
 *
 * Based on RTnet's examples/xenomai/posix/rtt-sender.c.
 *
 * Copyright (C) 2002 Ulrich Marx <marx@kammer.uni-hannover.de>
 *               2002 Marc Kleine-Budde <kleine-budde@gmx.de>
 *               2006 Jan Kiszka <jan.kiszka@web.de>
 *
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 * (at your option) any later version.
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 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
 *
 *
 * The program sends out CAN messages periodically and copies the current
 * time-stamp to the payload. At reception, that time-stamp is compared
 * with the current time to determine the round-trip time. The jitter
 * values are printer out regularly. Concurrent tests can be carried out
 * by starting the program with different message identifiers. It is also
 * possible to use this program on a remote system as simple repeater to
 * loopback messages.
 */

#include <errno.h>
#include <mqueue.h>
#include <signal.h>
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
#include <limits.h>
#include <getopt.h>
#include <netinet/in.h>
#include <net/if.h>
#include <sys/ioctl.h>
#include <sys/mman.h>

#ifdef CONFIG_XENO_COBALT
#include <rtdm/can.h>
#else
#include <linux/can.h>
#include <linux/can/raw.h>
#endif

#define NSEC_PER_SEC 1000000000

static unsigned int cycle = 10000; /* 10 ms */
static canid_t can_id = 0x1;

static pthread_t txthread, rxthread;
static int txsock, rxsock;
static mqd_t mq;
static int txcount, rxcount;
static int overruns;
static int repeater;
```

```
struct rtt_stat {
    long long rtt;
    long long rtt_min;
    long long rtt_max;
    long long rtt_sum;
    long long rtt_sum_last;
    int counts_per_sec;
};

static void print_usage(char *prg)
{
    fprintf(stderr,
            "Usage: %s  [Options] <tx-can-interface> <rx-can-interface>\n"
            "Options:\n"
            " -h, --help     This help\n"
            " -r, --repeater Repeater, send back received messages\n"
            " -i, --id=ID    CAN Identifier (default = 0x1)\n"
            " -c, --cycle    Cycle time in us (default = 10000us)\n",
            prg);
}

static void *transmitter(void *arg)
{
    struct sched_param  param = { .sched_priority = 80 };
    struct timespec next_period;
    struct timespec time;
    struct can_frame frame;
    long long *rtt_time = (long long *)&frame.data;

    /* Pre-fill CAN frame */
    frame.can_id = can_id;
    frame.can_dlc = sizeof(*rtt_time);

#ifdef CONFIG_XENO_COBALT
    pthread_set_name_np(pthread_self(), "rtcan_rtt_transmitter");
#endif
    pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);

    clock_gettime(CLOCK_MONOTONIC, &next_period);

    while(1) {
        next_period.tv_nsec += cycle * 1000;
        while (next_period.tv_nsec >= NSEC_PER_SEC) {
                next_period.tv_nsec -= NSEC_PER_SEC;
                next_period.tv_sec++;
        }

        clock_nanosleep(CLOCK_MONOTONIC, TIMER_ABSTIME, &next_period, NULL);

        if (rxcount != txcount) {
            overruns++;
            continue;
        }

        clock_gettime(CLOCK_MONOTONIC, &time);
        *rtt_time = (long long)time.tv_sec * NSEC_PER_SEC + time.tv_nsec;

        /* Transmit the message containing the local time */
        if (send(txsock, (void *)&frame, sizeof(struct can_frame), 0) < 0) {
            if (errno == EBADF)
                printf("terminating transmitter thread\n");
            else
                perror("send failed");
            return NULL;
        }
        txcount++;
    }
}


static void *receiver(void *arg)
{
    struct sched_param param = { .sched_priority = 82 };
    struct timespec time;
    struct can_frame frame;
    long long *rtt_time = (long long *)frame.data;
    struct rtt_stat rtt_stat = {0, 1000000000000000000LL, -1000000000000000000LL,
                                0, 0, 0};

#ifdef CONFIG_XENO_COBALT
    pthread_set_name_np(pthread_self(), "rtcan_rtt_receiver");
#endif
    pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);

    rtt_stat.counts_per_sec = 1000000 / cycle;
```

```
    while (1) {
        if (recv(rxsock, (void *)&frame, sizeof(struct can_frame), 0) < 0) {
            if (errno == EBADF)
                printf("terminating receiver thread\n");
            else
                perror("recv failed");
            return NULL;
        }
        if (repeater) {
            /* Transmit the message back as is */
            if (send(txsock, (void *)&frame, sizeof(struct can_frame), 0) < 0) {
                if (errno == EBADF)
                    printf("terminating transmitter thread\n");
                else
                    perror("send failed");
                return NULL;
            }
            txcount++;
        } else {
            clock_gettime(CLOCK_MONOTONIC, &time);
            if (rxcount > 0) {
                rtt_stat.rtt = ((long long)time.tv_sec * 1000000000LL +
                                time.tv_nsec - *rtt_time);
                rtt_stat.rtt_sum += rtt_stat.rtt;
                if (rtt_stat.rtt <  rtt_stat.rtt_min)
                    rtt_stat.rtt_min = rtt_stat.rtt;
                if (rtt_stat.rtt > rtt_stat.rtt_max)
                    rtt_stat.rtt_max = rtt_stat.rtt;
            }
        }
        rxcount++;

        if ((rxcount % rtt_stat.counts_per_sec) == 0) {
            mq_send(mq, (char *)&rtt_stat, sizeof(rtt_stat), 0);
            rtt_stat.rtt_sum_last = rtt_stat.rtt_sum;
        }
    }
}

static void catch_signal(int sig)
{
    mq_close(mq);
}


int main(int argc, char *argv[])
{
    struct sched_param param = { .sched_priority = 1 };
    pthread_attr_t thattr;
    struct mq_attr mqattr;
    struct sockaddr_can rxaddr, txaddr;
    struct can_filter rxfilter[1];
    struct rtt_stat rtt_stat;
    char mqname[32];
    char *txdev, *rxdev;
    struct ifreq ifr;
    int ret, opt;

    struct option long_options[] = {
        { "id", required_argument, 0, 'i'},
        { "cycle", required_argument, 0, 'c'},
        { "repeater", no_argument, 0, 'r'},
        { "help", no_argument, 0, 'h'},
        { 0, 0, 0, 0},
    };

    while ((opt = getopt_long(argc, argv, "hri:c:",
                              long_options, NULL)) != -1) {
        switch (opt) {
        case 'c':
            cycle = atoi(optarg);
            break;

        case 'i':
            can_id = strtoul(optarg, NULL, 0);
            break;

        case 'r':
            repeater = 1;
            break;

        default:
            fprintf(stderr, "Unknown option %c\n", opt);
        case 'h':
            print_usage(argv[0]);
            exit(-1);
        }
```

```
}

printf("%d %d\n", optind, argc);
if (optind + 2 != argc) {
    print_usage(argv[0]);
    exit(0);
}

txdev = argv[optind];
rxdev = argv[optind + 1];

/* Create and configure RX socket */
if ((rxsock = socket(PF_CAN, SOCK_RAW, CAN_RAW)) < 0) {
    perror("RX socket failed");
    return -1;
}

strncpy(ifr.ifr_name, rxdev, IFNAMSIZ);
printf("RX rxsock=%d, ifr_name=%s\n", rxsock, ifr.ifr_name);

if (ioctl(rxsock, SIOCGIFINDEX, &ifr) < 0) {
    perror("RX ioctl SIOCGIFINDEX failed");
    goto failure1;
}

/* We only want to receive our own messages */
rxfilter[0].can_id = can_id;
rxfilter[0].can_mask = 0x3ff;
if (setsockopt(rxsock, SOL_CAN_RAW, CAN_RAW_FILTER,
               &rxfilter, sizeof(struct can_filter)) < 0) {
    perror("RX setsockopt CAN_RAW_FILTER failed");
    goto failure1;
}
memset(&rxaddr, 0, sizeof(rxaddr));
rxaddr.can_ifindex = ifr.ifr_ifindex;
rxaddr.can_family = AF_CAN;
if (bind(rxsock, (struct sockaddr *)&rxaddr, sizeof(rxaddr)) < 0) {
    perror("RX bind failed\n");
    goto failure1;
}

/* Create and configure TX socket */

if (strcmp(rxdev, txdev) == 0) {
    txsock = rxsock;
} else {
    if ((txsock = socket(PF_CAN, SOCK_RAW, 0)) < 0) {
        perror("TX socket failed");
        goto failure1;
    }

    strncpy(ifr.ifr_name, txdev, IFNAMSIZ);
    printf("TX txsock=%d, ifr_name=%s\n", txsock, ifr.ifr_name);

    if (ioctl(txsock, SIOCGIFINDEX, &ifr) < 0) {
        perror("TX ioctl SIOCGIFINDEX failed");
        goto failure2;
    }

    /* Suppress definiton of a default receive filter list */
    if (setsockopt(txsock, SOL_CAN_RAW, CAN_RAW_FILTER, NULL, 0) < 0) {
        perror("TX setsockopt CAN_RAW_FILTER failed");
        goto failure2;
    }

    memset(&txaddr, 0, sizeof(txaddr));
    txaddr.can_ifindex = ifr.ifr_ifindex;
    txaddr.can_family = AF_CAN;

    if (bind(txsock, (struct sockaddr *)&txaddr, sizeof(txaddr)) < 0) {
            perror("TX bind failed\n");
            goto failure2;
    }
}

signal(SIGTERM, catch_signal);
signal(SIGINT, catch_signal);
signal(SIGHUP, catch_signal);
mlockall(MCL_CURRENT|MCL_FUTURE);

printf("Round-Trip-Time test %s -> %s with CAN ID 0x%x\n",
       argv[optind], argv[optind + 1], can_id);
printf("Cycle time: %d us\n", cycle);
printf("All RTT timing figures are in us.\n");

/* Create statistics message queue */
snprintf(mqname, sizeof(mqname), "/rtcan_rtt-%d", getpid());
```

```
    mqattr.mq_flags   = 0;
    mqattr.mq_maxmsg  = 100;
    mqattr.mq_msgsize = sizeof(struct rtt_stat);
    mq = mq_open(mqname, O_RDWR | O_CREAT | O_EXCL, 0600, &mqattr);
    if (mq == (mqd_t)-1) {
        perror("opening mqueue failed");
        goto failure2;
    }

