

Xenomai RTDM skin API Reference Manual

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Chapter 1

Xenomai RTDM skin API Module Index

1.1 Xenomai RTDM skin API Modules

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Chapter 2

Xenomai RTDM skin API Hierarchical Index

2.1 Xenomai RTDM skin API Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

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can_frame	120
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sockaddr_can	129

Chapter 3

Xenomai RTDM skin API Data Structure Index

3.1 Xenomai RTDM skin API Data Structures

Here are the data structures with brief descriptions:

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rtdm_dev_context (Device context)	121
rtdm_device (RTDM device)	122
rtdm_device_info (Device information)	124
rtdm_operations (Device operations)	125
rtser_config (Serial device configuration)	126
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rtser_status (Serial device status)	128
sockaddr_can (Socket address structure for the CAN address family)	129

Chapter 4

Xenomai RTDM skin API File Index

4.1 Xenomai RTDM skin API File List

Here is a list of all documented files with brief descriptions:

include/rtdm/ rtcan.h (Real-Time Driver Model for RT-Socket-CAN, CAN device profile header)	131
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include/rtdm/ rtdm_driver.h (Real-Time Driver Model for Xenomai, driver API header)	144
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include/rtdm/ syscall.h	??
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Chapter 5

Xenomai RTDM skin API Module Documentation

5.1 CAN Devices

Collaboration diagram for CAN Devices:



5.1.1 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

Environments: non-RT (RT optional)

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.

Environments: non-RT (RT optional)

Specific return values: none

IOCTL

Mandatory Environments: 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 [Sockets](#)), 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.

Environments: non-RT (RT optional)

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

Environments: non-RT (RT optional)

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 `msg_hdr` 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

Environments: RT (non-RT optional)

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](#).)

Environments: RT (non-RT optional)

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.

Files

- file [rtcan.h](#)
Real-Time Driver Model for RT-Socket-CAN, CAN device profile header.

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.

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

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.

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 occurred, 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 else bit number in bitstream

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 occurred on transmission

Protocol error location

Error in the data[3] 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

Protocol error location

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

- #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

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_ACTIVE` = 0, `CAN_STATE_BUS_WARNING`, `CAN_STATE_BUS_PASSIVE`,
`CAN_STATE_BUS_OFF`,
`CAN_STATE_SCANNING_BAUDRATE`, `CAN_STATE_STOPPED`, `CAN_STATE_SLEEPING` }

Defines

- #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 [can_filter](#) [can_filter_t](#)
Filter for reception of CAN messages.
- typedef [can_frame](#) [can_frame_t](#)
Raw CAN frame.

Enumerations

- enum [CAN_BITTIME_TYPE](#) { [CAN_BITTIME_STD](#), [CAN_BITTIME_BTR](#) }
Supported CAN bit-time types.

5.1.2 Define Documentation

5.1.2.1 #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](#).

5.1.2.2 `#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](#).

5.1.2.3 `#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 conditions. 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 further details).

Parameters:

- ← *level* `SOL_CAN_RAW`
- ← *optname* `CAN_RAW_ERR_FILTER`
- ← *optval* Pointer to error mask of type `can_err_mask_t`.
- ← *optlen* Size of error mask: `sizeof(can_err_mask_t)`.

Environments: non-RT (RT optional)

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](#).

5.1.2.4 `#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 recommended 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:

- ← *level* `SOL_CAN_RAW`
- ← *optname* `CAN_RAW_FILTER`

- ← *optval* Pointer to array of struct [can_filter](#).
- ← *optlen* Size of filter list: count * sizeof(struct can_filter).
Environments: non-RT (RT optional)
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:

[rtcan_rtt.c](#), [rtcanrecv.c](#), and [rtcansend.c](#).

5.1.2.5 #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:

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

Environments: non-RT (RT optional)

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](#).

5.1.2.6 #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:

← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

Examples:

[rtcanrecv.c](#).

5.1.2.7 `#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:

← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

Examples:

[rtcansend.c](#).

5.1.2.8 #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:

← *arg* int variable, see [Timestamp switches](#)

Returns:

0 on success.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

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.

Rescheduling: never.

Examples:

[rtcanrecv.c](#).

5.1.2.9 #define SIOCGCANBAUDRATE_IOWR(RTIOC_TYPE_CAN, 0x02, struct ifreq)

Get baud rate.

Parameters:

↔ *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.1.2.10 #define SIOCGCANCTRLMODE_IOWR(RTIOC_TYPE_CAN, 0x08, struct ifreq)

Get special controller modes.