    /* Create receiver RT-thread */
    pthread_attr_init(&thattr);
    pthread_attr_setdetachstate(&thattr, PTHREAD_CREATE_JOINABLE);
    pthread_attr_setstacksize(&thattr, PTHREAD_STACK_MIN);
    ret = pthread_create(&rxthread, &thattr, &receiver, NULL);
    if (ret) {
        fprintf(stderr, "%s: pthread_create(receiver) failed\n",
                strerror(-ret));
        goto failure3;
    }

    if (!repeater) {
        /* Create transitter RT-thread */
        ret = pthread_create(&txthread, &thattr, &transmitter, NULL);
        if (ret) {
            fprintf(stderr, "%s: pthread_create(transmitter) failed\n",
                    strerror(-ret));
            goto failure4;
        }
    }

    pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);

    if (repeater)
        printf("Messages\n");
    else
        printf("Messages RTTlast RTT_avg RTT_min RTT_max Overruns\n");

    while (1) {
        long long rtt_avg;

        ret = mq_receive(mq, (char *)&rtt_stat, sizeof(rtt_stat), NULL);
        if (ret != sizeof(rtt_stat)) {
            if (ret < 0) {
                if (errno == EBADF)
                    printf("terminating mq_receive\n");
                else
                    perror("mq_receive failed");
            } else
                fprintf(stderr,
                        "mq_receive returned invalid length %d\n", ret);
            break;
        }

        if (repeater) {
            printf("%8d\n", rxcount);
        } else {
            rtt_avg = ((rtt_stat.rtt_sum - rtt_stat.rtt_sum_last) /
                       rtt_stat.counts_per_sec);
            printf("%8d %7ld %7ld %7ld %7ld %8d\n", rxcount,
                   (long)(rtt_stat.rtt / 1000), (long)(rtt_avg / 1000),
                   (long)(rtt_stat.rtt_min / 1000),
                   (long)(rtt_stat.rtt_max / 1000),
                   overruns);
        }
    }

    /* This call also leaves primary mode, required for socket cleanup. */
    printf("shutting down\n");

    /* Important: First close the sockets! */
    while ((close(rxsock) < 0) && (errno == EAGAIN)) {
        printf("RX socket busy - waiting...\n");
        sleep(1);
    }
    while ((close(txsock) < 0) && (errno == EAGAIN)) {
        printf("TX socket busy - waiting...\n");
        sleep(1);
    }

    pthread_join(txthread, NULL);
    pthread_kill(rxthread, SIGHUP);
    pthread_join(rxthread, NULL);

    return 0;

failure4:
    pthread_kill(rxthread, SIGHUP);
```

```
    pthread_join(rxthread, NULL);
 failure3:
    mq_close(mq);
 failure2:
    close(txsock);
 failure1:
    close(rxsock);

    return 1;
}
```

8.4 cross-link.c

```
/*
 * cross-link.c
 *
 * Userspace test program (Xenomai alchemy skin) for RTDM-based UART drivers
 * Copyright 2005 by Joerg Langenberg <joergel75@gmx.net>
 *
 * Updates by Jan Kiszka <jan.kiszka@web.de>
 *
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 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
 */
#include <stdio.h>
#include <signal.h>
#include <unistd.h>
#include <sys/mman.h>
#include <alchemy/task.h>
#include <alchemy/timer.h>
#include <rtdm/serial.h>

#define MAIN_PREFIX   "main : "
#define WTASK_PREFIX  "write_task: "
#define RTASK_PREFIX  "read_task: "

#define WRITE_FILE    "rtser0"
#define READ_FILE     "rtser1"

int read_fd  = -1;
int write_fd = -1;

#define STATE_FILE_OPENED         1
#define STATE_TASK_CREATED        2

unsigned int read_state = 0;
unsigned int write_state = 0;

/*                             --s-ms-us-ns */
RTIME write_task_period_ns =    100000000llu;
RT_TASK write_task;
RT_TASK read_task;

static const struct rtser_config read_config = {
        .config_mask       = 0xFFFF,
        .baud_rate         = 115200,
        .parity            = RTSER_DEF_PARITY,
        .data_bits         = RTSER_DEF_BITS,
        .stop_bits         = RTSER_DEF_STOPB,
        .handshake         = RTSER_DEF_HAND,
        .fifo_depth        = RTSER_DEF_FIFO_DEPTH,
        .rx_timeout        = RTSER_DEF_TIMEOUT,
        .tx_timeout        = RTSER_DEF_TIMEOUT,
        .event_timeout     = 1000000000, /* 1 s */
        .timestamp_history = RTSER_RX_TIMESTAMP_HISTORY,
        .event_mask        = RTSER_EVENT_RXPEND,
};

static const struct rtser_config write_config = {
        .config_mask       = RTSER_SET_BAUD | RTSER_SET_TIMESTAMP_HISTORY,
        .baud_rate         = 115200,
        .timestamp_history = RTSER_DEF_TIMESTAMP_HISTORY,
```

```
        /* the rest implicitly remains default */
};

static int close_file( int fd, char *name)
{
        int err, i=0;

        do {
                i++;
                err = rt_dev_close(fd);
                switch (err) {
                case -EAGAIN:
                        printf(MAIN_PREFIX "%s -> EAGAIN (%d times)\n",
                               name, i);
                        rt_task_sleep(50000); /* wait 50us */
                        break;
                case 0:
                        printf(MAIN_PREFIX "%s -> closed\n", name);
                        break;
                default:
                        printf(MAIN_PREFIX "%s -> %s\n", name,
                               strerror(-err));
                        break;
                }
        } while (err == -EAGAIN && i < 10);

        return err;
}

static void cleanup_all(void)
{
        if (read_state & STATE_FILE_OPENED) {
                close_file(read_fd, READ_FILE" (read)");
                read_state &= ~STATE_FILE_OPENED;
        }

        if (write_state & STATE_FILE_OPENED) {
                close_file(write_fd, WRITE_FILE " (write)");
                write_state &= ~STATE_FILE_OPENED;
        }

        if (write_state & STATE_TASK_CREATED) {
                printf(MAIN_PREFIX "delete write_task\n");
                rt_task_delete(&write_task);
                write_state &= ~STATE_TASK_CREATED;
        }

        if (read_state & STATE_TASK_CREATED) {
                printf(MAIN_PREFIX "delete read_task\n");
                rt_task_delete(&read_task);
                read_state &= ~STATE_TASK_CREATED;
        }
}

static void catch_signal(int sig)
{
        cleanup_all();
        printf(MAIN_PREFIX "exit\n");
        return;
}

static void write_task_proc(void *arg)
{
        int err;
        RTIME write_time;
        ssize_t sz = sizeof(RTIME);
        int written = 0;

        err = rt_task_set_periodic(NULL, TM_NOW,
                                   rt_timer_ns2ticks(write_task_period_ns));
        if (err) {
                printf(WTASK_PREFIX "error on set periodic, %s\n",
                       strerror(-err));
                goto exit_write_task;
        }

        while (1) {
                err = rt_task_wait_period(NULL);
                if (err) {
                        printf(WTASK_PREFIX
                               "error on rt_task_wait_period, %s\n",
                               strerror(-err));
                        break;
                }

                write_time = rt_timer_read();
```

```
                written = rt_dev_write(write_fd, &write_time, sz);
                if (written < 0 ) {
                        printf(WTASK_PREFIX "error on rt_dev_write, %s\n",
                               strerror(-err));
                        break;
                } else if (written != sz) {
                        printf(WTASK_PREFIX "only %d / %zd byte transmitted\n",
                               written, sz);
                        break;
                }
        }

 exit_write_task:
        if ((write_state & STATE_FILE_OPENED) &&
            close_file(write_fd, WRITE_FILE " (write)") == 0)
                write_state &= ~STATE_FILE_OPENED;

        printf(WTASK_PREFIX "exit\n");
}

static void read_task_proc(void *arg)
{
        int err;
        int nr = 0;
        RTIME read_time  = 0;
        RTIME write_time = 0;
        RTIME irq_time   = 0;
        ssize_t sz = sizeof(RTIME);
        int read = 0;
        struct rtser_event rx_event;

        printf(" Nr |   write->irq    |    irq->read    |   write->read   |\n");
        printf("-----------------------------------------------------------\n");

        /*
         * We are in secondary mode now due to printf, the next
         * blocking Xenomai or driver call will switch us back
         * (here: RTSER_RTIOC_WAIT_EVENT).
         */

        while (1) {
                /* waiting for event */
                err = rt_dev_ioctl(read_fd, RTSER_RTIOC_WAIT_EVENT, &
      rx_event);
                if (err) {
                        printf(RTASK_PREFIX
                               "error on RTSER_RTIOC_WAIT_EVENT, %s\n",
                               strerror(-err));
                        if (err == -ETIMEDOUT)
                                continue;
                        break;
                }

                irq_time = rx_event.rxpend_timestamp;
                read = rt_dev_read(read_fd, &write_time, sz);
                if (read == sz) {
                        read_time = rt_timer_read();
                        printf("%3d |%16llu |%16llu |%16llu\n", nr,
                               irq_time  - write_time,
                               read_time - irq_time,
                               read_time - write_time);
                        nr++;
                } else if (read < 0 ) {
                        printf(RTASK_PREFIX "error on rt_dev_read, code %s\n",
                               strerror(-err));
                        break;
                } else {
                        printf(RTASK_PREFIX "only %d / %zd byte received \n",
                               read, sz);
                        break;
                }
        }

        if ((read_state & STATE_FILE_OPENED) &&
            close_file(read_fd, READ_FILE " (read)") == 0)
                read_state &= ~STATE_FILE_OPENED;

        printf(RTASK_PREFIX "exit\n");
}

int main(int argc, char* argv[])
{
        int err = 0;

        signal(SIGTERM, catch_signal);
        signal(SIGINT, catch_signal);
```

```
        /* no memory-swapping for this programm */
        mlockall(MCL_CURRENT | MCL_FUTURE);

        /* open rtser0 */
        write_fd = rt_dev_open( WRITE_FILE, 0);
        if (write_fd < 0) {
                printf(MAIN_PREFIX "can't open %s (write), %s\n", WRITE_FILE,
                       strerror(-write_fd));
                goto error;
        }
        write_state |= STATE_FILE_OPENED;
        printf(MAIN_PREFIX "write-file opened\n");

        /* writing write-config */
        err = rt_dev_ioctl(write_fd, RTSER_RTIOC_SET_CONFIG, &
      write_config);
        if (err) {
                printf(MAIN_PREFIX "error while RTSER_RTIOC_SET_CONFIG, %s\n",
                       strerror(-err));
                goto error;
        }
        printf(MAIN_PREFIX "write-config written\n");

        /* open rtser1 */
        read_fd = rt_dev_open( READ_FILE, 0 );
        if (read_fd < 0) {
                printf(MAIN_PREFIX "can't open %s (read), %s\n", READ_FILE,
                       strerror(-read_fd));
                goto error;
        }
        read_state |= STATE_FILE_OPENED;
        printf(MAIN_PREFIX "read-file opened\n");

        /* writing read-config */
        err = rt_dev_ioctl(read_fd, RTSER_RTIOC_SET_CONFIG, &read_config)
      ;
        if (err) {
                printf(MAIN_PREFIX "error while rt_dev_ioctl, %s\n",
                       strerror(-err));
                goto error;
        }
        printf(MAIN_PREFIX "read-config written\n");

        /* create write_task */
        err = rt_task_create(&write_task, "write_task", 0, 50, 0);
        if (err) {
                printf(MAIN_PREFIX "failed to create write_task, %s\n",
                       strerror(-err));
                goto error;
        }
        write_state |= STATE_TASK_CREATED;
        printf(MAIN_PREFIX "write-task created\n");

        /* create read_task */
        err = rt_task_create(&read_task, "read_task", 0, 51, 0);
        if (err) {
                printf(MAIN_PREFIX "failed to create read_task, %s\n",
                       strerror(-err));
                goto error;
        }
        read_state |= STATE_TASK_CREATED;
        printf(MAIN_PREFIX "read-task created\n");

        /* start write_task */
        printf(MAIN_PREFIX "starting write-task\n");
        err = rt_task_start(&write_task, &write_task_proc, NULL);
        if (err) {
                printf(MAIN_PREFIX "failed to start write_task, %s\n",
                       strerror(-err));
                goto error;
        }

        /* start read_task */
        printf(MAIN_PREFIX "starting read-task\n");
        err = rt_task_start(&read_task,&read_task_proc,NULL);
        if (err) {
                printf(MAIN_PREFIX "failed to start read_task, %s\n",
                       strerror(-err));
                goto error;
        }

        pause();
        return 0;

error:
        cleanup_all();
        return err;
```

```
}
```

8.5 iddp-label.c

```
/*
 * IDDP-based client/server demo, using the write(2)/recvfrom(2)
 * system calls to exchange data over a socket.
 *
 * In this example, two sockets are created.  A server thread (reader)
 * is bound to a labeled real-time port and receives datagrams sent to
 * this port from a client thread (writer). The client thread attaches
 * to the port opened by the server using a labeled connection
 * request. The client socket is bound to a different port, only to
 * provide a valid peer name; this is optional.
 *
 * ASCII labels can be attached to bound ports, in order to connect
 * sockets to them in a more descriptive way than using plain numeric
 * port values.
 *
 * See Makefile in this directory for build directives.
 */
#include <sys/mman.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <signal.h>
#include <string.h>
#include <pthread.h>
#include <errno.h>
#include <rtdm/ipc.h>

pthread_t svtid, cltid;

#define IDDP_CLPORT  27

#define IDDP_PORT_LABEL  "iddp-demo"

static const char *msg[] = {
    "Surfing With The Alien",
    "Lords of Karma",
    "Banana Mango",
    "Psycho Monkey",
    "Luminous Flesh Giants",
    "Moroccan Sunset",
    "Satch Boogie",
    "Flying In A Blue Dream",
    "Ride",
    "Summer Song",
    "Speed Of Light",
    "Crystal Planet",
    "Raspberry Jam Delta-V",
    "Champagne?",
    "Clouds Race Across The Sky",
    "Engines Of Creation"
};

static void fail(const char *reason)
{
        perror(reason);
        exit(EXIT_FAILURE);
}

static void *server(void *arg)
{
        struct sockaddr_ipc saddr, claddr;
        struct rtipc_port_label plabel;
        socklen_t addrlen;
        char buf[128];
        int ret, s;

        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_IDDP);
        if (s < 0)
                fail("socket");

        /*
         * We will use Xenomai's system heap for datagram, so no
         * IDDP_POOLSZ required here.
         */

        /*
         * Set a port label. This name will be registered when
         * binding, in addition to the port number (if given).
         */
```

```
        strcpy(plabel.label, IDDP_PORT_LABEL);
        ret = setsockopt(s, SOL_IDDP, IDDP_LABEL,
                         &plabel, sizeof(plabel));
        if (ret)
                fail("setsockopt");

        /*
         * Bind the socket to the port. Assign that port a label, so
         * that peers may use a descriptive information to locate
         * it. Labeled ports will appear in the
         * /proc/xenomai/registry/rtipc/iddp directory once the socket
         * is bound.
         *
         * saddr.sipc_port specifies the port number to use. If -1 is
         * passed, the IDDP driver will auto-select an idle port.
         */
        saddr.sipc_family = AF_RTIPC;
        saddr.sipc_port = -1;   /* Pick next free */
        ret = bind(s, (struct sockaddr *)&saddr, sizeof(saddr));
        if (ret)
                fail("bind");

        for (;;) {
                addrlen = sizeof(saddr);
                ret = recvfrom(s, buf, sizeof(buf), 0,
                               (struct sockaddr *)&claddr, &addrlen);
                if (ret < 0) {
                        close(s);
                        fail("recvfrom");
                }
                rt_printf("%s: received %d bytes, \"%.*s\" from port %d\n",
                          __FUNCTION__, ret, ret, buf, claddr.sipc_port);
        }

        return NULL;
}

static void *client(void *arg)
{
        struct sockaddr_ipc svsaddr, clsaddr;
        struct rtipc_port_label plabel;
        int ret, s, n = 0, len;
        struct timespec ts;

        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_IDDP);
        if (s < 0)
                fail("socket");

        /*
         * Set a name on the client socket. This is strictly optional,
         * and only done here for the purpose of getting back a
         * different port number in recvfrom().
         */
        clsaddr.sipc_family = AF_RTIPC;
        clsaddr.sipc_port = IDDP_CLPORT;
        ret = bind(s, (struct sockaddr *)&clsaddr, sizeof(clsaddr));
        if (ret)
                fail("bind");

        /*
         * Set the port label. This name will be used to find the peer
         * when connecting, instead of the port number. The label must
         * be set _after_ the socket is bound to the port, so that
         * IDDP does not try to register this label for the client
         * port as well (like the server thread did).
         */
        strcpy(plabel.label, IDDP_PORT_LABEL);
        ret = setsockopt(s, SOL_IDDP, IDDP_LABEL,
                         &plabel, sizeof(plabel));
        if (ret)
                fail("setsockopt");

        memset(&svsaddr, 0, sizeof(svsaddr));
        svsaddr.sipc_family = AF_RTIPC;
        svsaddr.sipc_port = -1; /* Tell IDDP to search by label. */
        ret = connect(s, (struct sockaddr *)&svsaddr, sizeof(svsaddr));
        if (ret)
                fail("connect");

        for (;;) {
                len = strlen(msg[n]);
                /* Send to default destination we connected to. */
                ret = write(s, msg[n], len);
                if (ret < 0) {
                        close(s);
                        fail("sendto");
                }
```

```
                rt_printf("%s: sent %d bytes, \"%.*s\"\n",
                          __FUNCTION__, ret, ret, msg[n]);
                n = (n + 1) % (sizeof(msg) / sizeof(msg[0]));
                /*
                 * We run in full real-time mode (i.e. primary mode),
                 * so we have to let the system breathe between two
                 * iterations.
                 */
                ts.tv_sec = 0;
                ts.tv_nsec = 500000000; /* 500 ms */
                clock_nanosleep(CLOCK_REALTIME, 0, &ts, NULL);
        }

        return NULL;
}

static void cleanup_upon_sig(int sig)
{
        pthread_cancel(svtid);
        pthread_cancel(cltid);
        signal(sig, SIG_DFL);
        pthread_join(svtid, NULL);
        pthread_join(cltid, NULL);
}

int main(int argc, char **argv)
{
        struct sched_param svparam = {.sched_priority = 71 };
        struct sched_param clparam = {.sched_priority = 70 };
        pthread_attr_t svattr, clattr;
        sigset_t mask, oldmask;

        mlockall(MCL_CURRENT | MCL_FUTURE);

        sigemptyset(&mask);
        sigaddset(&mask, SIGINT);
        signal(SIGINT, cleanup_upon_sig);
        sigaddset(&mask, SIGTERM);
        signal(SIGTERM, cleanup_upon_sig);
        sigaddset(&mask, SIGHUP);
        signal(SIGHUP, cleanup_upon_sig);
        pthread_sigmask(SIG_BLOCK, &mask, &oldmask);

        /*
         * This is a real-time compatible printf() package from
         * Xenomai's RT Development Kit (RTDK), that does NOT cause
         * any transition to secondary mode.
         */
        rt_print_auto_init(1);

        pthread_attr_init(&svattr);
        pthread_attr_setdetachstate(&svattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&svattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&svattr, SCHED_FIFO);
        pthread_attr_setschedparam(&svattr, &svparam);

        errno = pthread_create(&svtid, &svattr, &server, NULL);
        if (errno)
                fail("pthread_create");

        pthread_attr_init(&clattr);
        pthread_attr_setdetachstate(&clattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&clattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&clattr, SCHED_FIFO);
        pthread_attr_setschedparam(&clattr, &clparam);

        errno = pthread_create(&cltid, &clattr, &client, NULL);
        if (errno)
                fail("pthread_create");

        sigsuspend(&oldmask);

        return 0;
}
```

8.6 iddp-sendrecv.c

```
/*
 * IDDP-based client/server demo, using the sendto(2)/recvfrom(2)
 * system calls to exchange data over a socket.
 *
 * In this example, two sockets are created.  A server thread (reader)
 * is bound to a real-time port and receives datagrams sent to this
```

```
 * port from a client thread (writer). The client socket is bound to a
 * different port, only to provide a valid peer name; this is
 * optional.
 *
 * See Makefile in this directory for build directives.
 */
#include <sys/mman.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <signal.h>
#include <string.h>
#include <pthread.h>
#include <errno.h>
#include <rtdm/ipc.h>

pthread_t svtid, cltid;

#define IDDP_SVPORT 12
#define IDDP_CLPORT 13

static const char *msg[] = {
    "Surfing With The Alien",
    "Lords of Karma",
    "Banana Mango",
    "Psycho Monkey",
    "Luminous Flesh Giants",
    "Moroccan Sunset",
    "Satch Boogie",
    "Flying In A Blue Dream",
    "Ride",
    "Summer Song",
    "Speed Of Light",
    "Crystal Planet",
    "Raspberry Jam Delta-V",
    "Champagne?",
    "Clouds Race Across The Sky",
    "Engines Of Creation"
};

static void fail(const char *reason)
{
        perror(reason);
        exit(EXIT_FAILURE);
}

static void *server(void *arg)
{
        struct sockaddr_ipc saddr, claddr;
        socklen_t addrlen;
        char buf[128];
        size_t poolsz;
        int ret, s;

        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_IDDP);
        if (s < 0)
                fail("socket");

        /*
         * Set a local 32k pool for the server endpoint. Memory needed
         * to convey datagrams will be pulled from this pool, instead
         * of Xenomai's system pool.
         */
        poolsz = 32768; /* bytes */
        ret = setsockopt(s, SOL_IDDP, IDDP_POOLSZ,
                         &poolsz, sizeof(poolsz));
        if (ret)
                fail("setsockopt");

        saddr.sipc_family = AF_RTIPC;
        saddr.sipc_port = IDDP_SVPORT;
        ret = bind(s, (struct sockaddr *)&saddr, sizeof(saddr));
        if (ret)
                fail("bind");

        for (;;) {
                addrlen = sizeof(saddr);
                ret = recvfrom(s, buf, sizeof(buf), 0,
                               (struct sockaddr *)&claddr, &addrlen);
                if (ret < 0) {
                        close(s);
                        fail("recvfrom");
                }
                rt_printf("%s: received %d bytes, \"%.*s\" from port %d\n",
                          __FUNCTION__, ret, ret, buf, claddr.sipc_port);
        }
```

```
        return NULL;
}

static void *client(void *arg)
{
        struct sockaddr_ipc svsaddr, clsaddr;
        int ret, s, n = 0, len;
        struct timespec ts;