Parameters:

← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.1.2.11 #define SIOCGCANCUSTOMBITTIME_IOWR(RTIOC_TYPE_CAN, 0x04, struct ifreq)

Get custom bit-time parameters.

Parameters:

↔ *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.1.2.12 #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 occurred since the last call of this IOCTL are reported and thereafter the error indicators are cleared. See also [CAN controller states](#).

Parameters:

↔ *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.1.2.13 #define SIOCGIFINDEX defined_by_kernel_header_file

Get CAN interface index by name.

Parameters:

↔ *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

Examples:

[rtcan_rtt.c](#), [rtcanconfig.c](#), [rtcanrecv.c](#), and [rtcansend.c](#).

5.1.2.14 #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:

↔ *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 successfully fulfilled. Try again.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

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

Rescheduling: possible.

Examples:

[rtcanconfig.c](#).

5.1.2.15 #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:

← *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 successfully fulfilled. Try again.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

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

Rescheduling: possible.

Examples:

[rtcanconfig.c](#).

5.1.2.16 `#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:

← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

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

Rescheduling: possible.

Examples:

[rtcanconfig.c](#).

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

Set operation mode of CAN controller.

See [CAN controller modes](#) for available modes.

Parameters:

← *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

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

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.

Rescheduling: possible.

Examples:

[rtcanconfig.c](#).

5.1.2.18 #define SOL_CAN_RAW 103

CAN socket levels.

Used for [Sockopts](#) for the particular protocols.

Examples:

[rtcan_rtt.c](#), [rtcanrecv.c](#), and [rtcansend.c](#).

5.1.3 Typedef Documentation

5.1.3.1 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.

5.1.3.2 typedef struct [can_frame](#) [can_frame_t](#)

Raw CAN frame.

Central structure for receiving and sending CAN frames.

5.1.4 Enumeration Type Documentation

5.1.4.1 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.

5.1.4.2 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*.

5.1.4.3 enum [CAN_STATE](#)

Enumerator:

CAN_STATE_ACTIVE CAN controller is error active.

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

CAN_STATE_BUS_PASSIVE CAN controller is error passive.

CAN_STATE_BUS_OFF CAN controller went into Bus Off.

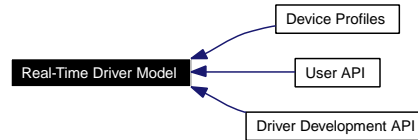
CAN_STATE_SCANNING_BAUDRATE CAN controller is scanning to get the baudrate.

CAN_STATE_STOPPED CAN controller is in stopped mode.

CAN_STATE_SLEEPING CAN controller is in Sleep mode.

5.2 Real-Time Driver Model

Collaboration diagram for Real-Time Driver Model:



5.2.1 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: 6

Modules

- [User API](#)
- [Driver Development API](#)
- [Device Profiles](#)

API Versioning

- `#define RTDM_API_VER 6`
Common user and driver API version.
- `#define RTDM_API_MIN_COMPAT_VER 6`
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.

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.

5.2.2 Typedef Documentation

5.2.2.1 `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](#).

5.2.2.2 `typedef int64_t nanosecs_rel_t`

RTDM type for representing relative intervals.

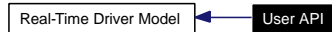
Its base type is a 64 bit signed integer. The unit is 1 nanosecond. Relative intervals can also encode the special timeouts "infinite" and "non-blocking", see [RTDM_TIMEOUT_xxx](#).

Examples:

[rtcanrecv.c](#), and [rtcansend.c](#).

5.3 User API

Collaboration diagram for User API:



5.3.1 Detailed Description

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.

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 incoming connection requests.
- `int rt_dev_accept` (int fd, struct sockaddr *addr, socklen_t *addrlen)
Accept a 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.

5.3.2 Function Documentation

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

Accept a connection requests.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- *addr* Buffer for remote address
- ↔ *addrlen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Bind to local address.

Parameters:

← *fd* File descriptor as returned by `rt_dev_socket()`

← *my_addr* Address buffer

← *addrlen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

5.3.2.3 `int rt_dev_close (int fd)`

Close a device or socket.

Parameters:

← *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.

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Connect to remote address.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- ← *serv_addr* Address buffer
- ← *addrlen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Get socket destination address.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- *name* Address buffer
- ↔ *namelen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Get local socket address.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- *name* Address buffer
- ↔ *namelen* Address buffer size

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Get socket option.