        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_IDDP);
        if (s < 0)
                fail("socket");

        clsaddr.sipc_family = AF_RTIPC;
        clsaddr.sipc_port = IDDP_CLPORT;
        ret = bind(s, (struct sockaddr *)&clsaddr, sizeof(clsaddr));
        if (ret)
                fail("bind");

        svsaddr.sipc_family = AF_RTIPC;
        svsaddr.sipc_port = IDDP_SVPORT;
        for (;;) {
                len = strlen(msg[n]);
                ret = sendto(s, msg[n], len, 0,
                             (struct sockaddr *)&svsaddr, sizeof(svsaddr));
                if (ret < 0) {
                        close(s);
                        fail("sendto");
                }
                rt_printf("%s: sent %d bytes, \"%.*s\"\n",
                          __FUNCTION__, ret, ret, msg[n]);
                n = (n + 1) % (sizeof(msg) / sizeof(msg[0]));
                /*
                 * We run in full real-time mode (i.e. primary mode),
                 * so we have to let the system breathe between two
                 * iterations.
                 */
                ts.tv_sec = 0;
                ts.tv_nsec = 500000000; /* 500 ms */
                clock_nanosleep(CLOCK_REALTIME, 0, &ts, NULL);
        }

        return NULL;
}

static void cleanup_upon_sig(int sig)
{
        pthread_cancel(svtid);
        pthread_cancel(cltid);
        signal(sig, SIG_DFL);
        pthread_join(svtid, NULL);
        pthread_join(cltid, NULL);
}

int main(int argc, char **argv)
{
        struct sched_param svparam = {.sched_priority = 71 };
        struct sched_param clparam = {.sched_priority = 70 };
        pthread_attr_t svattr, clattr;
        sigset_t mask, oldmask;

        mlockall(MCL_CURRENT | MCL_FUTURE);

        sigemptyset(&mask);
        sigaddset(&mask, SIGINT);
        signal(SIGINT, cleanup_upon_sig);
        sigaddset(&mask, SIGTERM);
        signal(SIGTERM, cleanup_upon_sig);
        sigaddset(&mask, SIGHUP);
        signal(SIGHUP, cleanup_upon_sig);
        pthread_sigmask(SIG_BLOCK, &mask, &oldmask);

        /*
         * This is a real-time compatible printf() package from
         * Xenomai's RT Development Kit (RTDK), that does NOT cause
         * any transition to secondary mode.
         */
        rt_print_auto_init(1);

        pthread_attr_init(&svattr);
        pthread_attr_setdetachstate(&svattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&svattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&svattr, SCHED_FIFO);
        pthread_attr_setschedparam(&svattr, &svparam);

        errno = pthread_create(&svtid, &svattr, &server, NULL);
        if (errno)
```

```
                fail("pthread_create");

        pthread_attr_init(&clattr);
        pthread_attr_setdetachstate(&clattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&clattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&clattr, SCHED_FIFO);
        pthread_attr_setschedparam(&clattr, &clparam);

        errno = pthread_create(&cltid, &clattr, &client, NULL);
        if (errno)
                fail("pthread_create");

        sigsuspend(&oldmask);

        return 0;
}
```

8.7 rtcanconfig.c

```
/*
 * Program to configuring the CAN controller
 *
 * Copyright (C) 2006 Wolfgang Grandegger <wg@grandegger.com>
 *
 * Copyright (C) 2005, 2006 Sebastian Smolorz
 *                          <Sebastian.Smolorz@stud.uni-hannover.de>
 *
 *
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 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
 */

#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
#include <string.h>
#include <time.h>
#include <errno.h>
#include <getopt.h>
#include <sys/mman.h>

#include <rtdm/can.h>

static void print_usage(char *prg)
{
    fprintf(stderr,
            "Usage: %s <can-interface> [Options] [up|down|start|stop|sleep]\n"
            "Options:\n"
            " -v, --verbose            be verbose\n"
            " -h, --help               this help\n"
            " -c, --ctrlmode=CTRLMODE  listenonly, loopback or none\n"
            " -b, --baudrate=BPS       baudrate in bits/sec\n"
            " -B, --bittime=BTR0:BTR1  BTR or standard bit-time\n"
            " -B, --bittime=BRP:PROP_SEG:PHASE_SEG1:PHASE_SEG2:SJW:SAM\n",
            prg);
}

static can_baudrate_t string_to_baudrate(char *str)
{
    can_baudrate_t baudrate;
    if (sscanf(str, "%i", &baudrate) != 1)
        return -1;
    return baudrate;
}

static int string_to_mode(char *str)
{
    if ( !strcmp(str, "up") || !strcmp(str, "start") )
        return CAN_MODE_START;
    else if ( !strcmp(str, "down") || !strcmp(str, "stop") )
        return CAN_MODE_STOP;
```

```
    else if ( !strcmp(str, "sleep") )
        return CAN_MODE_SLEEP;
    return -EINVAL;
}

static int string_to_ctrlmode(char *str)
{
    if ( !strcmp(str, "listenonly") )
        return CAN_CTRLMODE_LISTENONLY;
    else if ( !strcmp(str, "loopback") )
        return CAN_CTRLMODE_LOOPBACK;
    else if ( !strcmp(str, "none") )
        return 0;

    return -1;
}

int main(int argc, char *argv[])
{
    char    ifname[16];
    int     can_fd = -1;
    int     new_baudrate = -1;
    int     new_mode = -1;
    int     new_ctrlmode = 0, set_ctrlmode = 0;
    int     verbose = 0;
    int     bittime_count = 0, bittime_data[6];
    can_baudrate_t *baudrate;
    can_ctrlmode_t *ctrlmode;
    can_mode_t *mode;
    union {
      struct ifreq ifr;
      struct can_bittime bittime;
      can_baudrate_t baudrate;
      can_ctrlmode_t ctrlmode;
      can_mode_t mode;
    } u;
    struct can_bittime *bittime;
    int opt, ret;
    char* ptr;

    struct option long_options[] = {
        { "help", no_argument, 0, 'h' },
        { "verbose", no_argument, 0, 'v'},
        { "baudrate", required_argument, 0, 'b'},
        { "bittime", required_argument, 0, 'B'},
        { "ctrlmode", required_argument, 0, 'c'},
        { 0, 0, 0, 0},
    };

    while ((opt = getopt_long(argc, argv, "hvb:B:c:",
                              long_options, NULL)) != -1) {
        switch (opt) {
        case 'h':
            print_usage(argv[0]);
            exit(0);

        case 'v':
            verbose = 1;
            break;

        case 'b':
            new_baudrate = string_to_baudrate(optarg);
            if (new_baudrate == -1) {
                print_usage(argv[0]);
                exit(0);
            }
            break;

        case 'B':
            ptr = optarg;
            while (1) {
                bittime_data[bittime_count++] = strtoul(ptr, NULL, 0);
                if (!(ptr = strchr(ptr, ':')))
                    break;
                ptr++;
            }
            if (bittime_count != 2 && bittime_count != 6) {
                print_usage(argv[0]);
                exit(0);
            }
            break;

        case 'c':
            ret = string_to_ctrlmode(optarg);
            if (ret == -1) {
                print_usage(argv[0]);
                exit(0);
```

```
        }
        new_ctrlmode |= ret;
        set_ctrlmode = 1;
        break;

        break;

    default:
        fprintf(stderr, "Unknown option %c\n", opt);
        break;
    }
}

/* Get CAN interface name */
if (optind != argc - 1 && optind != argc - 2) {
    print_usage(argv[0]);
    return 0;
}

strncpy(ifname, argv[optind], IFNAMSIZ);
strncpy(u.ifr.ifr_name, ifname, IFNAMSIZ);

if (optind == argc - 2) {   /* Get mode setting */
    new_mode = string_to_mode(argv[optind + 1]);
    if (verbose)
        printf("mode: %s (%#x)\n", argv[optind + 1], new_mode);
    if (new_mode < 0) {
        print_usage(argv[0]);
        return 0;
    }
}

can_fd = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
if (can_fd < 0) {
    fprintf(stderr, "Cannot open RTDM CAN socket. Maybe driver not loaded? \n");
    return can_fd;
}

ret = rt_dev_ioctl(can_fd, SIOCGIFINDEX, &u.ifr);
if (ret) {
    fprintf(stderr,"Can't get interface index for %s, code = %d\n", ifname, ret);
    return ret;
}


if (new_baudrate != -1) {
    if (verbose)
        printf("baudrate: %d\n", new_baudrate);
    baudrate = &u.baudrate;
    *baudrate = new_baudrate;
    ret = rt_dev_ioctl(can_fd, SIOCSCANBAUDRATE, &u.ifr);
    if (ret) {
        goto abort;
    }
}

if (bittime_count) {
    bittime = &u.bittime;
    if (bittime_count == 2) {
        bittime->type = CAN_BITTIME_BTR;
        bittime->btr.btr0 = bittime_data[0];
        bittime->btr.btr1 = bittime_data[1];
        if (verbose)
            printf("bit-time: btr0=0x%02x btr1=0x%02x\n",
                   bittime->btr.btr0, bittime->btr.btr1);
    } else {
        bittime->type = CAN_BITTIME_STD;
        bittime->std.brp = bittime_data[0];
        bittime->std.prop_seg = bittime_data[1];
        bittime->std.phase_seg1 = bittime_data[2];
        bittime->std.phase_seg2 = bittime_data[3];
        bittime->std.sjw = bittime_data[4];
        bittime->std.sam = bittime_data[5];
        if (verbose)
            printf("bit-time: brp=%d prop_seg=%d phase_seg1=%d "
                   "phase_seg2=%d sjw=%d sam=%d\n",
                   bittime->std.brp,
                   bittime->std.prop_seg,
                   bittime->std.phase_seg1,
                   bittime->std.phase_seg2,
                   bittime->std.sjw,
                   bittime->std.sam);
    }

    ret = rt_dev_ioctl(can_fd, SIOCSCANCUSTOMBITTIME, &u.ifr);
    if (ret) {
        goto abort;
```

```
        }

    }

    if (set_ctrlmode != 0) {
        ctrlmode = &u.ctrlmode;
        *ctrlmode = new_ctrlmode;
        if (verbose)
            printf("ctrlmode: %#x\n", new_ctrlmode);
        ret = rt_dev_ioctl(can_fd, SIOCSCANCTRLMODE, &u.ifr);
        if (ret) {
            goto abort;
        }
    }

    if (new_mode != -1) {
        mode = &u.mode;
        *mode = new_mode;
        ret = rt_dev_ioctl(can_fd, SIOCSCANMODE, &u.ifr);
        if (ret) {
            goto abort;
        }
    }

    rt_dev_close(can_fd);
    return 0;

 abort:
    rt_dev_close(can_fd);
    return ret;
}
```

8.8 rtcanrecv.c

```
#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
#include <time.h>
#include <errno.h>
#include <getopt.h>
#include <sys/mman.h>

#include <alchemy/task.h>

#include <rtdm/can.h>

static void print_usage(char *prg)
{
    fprintf(stderr,
            "Usage: %s [<can-interface>] [Options]\n"
            "Options:\n"
            " -f  --filter=id:mask[:id:mask]... apply filter\n"
            " -e  --error=mask      receive error messages\n"
            " -t, --timeout=MS      timeout in ms\n"
            " -T, --timestamp       with absolute timestamp\n"
            " -R, --timestamp-rel   with relative timestamp\n"
            " -v, --verbose         be verbose\n"
            " -p, --print=MODULO    print every MODULO message\n"
            " -h, --help            this help\n",
            prg);
}


extern int optind, opterr, optopt;

static int s = -1, verbose = 0, print = 1;
static nanosecs_rel_t timeout = 0, with_timestamp = 0, timestamp_rel = 0;

RT_TASK rt_task_desc;

#define BUF_SIZ 255
#define MAX_FILTER 16

struct sockaddr_can recv_addr;
struct can_filter recv_filter[MAX_FILTER];
static int filter_count = 0;

static int add_filter(u_int32_t id, u_int32_t mask)
{
    if (filter_count >= MAX_FILTER)
        return -1;
    recv_filter[filter_count].can_id = id;
```