Parameters:

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

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

5.3.2.8 int rt_dev_ioctl (int *fd*, int *request*, ...)

Issue an IOCTL.

Parameters:

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

Returns:

Positiv value on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

5.3.2.9 `int rt_dev_listen (int fd, int backlog)`

Listen for incoming connection requests.

Parameters:

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

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

5.3.2.10 `int rt_dev_open (const char * path, int oflag, ...)`

Open a device.

Parameters:

- ← *path* Device name
- ← *oflag* Open flags
- ... Further parameters will be ignored.

Returns:

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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Read from device.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_open()`
- *buf* Input buffer
- ← *nbyte* Number of bytes to read

Returns:

Number of bytes read, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Receive message from socket.

Parameters:

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

Returns:

Number of bytes received, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

5.3.2.13 `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:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- *buf* Message buffer
- ← *len* Message buffer size
- ← *flags* Message flags
- *from* Buffer for message sender address
- ↔ *fromlen* Address buffer size

Returns:

Number of bytes received, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Receive message from socket.

Parameters:

← *fd* File descriptor as returned by rt_dev_socket()

↔ *msg* Message descriptor

← *flags* Message flags

Returns:

Number of bytes received, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Transmit message to socket.

Parameters:

← *fd* File descriptor as returned by rt_dev_socket()

← *buf* Message buffer

← *len* Message buffer size

← *flags* Message flags

Returns:

Number of bytes sent, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Transmit message to socket.

Parameters:

- ← *fd* File descriptor as returned by `rt_dev_socket()`
- ← *msg* Message descriptor
- ← *flags* Message flags

Returns:

Number of bytes sent, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

5.3.2.17 `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:

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

Returns:

Number of bytes sent, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Set socket option.

Parameters:

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

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

5.3.2.19 `int rt_dev_shutdown (int fd, int how)`

Shut down parts of a connection.

Parameters:

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

Returns:

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

5.3.2.20 `int rt_dev_socket (int protocol_family, int socket_type, int protocol)`

Create a socket.

Parameters:

- ← *protocol_family* Protocol family (`PF_xxx`)

← *socket_type* Socket type (SOCK_XXX)

← *protocol* Protocol ID, 0 for default

Returns:

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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

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

Write to device.

Parameters:

← *fd* File descriptor as returned by rt_dev_open()

← *buf* Output buffer

← *nbyte* Number of bytes to write

Returns:

Number of bytes written, otherwise negative error code

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

See also:

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

5.4 Serial Devices

Collaboration diagram for Serial Devices:



5.4.1 Detailed Description

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: 2

Device Characteristics

Device Flags: RTDM_NAMED_DEVICE, RTDM_EXCLUSIVE

Device Name: "rtser<N>", N >= 0

Device Class: RTDM_CLASS_SERIAL

Supported Operations

Open

Environments: non-RT (RT optional)

Specific return values: none

Close

Environments: non-RT (RT optional)

Specific return values: none

IOCTL

Mandatory Environments: see [below](#)

Specific return values: see [below](#)

Read

Environments: RT (non-RT optional)

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

Environments: RT (non-RT optional)

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)

Files

- file [rtserial.h](#)

Real-Time Driver Model for Xenomai, serial device profile header.

Data Structures

- struct [rtser_config](#)
Serial device configuration.
- struct [rtser_status](#)
Serial device status.
- struct [rtser_event](#)
Additional information about serial device events.

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`
- `#define RTSER_1_5_STOPB 0x01`
valid only in combination with 5 data bits
- `#define RTSER_2_STOPB 0x01`
- `#define RTSER_DEF_STOPB RTSER_1_STOPB`

RTSER_xxx_HAND

Handshake mechanisms

- `#define RTSER_NO_HAND 0x00`
- `#define RTSER_RTSCTS_HAND 0x01`
- `#define RTSER_DEF_HAND RTSER_NO_HAND`

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_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`

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_EMPTY 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_DDSD 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

RTSER_BREAK_xxx

Break control

- #define **RTSER_BREAK_CLR** 0x00
- #define **RTSER_BREAK_SET** 0x01
- #define **RTIOC_TYPE_SERIAL** RTDM_CLASS_SERIAL
- typedef [rtser_config](#) [rtser_config_t](#)
Serial device configuration.
- typedef [rtser_status](#) [rtser_status_t](#)
Serial device status.
- typedef [rtser_event](#) [rtser_event_t](#)
Additional information about serial device events.