```
    recv_filter[filter_count].can_mask = mask;
    printf("Filter #%d: id=0x%08x mask=0x%08x\n", filter_count, id, mask);
    filter_count++;
    return 0;
}

static void cleanup(void)
{
    int ret;

    if (verbose)
        printf("Cleaning up...\n");

    if (s >= 0) {
        ret = rt_dev_close(s);
        s = -1;
        if (ret) {
            fprintf(stderr, "rt_dev_close: %s\n", strerror(-ret));
        }
        exit(EXIT_SUCCESS);
    }
}

static void cleanup_and_exit(int sig)
{
    if (verbose)
        printf("Signal %d received\n", sig);
    cleanup();
    exit(0);
}

static void rt_task(void)
{
    int i, ret, count = 0;
    struct can_frame frame;
    struct sockaddr_can addr;
    socklen_t addrlen = sizeof(addr);
    struct msghdr msg;
    struct iovec iov;
    nanosecs_abs_t timestamp, timestamp_prev = 0;

    if (with_timestamp) {
        msg.msg_iov = &iov;
        msg.msg_iovlen = 1;
        msg.msg_name = (void *)&addr;
        msg.msg_namelen = sizeof(struct sockaddr_can);
        msg.msg_control = (void *)&timestamp;
        msg.msg_controllen = sizeof(nanosecs_abs_t);
    }

    while (1) {
        if (with_timestamp) {
            iov.iov_base = (void *)&frame;
            iov.iov_len = sizeof(can_frame_t);
            ret = rt_dev_recvmsg(s, &msg, 0);
        } else
            ret = rt_dev_recvfrom(s, (void *)&frame, sizeof(
      can_frame_t), 0,
                                  (struct sockaddr *)&addr, &addrlen);
        if (ret < 0) {
            switch (ret) {
            case -ETIMEDOUT:
                if (verbose)
                    printf("rt_dev_recv: timed out");
                continue;
            case -EBADF:
                if (verbose)
                    printf("rt_dev_recv: aborted because socket was closed");
                break;
            default:
                fprintf(stderr, "rt_dev_recv: %s\n", strerror(-ret));
            }
            break;
        }

        if (print && (count % print) == 0) {
            printf("#%d: (%d) ", count, addr.can_ifindex);
            if (with_timestamp && msg.msg_controllen) {
                if (timestamp_rel) {
                printf("%lldns ", (long long)(timestamp - timestamp_prev));
                    timestamp_prev = timestamp;
                } else
                    printf("%lldns ", (long long)timestamp);
            }
            if (frame.can_id & CAN_ERR_FLAG)
                printf("!0x%08x!", frame.can_id & CAN_ERR_MASK);
            else if (frame.can_id & CAN_EFF_FLAG)
```

```
                printf("<0x%08x>", frame.can_id & CAN_EFF_MASK);
            else
                printf("<0x%03x>", frame.can_id & CAN_SFF_MASK);

            printf(" [%d]", frame.can_dlc);
            if (!(frame.can_id & CAN_RTR_FLAG))
                for (i = 0; i < frame.can_dlc; i++) {
                    printf(" %02x", frame.data[i]);
                }
            if (frame.can_id & CAN_ERR_FLAG) {
                printf(" ERROR ");
                if (frame.can_id & CAN_ERR_BUSOFF)
                    printf("bus-off");
                if (frame.can_id & CAN_ERR_CRTL)
                    printf("controller problem");
            } else if (frame.can_id & CAN_RTR_FLAG)
                printf(" remote request");
            printf("\n");
        }
        count++;
    }
}

int main(int argc, char **argv)
{
    int opt, ret;
    u_int32_t id, mask;
    u_int32_t err_mask = 0;
    struct ifreq ifr;
    char *ptr;
    char name[32];

    struct option long_options[] = {
        { "help", no_argument, 0, 'h' },
        { "verbose", no_argument, 0, 'v'},
        { "filter", required_argument, 0, 'f'},
        { "error", required_argument, 0, 'e'},
        { "timeout", required_argument, 0, 't'},
        { "timestamp", no_argument, 0, 'T'},
        { "timestamp-rel", no_argument, 0, 'R'},
        { 0, 0, 0, 0},
    };

    mlockall(MCL_CURRENT | MCL_FUTURE);

    signal(SIGTERM, cleanup_and_exit);
    signal(SIGINT, cleanup_and_exit);

    while ((opt = getopt_long(argc, argv, "hve:f:t:p:RT",
                              long_options, NULL)) != -1) {
        switch (opt) {
        case 'h':
            print_usage(argv[0]);
            exit(0);

        case 'p':
            print = strtoul(optarg, NULL, 0);
            break;

        case 'v':
            verbose = 1;
            break;

        case 'e':
            err_mask = strtoul(optarg, NULL, 0);
            break;

        case 'f':
            ptr = optarg;
            while (1) {
                id = strtoul(ptr, NULL, 0);
                ptr = strchr(ptr, ':');
                if (!ptr) {
                    fprintf(stderr, "filter must be applied in the form id:mask[:id:mask]...\n");
                    exit(1);
                }
                ptr++;
                mask = strtoul(ptr, NULL, 0);
                ptr = strchr(ptr, ':');
                add_filter(id, mask);
                if (!ptr)
                    break;
                ptr++;
            }
            break;

        case 't':
```

```
        timeout = (nanosecs_rel_t)strtoul(optarg, NULL, 0) * 1000000;
        break;

    case 'R':
        timestamp_rel = 1;
    case 'T':
        with_timestamp = 1;
        break;

    default:
        fprintf(stderr, "Unknown option %c\n", opt);
        break;
    }
}

ret = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
if (ret < 0) {
    fprintf(stderr, "rt_dev_socket: %s\n", strerror(-ret));
    return -1;
}
s = ret;

if (argv[optind] == NULL) {
    if (verbose)
        printf("interface all\n");

    ifr.ifr_ifindex = 0;
} else {
    if (verbose)
        printf("interface %s\n", argv[optind]);

    strncpy(ifr.ifr_name, argv[optind], IFNAMSIZ);
    if (verbose)
        printf("s=%d, ifr_name=%s\n", s, ifr.ifr_name);

    ret = rt_dev_ioctl(s, SIOCGIFINDEX, &ifr);
    if (ret < 0) {
        fprintf(stderr, "rt_dev_ioctl GET_IFINDEX: %s\n", strerror(-ret));
        goto failure;
    }
}

if (err_mask) {
    ret = rt_dev_setsockopt(s, SOL_CAN_RAW,
  CAN_RAW_ERR_FILTER,
                            &err_mask, sizeof(err_mask));
    if (ret < 0) {
        fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
        goto failure;
    }
    if (verbose)
        printf("Using err_mask=%#x\n", err_mask);
}

if (filter_count) {
    ret = rt_dev_setsockopt(s, SOL_CAN_RAW,
  CAN_RAW_FILTER,
                            &recv_filter, filter_count *
                            sizeof(struct can_filter));
    if (ret < 0) {
        fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
        goto failure;
    }
}

recv_addr.can_family = AF_CAN;
recv_addr.can_ifindex = ifr.ifr_ifindex;
ret = rt_dev_bind(s, (struct sockaddr *)&recv_addr,
                  sizeof(struct sockaddr_can));
if (ret < 0) {
    fprintf(stderr, "rt_dev_bind: %s\n", strerror(-ret));
    goto failure;
}

if (timeout) {
    if (verbose)
        printf("Timeout: %lld ns\n", (long long)timeout);
    ret = rt_dev_ioctl(s, RTCAN_RTIOC_RCV_TIMEOUT, &timeout);
    if (ret) {
        fprintf(stderr, "rt_dev_ioctl RCV_TIMEOUT: %s\n", strerror(-ret));
        goto failure;
    }
}

if (with_timestamp) {
    ret = rt_dev_ioctl(s, RTCAN_RTIOC_TAKE_TIMESTAMP,
  RTCAN_TAKE_TIMESTAMPS);
```

```
        if (ret) {
            fprintf(stderr, "rt_dev_ioctl TAKE_TIMESTAMP: %s\n", strerror(-ret));
            goto failure;
        }
    }

    snprintf(name, sizeof(name), "rtcanrecv-%d", getpid());
    ret = rt_task_shadow(&rt_task_desc, name, 0, 0);
    if (ret) {
        fprintf(stderr, "rt_task_shadow: %s\n", strerror(-ret));
        goto failure;
    }

    rt_task();
    /* never returns */

 failure:
    cleanup();
    return -1;
}
```

8.9 rtcansend.c

```
#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
#include <time.h>
#include <errno.h>
#include <getopt.h>
#include <sys/mman.h>

#include <alchemy/task.h>
#include <alchemy/timer.h>

#include <rtdm/can.h>

extern int optind, opterr, optopt;

static void print_usage(char *prg)
{
    fprintf(stderr,
            "Usage: %s <can-interface> [Options] <can-msg>\n"
            "<can-msg> can consist of up to 8 bytes given as a space separated list\n"
            "Options:\n"
            " -i, --identifier=ID   CAN Identifier (default = 1)\n"
            " -r  --rtr             send remote request\n"
            " -e  --extended        send extended frame\n"
            " -l  --loop=COUNT      send message COUNT times\n"
            " -c, --count           message count in data[0-3]\n"
            " -d, --delay=MS        delay in ms (default = 1ms)\n"
            " -s, --send            use send instead of sendto\n"
            " -t, --timeout=MS      timeout in ms\n"
            " -L, --loopback=0|1    switch local loopback off or on\n"
            " -v, --verbose         be verbose\n"
            " -p, --print=MODULO    print every MODULO message\n"
            " -h, --help            this help\n",
            prg);
}


RT_TASK rt_task_desc;

static int s=-1, dlc=0, rtr=0, extended=0, verbose=0, loops=1;
static SRTIME delay=1000000;
static int count=0, print=1, use_send=0, loopback=-1;
static nanosecs_rel_t timeout = 0;
static struct can_frame frame;
static struct sockaddr_can to_addr;


static void cleanup(void)
{
    int ret;

    if (verbose)
        printf("Cleaning up...\n");

    usleep(100000);

    if (s >= 0) {
        ret = rt_dev_close(s);
        s = -1;
```

```
        if (ret) {
            fprintf(stderr, "rt_dev_close: %s\n", strerror(-ret));
        }
        exit(EXIT_SUCCESS);
    }
}

static void cleanup_and_exit(int sig)
{
    if (verbose)
        printf("Signal %d received\n", sig);
    cleanup();
    exit(0);
}

static void rt_task(void)
{
    int i, j, ret;

    for (i = 0; i < loops; i++) {
        rt_task_sleep(rt_timer_ns2ticks(delay));
        if (count)
            memcpy(&frame.data[0], &i, sizeof(i));
        /* Note: sendto avoids the definiton of a receive filter list */
        if (use_send)
            ret = rt_dev_send(s, (void *)&frame, sizeof(can_frame_t), 0);
        else
            ret = rt_dev_sendto(s, (void *)&frame, sizeof(
      can_frame_t), 0,
                                (struct sockaddr *)&to_addr, sizeof(to_addr));
        if (ret < 0) {
            switch (ret) {
            case -ETIMEDOUT:
                if (verbose)
                    printf("rt_dev_send(to): timed out");
                break;
            case -EBADF:
                if (verbose)
                    printf("rt_dev_send(to): aborted because socket was closed");
                break;
            default:
                fprintf(stderr, "rt_dev_send: %s\n", strerror(-ret));
                break;
            }
            i = loops;          /* abort */
            break;
        }
        if (verbose && (i % print) == 0) {
            if (frame.can_id & CAN_EFF_FLAG)
                printf("<0x%08x>", frame.can_id & CAN_EFF_MASK);
            else
                printf("<0x%03x>", frame.can_id & CAN_SFF_MASK);
            printf(" [%d]", frame.can_dlc);
            for (j = 0; j < frame.can_dlc; j++) {
                printf(" %02x", frame.data[j]);
            }
            printf("\n");
        }
    }
}

int main(int argc, char **argv)
{
    int i, opt, ret;
    struct ifreq ifr;
    char name[32];

    struct option long_options[] = {
        { "help", no_argument, 0, 'h' },
        { "identifier", required_argument, 0, 'i'},
        { "rtr", no_argument, 0, 'r'},
        { "extended", no_argument, 0, 'e'},
        { "verbose", no_argument, 0, 'v'},
        { "count", no_argument, 0, 'c'},
        { "print", required_argument, 0, 'p'},
        { "loop", required_argument, 0, 'l'},
        { "delay", required_argument, 0, 'd'},
        { "send", no_argument, 0, 's'},
        { "timeout", required_argument, 0, 't'},
        { "loopback", required_argument, 0, 'L'},
        { 0, 0, 0, 0},
    };

    mlockall(MCL_CURRENT | MCL_FUTURE);

    signal(SIGTERM, cleanup_and_exit);
    signal(SIGINT, cleanup_and_exit);
```

```
    frame.can_id = 1;

    while ((opt = getopt_long(argc, argv, "hvi:l:red:t:cp:sL:",
                              long_options, NULL)) != -1) {
        switch (opt) {
        case 'h':
            print_usage(argv[0]);
            exit(0);

        case 'p':
            print = strtoul(optarg, NULL, 0);

        case 'v':
            verbose = 1;
            break;

        case 'c':
            count = 1;
            break;

        case 'l':
            loops = strtoul(optarg, NULL, 0);
            break;

        case 'i':
            frame.can_id = strtoul(optarg, NULL, 0);
            break;

        case 'r':
            rtr = 1;
            break;

        case 'e':
            extended = 1;
            break;

        case 'd':
            delay = strtoul(optarg, NULL, 0) * 1000000LL;
            break;

        case 's':
            use_send = 1;
            break;

        case 't':
            timeout = strtoul(optarg, NULL, 0) * 1000000LL;
            break;

        case 'L':
            loopback = strtoul(optarg, NULL, 0);
            break;

        default:
            fprintf(stderr, "Unknown option %c\n", opt);
            break;
        }
    }

    if (optind == argc) {
        print_usage(argv[0]);
        exit(0);
    }

    if (argv[optind] == NULL) {
        fprintf(stderr, "No Interface supplied\n");
        exit(-1);
    }

    if (verbose)
        printf("interface %s\n", argv[optind]);

    ret = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
    if (ret < 0) {
        fprintf(stderr, "rt_dev_socket: %s\n", strerror(-ret));
        return -1;
    }
    s = ret;

    if (loopback >= 0) {
        ret = rt_dev_setsockopt(s, SOL_CAN_RAW,
      CAN_RAW_LOOPBACK,
                                &loopback, sizeof(loopback));
        if (ret < 0) {
            fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
            goto failure;
        }
```

```
        if (verbose)
            printf("Using loopback=%d\n", loopback);
    }

    strncpy(ifr.ifr_name, argv[optind], IFNAMSIZ);
    if (verbose)
        printf("s=%d, ifr_name=%s\n", s, ifr.ifr_name);

    ret = rt_dev_ioctl(s, SIOCGIFINDEX, &ifr);
    if (ret < 0) {
        fprintf(stderr, "rt_dev_ioctl: %s\n", strerror(-ret));
        goto failure;
    }

    memset(&to_addr, 0, sizeof(to_addr));
    to_addr.can_ifindex = ifr.ifr_ifindex;
    to_addr.can_family = AF_CAN;
    if (use_send) {
        /* Suppress definiton of a default receive filter list */
        ret = rt_dev_setsockopt(s, SOL_CAN_RAW,
      CAN_RAW_FILTER, NULL, 0);
        if (ret < 0) {
            fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
            goto failure;
        }

        ret = rt_dev_bind(s, (struct sockaddr *)&to_addr, sizeof(to_addr));
        if (ret < 0) {
            fprintf(stderr, "rt_dev_bind: %s\n", strerror(-ret));
            goto failure;
        }
    }

    if (count)
        frame.can_dlc = sizeof(int);
    else {
        for (i = optind + 1; i < argc; i++) {
            frame.data[dlc] = strtoul(argv[i], NULL, 0);
            dlc++;
            if( dlc == 8 )
                break;
        }
        frame.can_dlc = dlc;
    }

    if (rtr)
        frame.can_id |= CAN_RTR_FLAG;

    if (extended)
        frame.can_id |= CAN_EFF_FLAG;

    if (timeout) {
        if (verbose)
            printf("Timeout: %lld ns\n", (long long)timeout);
        ret = rt_dev_ioctl(s, RTCAN_RTIOC_SND_TIMEOUT, &timeout);
        if (ret) {
            fprintf(stderr, "rt_dev_ioctl SND_TIMEOUT: %s\n", strerror(-ret));
            goto failure;
        }
    }

    snprintf(name, sizeof(name), "rtcansend-%d", getpid());
    ret = rt_task_shadow(&rt_task_desc, name, 1, 0);
    if (ret) {
        fprintf(stderr, "rt_task_shadow: %s\n", strerror(-ret));
        goto failure;
    }

    rt_task();

    cleanup();
    return 0;

 failure:
    cleanup();
    return -1;
}
```

8.10 xddp-echo.c

```
/*
 * XDDP-based RT/NRT threads communication demo.
 *
```

```
 * Real-time Xenomai threads and regular Linux threads may want to
 * exchange data in a way that does not require the former to leave
 * the real-time domain (i.e. secondary mode). Message pipes - as
 * implemented by the RTDM-based XDDP protocol - are provided for this
 * purpose.
 *
 * On the Linux domain side, pseudo-device files named /dev/rtp<minor>
 * give regular POSIX threads access to non real-time communication
 * endpoints, via the standard character-based I/O interface. On the
 * Xenomai domain side, sockets may be bound to XDDP ports, which act
 * as proxies to send and receive data to/from the associated
 * pseudo-device files. Ports and pseudo-device minor numbers are
 * paired, meaning that e.g. port 7 will proxy the traffic for
 * /dev/rtp7. Therefore, port numbers may range from 0 to
 * CONFIG_XENO_OPT_PIPE_NRDEV - 1.
 *
 * All data sent through a bound/connected XDDP socket via sendto(2) or
 * write(2) will be passed to the peer endpoint in the Linux domain,
 * and made available for reading via the standard read(2) system
 * call. Conversely, all data sent using write(2) through the non
 * real-time endpoint will be conveyed to the real-time socket
 * endpoint, and made available to the recvfrom(2) or read(2) system
 * calls.
 *
 * Both threads can use the bi-directional data path to send and
 * receive datagrams in a FIFO manner, as illustrated by the simple
 * echoing process implemented by this program.
 *
 * realtime_thread------------------------------>-------+
 *   =>  get socket                                     |
 *   =>  bind socket to port 0                          v
 *   =>  write traffic to NRT domain via sendto()       |
 *   =>  read traffic from NRT domain via recvfrom() <--|--+
 *                                                      |  |
 * regular_thread---------------------------------------+  |
 *   =>  open /dev/rtp0                                 |  ^
 *   =>  read traffic from RT domain via read()         |  |
 *   =>  echo traffic back to RT domain via write()     +--+
 *
 * See Makefile in this directory for build directives.
 *
 * NOTE: XDDP is a replacement for the legacy RT_PIPE interface
 * available from the native skin until Xenomai 3.
 */
#include <sys/mman.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <signal.h>
#include <string.h>
#include <malloc.h>
#include <pthread.h>
#include <fcntl.h>
#include <errno.h>
#include <rtdm/ipc.h>

pthread_t rt, nrt;

#define XDDP_PORT 0     /* [0..CONFIG-XENO_OPT_PIPE_NRDEV - 1] */

static const char *msg[] = {
    "Surfing With The Alien",
    "Lords of Karma",
    "Banana Mango",
    "Psycho Monkey",
    "Luminous Flesh Giants",
    "Moroccan Sunset",
    "Satch Boogie",
    "Flying In A Blue Dream",
    "Ride",
    "Summer Song",
    "Speed Of Light",
    "Crystal Planet",
    "Raspberry Jam Delta-V",
    "Champagne?",
    "Clouds Race Across The Sky",
    "Engines Of Creation"
};

static void fail(const char *reason)
{
        perror(reason);
        exit(EXIT_FAILURE);
}

static void *realtime_thread(void *arg)
{
```

```
        struct sockaddr_ipc saddr;
        int ret, s, n = 0, len;
        struct timespec ts;
        size_t poolsz;
        char buf[128];

        /*
         * Get a datagram socket to bind to the RT endpoint. Each
         * endpoint is represented by a port number within the XDDP
         * protocol namespace.
         */
        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_XDDP);
        if (s < 0) {
                perror("socket");
                exit(EXIT_FAILURE);
        }

        /*
         * Set a local 16k pool for the RT endpoint. Memory needed to
         * convey datagrams will be pulled from this pool, instead of
         * Xenomai's system pool.
         */
        poolsz = 16384; /* bytes */
        ret = setsockopt(s, SOL_XDDP, XDDP_POOLSZ,
                         &poolsz, sizeof(poolsz));
        if (ret)
                fail("setsockopt");

        /*
         * Bind the socket to the port, to setup a proxy to channel
         * traffic to/from the Linux domain.
         *
         * saddr.sipc_port specifies the port number to use.
         */
        memset(&saddr, 0, sizeof(saddr));
        saddr.sipc_family = AF_RTIPC;
        saddr.sipc_port = XDDP_PORT;
        ret = bind(s, (struct sockaddr *)&saddr, sizeof(saddr));
        if (ret)
                fail("bind");

        for (;;) {
                len = strlen(msg[n]);
                /*
                 * Send a datagram to the NRT endpoint via the proxy.
                 * We may pass a NULL destination address, since a
                 * bound socket is assigned a default destination
                 * address matching the binding address (unless
                 * connect(2) was issued before bind(2), in which case
                 * the former would prevail).
                 */
                ret = sendto(s, msg[n], len, 0, NULL, 0);
                if (ret != len)
                        fail("sendto");

                rt_printf("%s: sent %d bytes, \"%.*s\"\n",
                          __FUNCTION__, ret, ret, msg[n]);

                /* Read back packets echoed by the regular thread */
                ret = recvfrom(s, buf, sizeof(buf), 0, NULL, 0);
                if (ret <= 0)
                        fail("recvfrom");

                rt_printf("   => \"%.*s\" echoed by peer\n", ret, buf);

                n = (n + 1) % (sizeof(msg) / sizeof(msg[0]));
                /*
                 * We run in full real-time mode (i.e. primary mode),
                 * so we have to let the system breathe between two
                 * iterations.
                 */
                ts.tv_sec = 0;
                ts.tv_nsec = 500000000; /* 500 ms */
                clock_nanosleep(CLOCK_REALTIME, 0, &ts, NULL);
        }

        return NULL;
}

static void *regular_thread(void *arg)
{
        char buf[128], *devname;
        int fd, ret;

        if (asprintf(&devname, "/dev/rtp%d", XDDP_PORT) < 0)
                fail("asprintf");
```

```
        fd = open(devname, O_RDWR);
        free(devname);
        if (fd < 0)
                fail("open");

        for (;;) {
                /* Get the next message from realtime_thread. */
                ret = read(fd, buf, sizeof(buf));
                if (ret <= 0)
                        fail("read");

                /* Echo the message back to realtime_thread. */
                ret = write(fd, buf, ret);
                if (ret <= 0)
                        fail("write");
        }

        return NULL;
}

static void cleanup_upon_sig(int sig)
{
        pthread_cancel(rt);
        pthread_cancel(nrt);
        signal(sig, SIG_DFL);
        pthread_join(rt, NULL);
        pthread_join(nrt, NULL);
}

int main(int argc, char **argv)
{
        struct sched_param rtparam = { .sched_priority = 42 };
        pthread_attr_t rtattr, regattr;
        sigset_t mask, oldmask;

        mlockall(MCL_CURRENT | MCL_FUTURE);

        sigemptyset(&mask);
        sigaddset(&mask, SIGINT);
        signal(SIGINT, cleanup_upon_sig);
        sigaddset(&mask, SIGTERM);
        signal(SIGTERM, cleanup_upon_sig);
        sigaddset(&mask, SIGHUP);
        signal(SIGHUP, cleanup_upon_sig);
        pthread_sigmask(SIG_BLOCK, &mask, &oldmask);

        /*
         * This is a real-time compatible printf() package from
         * Xenomai's RT Development Kit (RTDK), that does NOT cause
         * any transition to secondary (i.e. non real-time) mode when
         * writing output.
         */
        rt_print_auto_init(1);

        pthread_attr_init(&rtattr);
        pthread_attr_setdetachstate(&rtattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&rtattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&rtattr, SCHED_FIFO);
        pthread_attr_setschedparam(&rtattr, &rtparam);

        errno = pthread_create(&rt, &rtattr, &realtime_thread, NULL);
        if (errno)
                fail("pthread_create");

        pthread_attr_init(&regattr);
        pthread_attr_setdetachstate(&regattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&regattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&regattr, SCHED_OTHER);

        errno = pthread_create(&nrt, &regattr, &regular_thread, NULL);
        if (errno)
                fail("pthread_create");

        sigsuspend(&oldmask);

        return 0;
}
```

8.11 xddp-label.c

```
/*
 * XDDP-based RT/NRT threads communication demo.
 *
```

```
 * Real-time Xenomai threads and regular Linux threads may want to
 * exchange data in a way that does not require the former to leave
 * the real-time domain (i.e. secondary mode). Message pipes - as
 * implemented by the RTDM-based XDDP protocol - are provided for this
 * purpose.
 *
 * On the Linux domain side, pseudo-device files named /dev/rtp<minor>
 * give regular POSIX threads access to non real-time communication
 * endpoints, via the standard character-based I/O interface. On the
 * Xenomai domain side, sockets may be bound to XDDP ports, which act
 * as proxies to send and receive data to/from the associated
 * pseudo-device files. Ports and pseudo-device minor numbers are
 * paired, meaning that e.g. port 7 will proxy the traffic for
 * /dev/rtp7. Therefore, port numbers may range from 0 to
 * CONFIG_XENO_OPT_PIPE_NRDEV - 1.
 *
 * All data sent through a bound/connected XDDP socket via sendto(2) or
 * write(2) will be passed to the peer endpoint in the Linux domain,
 * and made available for reading via the standard read(2) system
 * call. Conversely, all data sent using write(2) through the non
 * real-time endpoint will be conveyed to the real-time socket
 * endpoint, and made available to the recvfrom(2) or read(2) system
 * calls.
 *
 * ASCII labels can be attached to bound ports, in order to connect
 * sockets to them in a more descriptive way than using plain numeric
 * port values.
 *
 * The example code below illustrates the following process:
 *
 * realtime_thread1----------------------------->----------+
 *   =>  get socket                                        |
 *   =>  bind socket to port "xddp-demo                    |
 *   =>  read traffic from NRT domain via recvfrom()    <--+--+
 *                                                         |  |
 * realtime_thread2----------------------------------------+  |
 *   =>  get socket                                        |  |
 *   =>  connect socket to port "xddp-demo"                |  |
 *   =>  write traffic to NRT domain via sendto()          v  |
 *                                                         |  ^
 * regular_thread------------------------------------------+  |
 *   =>  open /proc/xenomai/registry/rtipc/xddp/xddp-demo  |  |
 *   =>  read traffic from RT domain via read()            |  |
 *   =>  mirror traffic to RT domain via write()           +--+
 *
 * See Makefile in this directory for build directives.
 *
 * NOTE: XDDP is a replacement for the legacy RT_PIPE interface
 * available from the native skin until Xenomai 3.
 */
#include <sys/mman.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <signal.h>
#include <string.h>
#include <malloc.h>
#include <pthread.h>
#include <fcntl.h>
#include <errno.h>
#include <rtdm/ipc.h>

pthread_t rt1, rt2, nrt;

#define XDDP_PORT_LABEL  "xddp-demo"

static const char *msg[] = {
    "Surfing With The Alien",
    "Lords of Karma",
    "Banana Mango",
    "Psycho Monkey",
    "Luminous Flesh Giants",
    "Moroccan Sunset",
    "Satch Boogie",
    "Flying In A Blue Dream",
    "Ride",
    "Summer Song",
    "Speed Of Light",
    "Crystal Planet",
    "Raspberry Jam Delta-V",
    "Champagne?",
    "Clouds Race Across The Sky",
    "Engines Of Creation"
};

static void fail(const char *reason)
{
```

```
        perror(reason);
        exit(EXIT_FAILURE);
}

static void *realtime_thread1(void *arg)
{
        struct rtipc_port_label plabel;
        struct sockaddr_ipc saddr;
        char buf[128];
        int ret, s;

        /*
         * Get a datagram socket to bind to the RT endpoint. Each
         * endpoint is represented by a port number within the XDDP
         * protocol namespace.
         */
        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_XDDP);
        if (s < 0) {
                perror("socket");
                exit(EXIT_FAILURE);
        }

        /*
         * Set a port label. This name will be registered when
         * binding, in addition to the port number (if given).
         */
        strcpy(plabel.label, XDDP_PORT_LABEL);
        ret = setsockopt(s, SOL_XDDP, XDDP_LABEL,
                         &plabel, sizeof(plabel));
        if (ret)
                fail("setsockopt");
        /*
         * Bind the socket to the port, to setup a proxy to channel
         * traffic to/from the Linux domain. Assign that port a label,
         * so that peers may use a descriptive information to locate
         * it. For instance, the pseudo-device matching our RT
         * endpoint will appear as
         * /proc/xenomai/registry/rtipc/xddp/<XDDP_PORT_LABEL> in the
         * Linux domain, once the socket is bound.
         *
         * saddr.sipc_port specifies the port number to use. If -1 is
         * passed, the XDDP driver will auto-select an idle port.
         */
        memset(&saddr, 0, sizeof(saddr));
        saddr.sipc_family = AF_RTIPC;
        saddr.sipc_port = -1;
        ret = bind(s, (struct sockaddr *)&saddr, sizeof(saddr));
        if (ret)
                fail("bind");

        for (;;) {
                /* Get packets relayed by the regular thread */
                ret = recvfrom(s, buf, sizeof(buf), 0, NULL, 0);
                if (ret <= 0)
                        fail("recvfrom");

                rt_printf("%s: \"%.*s\" relayed by peer\n", __FUNCTION__, ret, buf);
        }

        return NULL;
}

static void *realtime_thread2(void *arg)
{
        struct rtipc_port_label plabel;
        struct sockaddr_ipc saddr;
        int ret, s, n = 0, len;
        struct timespec ts;
        struct timeval tv;
        socklen_t addrlen;

        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_XDDP);
        if (s < 0) {
                perror("socket");
                exit(EXIT_FAILURE);
        }

        /*
         * Set the socket timeout; it will apply when attempting to
         * connect to a labeled port, and to recvfrom() calls.  The
         * following setup tells the XDDP driver to wait for at most
         * one second until a socket is bound to a port using the same
         * label, or return with a timeout error.
         */
        tv.tv_sec = 1;
        tv.tv_usec = 0;
        ret = setsockopt(s, SOL_SOCKET, SO_RCVTIMEO,
```

```
                  &tv, sizeof(tv));
        if (ret)
                fail("setsockopt");

        /*
         * Set a port label. This name will be used to find the peer
         * when connecting, instead of the port number.
         */
        strcpy(plabel.label, XDDP_PORT_LABEL);
        ret = setsockopt(s, SOL_XDDP, XDDP_LABEL,
                         &plabel, sizeof(plabel));
        if (ret)
                fail("setsockopt");

        memset(&saddr, 0, sizeof(saddr));
        saddr.sipc_family = AF_RTIPC;
        saddr.sipc_port = -1;   /* Tell XDDP to search by label. */
        ret = connect(s, (struct sockaddr *)&saddr, sizeof(saddr));
        if (ret)
                fail("connect");

        /*
         * We succeeded in making the port our default destination
         * address by using its label, but we don't know its actual
         * port number yet. Use getpeername() to retrieve it.
         */
        addrlen = sizeof(saddr);
        ret = getpeername(s, (struct sockaddr *)&saddr, &addrlen);
        if (ret || addrlen != sizeof(saddr))
                fail("getpeername");

        rt_printf("%s: NRT peer is reading from /dev/rtp%d\n",
                  __FUNCTION__, saddr.sipc_port);

        for (;;) {
                len = strlen(msg[n]);
                /*
                 * Send a datagram to the NRT endpoint via the proxy.
                 * We may pass a NULL destination address, since the
                 * socket was successfully assigned the proper default
                 * address via connect(2).
                 */
                ret = sendto(s, msg[n], len, 0, NULL, 0);
                if (ret != len)
                        fail("sendto");

                rt_printf("%s: sent %d bytes, \"%.*s\"\n",
                          __FUNCTION__, ret, ret, msg[n]);

                n = (n + 1) % (sizeof(msg) / sizeof(msg[0]));
                /*
                 * We run in full real-time mode (i.e. primary mode),
                 * so we have to let the system breathe between two
                 * iterations.
                 */
                ts.tv_sec = 0;
                ts.tv_nsec = 500000000; /* 500 ms */
                clock_nanosleep(CLOCK_REALTIME, 0, &ts, NULL);
        }

        return NULL;
}

static void *regular_thread(void *arg)
{
        char buf[128], *devname;
        int fd, ret;

        if (asprintf(&devname,
                     "/proc/xenomai/registry/rtipc/xddp/%s",
                     XDDP_PORT_LABEL) < 0)
                fail("asprintf");

        fd = open(devname, O_RDWR);
        free(devname);
        if (fd < 0)
                fail("open");

        for (;;) {
                /* Get the next message from realtime_thread2. */
                ret = read(fd, buf, sizeof(buf));
                if (ret <= 0)
                        fail("read");

                /* Relay the message to realtime_thread1. */
                ret = write(fd, buf, ret);
                if (ret <= 0)
```

```
                        fail("write");
        }

        return NULL;
}

static void cleanup_upon_sig(int sig)
{
        pthread_cancel(rt1);
        pthread_cancel(rt2);
        pthread_cancel(nrt);
        signal(sig, SIG_DFL);
        pthread_join(rt1, NULL);
        pthread_join(rt2, NULL);
        pthread_join(nrt, NULL);
}

int main(int argc, char **argv)
{
        struct sched_param rtparam = { .sched_priority = 42 };
        pthread_attr_t rtattr, regattr;
        sigset_t mask, oldmask;

        mlockall(MCL_CURRENT | MCL_FUTURE);

        sigemptyset(&mask);
        sigaddset(&mask, SIGINT);
        signal(SIGINT, cleanup_upon_sig);
        sigaddset(&mask, SIGTERM);
        signal(SIGTERM, cleanup_upon_sig);
        sigaddset(&mask, SIGHUP);
        signal(SIGHUP, cleanup_upon_sig);
        pthread_sigmask(SIG_BLOCK, &mask, &oldmask);

        /*
         * This is a real-time compatible printf() package from
         * Xenomai's RT Development Kit (RTDK), that does NOT cause
         * any transition to secondary (i.e. non real-time) mode when
         * writing output.
         */
        rt_print_auto_init(1);

        pthread_attr_init(&rtattr);
        pthread_attr_setdetachstate(&rtattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&rtattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&rtattr, SCHED_FIFO);
        pthread_attr_setschedparam(&rtattr, &rtparam);

        /* Both real-time threads have the same attribute set. */

        errno = pthread_create(&rt1, &rtattr, &realtime_thread1, NULL);
        if (errno)
                fail("pthread_create");

        errno = pthread_create(&rt2, &rtattr, &realtime_thread2, NULL);
        if (errno)
                fail("pthread_create");

        pthread_attr_init(&regattr);
        pthread_attr_setdetachstate(&regattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&regattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&regattr, SCHED_OTHER);

        errno = pthread_create(&nrt, &regattr, &regular_thread, NULL);
        if (errno)
                fail("pthread_create");

        sigsuspend(&oldmask);

        return 0;
}
```

8.12 xddp-stream.c

```
/*
 * XDDP-based RT/NRT threads communication demo.
 *
 * Real-time Xenomai threads and regular Linux threads may want to
 * exchange data in a way that does not require the former to leave
 * the real-time domain (i.e. secondary mode). Message pipes - as
 * implemented by the RTDM-based XDDP protocol - are provided for this
 * purpose.
 *
```

```
 * On the Linux domain side, pseudo-device files named /dev/rtp<minor>
 * give regular POSIX threads access to non real-time communication
 * endpoints, via the standard character-based I/O interface. On the
 * Xenomai domain side, sockets may be bound to XDDP ports, which act
 * as proxies to send and receive data to/from the associated
 * pseudo-device files. Ports and pseudo-device minor numbers are
 * paired, meaning that e.g. port 7 will proxy the traffic for
 * /dev/rtp7. Therefore, port numbers may range from 0 to
 * CONFIG_XENO_OPT_PIPE_NRDEV - 1.
 *
 * All data sent through a bound/connected XDDP socket via sendto(2) or
 * write(2) will be passed to the peer endpoint in the Linux domain,
 * and made available for reading via the standard read(2) system
 * call. Conversely, all data sent using write(2) through the non
 * real-time endpoint will be conveyed to the real-time socket
 * endpoint, and made available to the recvfrom(2) or read(2) system
 * calls.
 *
 * In addition to sending datagrams, real-time threads may stream data
 * in a byte-oriented mode through the proxy as well. This increases
 * the bandwidth and reduces the overhead, when a lot of data has to
 * flow down to the Linux domain, if keeping the message boundaries is
 * not required. The example code below illustrates such use.
 *
 * realtime_thread-------------------------------------->----------+
 *   =>  get socket                                                |
 *   =>  bind socket to port 0                                     v
 *   =>  write scattered traffic to NRT domain via sendto()        |
 *   =>  read traffic from NRT domain via recvfrom()            <--|--+
 *                                                                 |  |
 * regular_thread--------------------------------------------------+  |
 *   =>  open /dev/rtp0                                            |  ^
 *   =>  read traffic from RT domain via read()                    |  |
 *   =>  echo traffic back to RT domain via write()                +--+
 *
 * See Makefile in this directory for build directives.
 *
 * NOTE: XDDP is a replacement for the legacy RT_PIPE interface
 * available from the native skin until Xenomai 3.
 */
#include <sys/mman.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <signal.h>
#include <string.h>
#include <malloc.h>
#include <pthread.h>
#include <fcntl.h>
#include <errno.h>
#include <rtdm/ipc.h>

pthread_t rt, nrt;

#define XDDP_PORT 0     /* [0..CONFIG-XENO_OPT_PIPE_NRDEV - 1] */

static const char *msg[] = {
    "Surfing With The Alien",
    "Lords of Karma",
    "Banana Mango",
    "Psycho Monkey",
    "Luminous Flesh Giants",
    "Moroccan Sunset",
    "Satch Boogie",
    "Flying In A Blue Dream",
    "Ride",
    "Summer Song",
    "Speed Of Light",
    "Crystal Planet",
    "Raspberry Jam Delta-V",
    "Champagne?",
    "Clouds Race Across The Sky",
    "Engines Of Creation"
};

static void fail(const char *reason)
{
        perror(reason);
        exit(EXIT_FAILURE);
}

static void *realtime_thread(void *arg)
{
        struct sockaddr_ipc saddr;
        int ret, s, n = 0, len, b;
        struct timespec ts;
        size_t streamsz;
```

```
        char buf[128];

        /*
         * Get a datagram socket to bind to the RT endpoint. Each
         * endpoint is represented by a port number within the XDDP
         * protocol namespace.
         */
        s = socket(AF_RTIPC, SOCK_DGRAM, IPCPROTO_XDDP);
        if (s < 0) {
                perror("socket");
                exit(EXIT_FAILURE);
        }

        /*
         * Tell the XDDP driver that we will use the streaming
         * capabilities on this socket. To this end, we have to
         * specify the size of the streaming buffer, as a count of
         * bytes. The real-time output will be buffered up to that
         * amount, and sent as a single datagram to the NRT endpoint
         * when fully gathered, or when another source port attempts
         * to send data to the same endpoint. Passing a null size
         * would disable streaming.
         */
        streamsz = 1024; /* bytes */
        ret = setsockopt(s, SOL_XDDP, XDDP_BUFSZ,
                         &streamsz, sizeof(streamsz));
        if (ret)
                fail("setsockopt");
        /*
         * Bind the socket to the port, to setup a proxy to channel
         * traffic to/from the Linux domain.
         *
         * saddr.sipc_port specifies the port number to use.
         */
        memset(&saddr, 0, sizeof(saddr));
        saddr.sipc_family = AF_RTIPC;
        saddr.sipc_port = XDDP_PORT;
        ret = bind(s, (struct sockaddr *)&saddr, sizeof(saddr));
        if (ret)
                fail("bind");

        for (;;) {
                len = strlen(msg[n]);
                /*
                 * Send a datagram to the NRT endpoint via the proxy.
                 * The output is artificially scattered in separate
                 * one-byte sendings, to illustrate the use of
                 * MSG_MORE.
                 */
                for (b = 0; b < len; b++) {
                        ret = sendto(s, msg[n] + b, 1, MSG_MORE, NULL, 0);
                        if (ret != 1)
                                fail("sendto");
                }

                rt_printf("%s: sent (scattered) %d-bytes message, \"%.*s\"\n",
                          __FUNCTION__, len, len, msg[n]);

                /* Read back packets echoed by the regular thread */
                ret = recvfrom(s, buf, sizeof(buf), 0, NULL, 0);
                if (ret <= 0)
                        fail("recvfrom");

                rt_printf("   => \"%.*s\" echoed by peer\n", ret, buf);

                n = (n + 1) % (sizeof(msg) / sizeof(msg[0]));
                /*
                 * We run in full real-time mode (i.e. primary mode),
                 * so we have to let the system breathe between two
                 * iterations.
                 */
                ts.tv_sec = 0;
                ts.tv_nsec = 500000000; /* 500 ms */
                clock_nanosleep(CLOCK_REALTIME, 0, &ts, NULL);
        }

        return NULL;
}

static void *regular_thread(void *arg)
{
        char buf[128], *devname;
        int fd, ret;

        if (asprintf(&devname, "/dev/rtp%d", XDDP_PORT) < 0)
                fail("asprintf");
```

```
        fd = open(devname, O_RDWR);
        free(devname);
        if (fd < 0)
                fail("open");

        for (;;) {
                /* Get the next message from realtime_thread. */
                ret = read(fd, buf, sizeof(buf));
                if (ret <= 0)
                        fail("read");

                /* Echo the message back to realtime_thread. */
                ret = write(fd, buf, ret);
                if (ret <= 0)
                        fail("write");
        }

        return NULL;
}

static void cleanup_upon_sig(int sig)
{
        pthread_cancel(rt);
        pthread_cancel(nrt);
        signal(sig, SIG_DFL);
        pthread_join(rt, NULL);
        pthread_join(nrt, NULL);
}

int main(int argc, char **argv)
{
        struct sched_param rtparam = { .sched_priority = 42 };
        pthread_attr_t rtattr, regattr;
        sigset_t mask, oldmask;

        mlockall(MCL_CURRENT | MCL_FUTURE);

        sigemptyset(&mask);
        sigaddset(&mask, SIGINT);
        signal(SIGINT, cleanup_upon_sig);
        sigaddset(&mask, SIGTERM);
        signal(SIGTERM, cleanup_upon_sig);
        sigaddset(&mask, SIGHUP);
        signal(SIGHUP, cleanup_upon_sig);
        pthread_sigmask(SIG_BLOCK, &mask, &oldmask);

        /*
         * This is a real-time compatible printf() package from
         * Xenomai's RT Development Kit (RTDK), that does NOT cause
         * any transition to secondary (i.e. non real-time) mode when
         * writing output.
         */
        rt_print_auto_init(1);

        pthread_attr_init(&rtattr);
        pthread_attr_setdetachstate(&rtattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&rtattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&rtattr, SCHED_FIFO);
        pthread_attr_setschedparam(&rtattr, &rtparam);

        errno = pthread_create(&rt, &rtattr, &realtime_thread, NULL);
        if (errno)
                fail("pthread_create");

        pthread_attr_init(&regattr);
        pthread_attr_setdetachstate(&regattr, PTHREAD_CREATE_JOINABLE);
        pthread_attr_setinheritsched(&regattr, PTHREAD_EXPLICIT_SCHED);
        pthread_attr_setschedpolicy(&regattr, SCHED_OTHER);

        errno = pthread_create(&nrt, &regattr, &regular_thread, NULL);
        if (errno)
                fail("pthread_create");

        sigsuspend(&oldmask);

        return 0;
}
```

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