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 control register.
- #define [RTSER_RTIOC_SET_CONTROL](#) _IOW(RTIOC_TYPE_SERIAL, 0x04, int)
Set serial device's modem control register.

- `#define RTSER_RTIOC_WAIT_EVENT _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_event)`

Wait on serial device events according to previously set mask.

Defines

- `#define RTSER_RTIOC_BREAK_CTL _IOR(RTIOC_TYPE_SERIAL, 0x06, int)`

Set or clear break on UART output line.

5.4.2 Define Documentation

5.4.2.1 `#define RTSER_RTIOC_BREAK_CTL _IOR(RTIOC_TYPE_SERIAL, 0x06, int)`

Set or clear break on UART output line.

Parameters:

← *arg* `RTSER_BREAK_SET` or `RTSER_BREAK_CLR` (int)

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

A set break condition may also be cleared on UART line reconfiguration.

Rescheduling: never.

5.4.2.2 `#define RTSER_RTIOC_GET_CONFIG _IOR(RTIOC_TYPE_SERIAL, 0x00, struct rtser_config)`

Get serial device configuration.

Parameters:

→ *arg* Pointer to configuration buffer (struct `rtser_config`)

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.4.2.3 `#define RTSER_RTIOC_GET_CONTROL _IOR(RTIOC_TYPE_SERIAL, 0x03, int)`

Get serial device's modem control register.

Parameters:

→ *arg* Pointer to variable receiving the content (int, see [RTSER_MCR_xxx](#))

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.4.2.4 `#define RTSER_RTIOC_GET_STATUS _IOR(RTIOC_TYPE_SERIAL, 0x02, struct rtser_status)`

Get serial device status.

Parameters:

→ *arg* Pointer to status buffer (struct [rtser_status](#))

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Note:

The error states `RTSER_LSR_OVERRUN_ERR`, `RTSER_LSR_PARITY_ERR`, `RTSER_LSR_FRAMING_ERR`, and `RTSER_SOFT_OVERRUN_ERR` that may have occurred 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.

Rescheduling: never.

5.4.2.5 `#define RTSER_RTIOC_SET_CONFIG _IOW(RTIOC_TYPE_SERIAL, 0x01, struct rtser_config)`

Set serial device configuration.

Parameters:

← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

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.

Rescheduling: never.

Examples:

[cross-link.c](#).

5.4.2.6 `#define RTSER_RTIOC_SET_CONTROL _IOW(RTIOC_TYPE_SERIAL, 0x04, int)`

Set serial device's modem control register.

Parameters:

← *arg* New control register content (int, see [RTSER_MCR_xxx](#))

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.4.2.7 `#define RTSER_RTIOC_WAIT_EVENT _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_event)`

Wait on serial device events according to previously set mask.

Parameters:

→ *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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

Examples:

[cross-link.c](#).

5.5 Testing Devices

Collaboration diagram for Testing Devices:



5.5.1 Detailed Description

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: 1

Device Characteristics

Device Flags: RTDM_NAMED_DEVICE
Device Name: "rtttest<N>", N >= 0
Device Class: RTDM_CLASS_TESTING

Supported Operations

Open

Environments: non-RT (RT optional)
 Specific return values: none

Close

Environments: non-RT (RT optional)
 Specific return values: none

IOCTL

Mandatory Environments: see [TSTIOCTLs](#) below
 Specific return values: see [TSTIOCTLs](#) below

Files

- file [rttesting.h](#)

Real-Time Driver Model for Xenomai, testing device profile header.

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)`

5.6 Inter-Driver API

Collaboration diagram for Inter-Driver API:



Functions

- `rt dm_dev_context * rt dm_context_get` (int fd)
Resolve file descriptor to device context.
- void `rt dm_context_lock` (struct `rt dm_dev_context` *context)
Increment context reference counter.
- void `rt dm_context_unlock` (struct `rt dm_dev_context` *context)
Decrement context reference counter.
- int `rt dm_open` (const char *path, int oflag,...)
Open a device.
- int `rt dm_socket` (int protocol_family, int socket_type, int protocol)
Create a socket.
- int `rt dm_close` (int fd)
Close a device or socket.
- int `rt dm_ioctl` (int fd, int request,...)
Issue an IOCTL.
- ssize_t `rt dm_read` (int fd, void *buf, size_t nbyte)
Read from device.
- ssize_t `rt dm_write` (int fd, const void *buf, size_t nbyte)
Write to device.
- ssize_t `rt dm_recvmmsg` (int fd, struct msghdr *msg, int flags)
Receive message from socket.
- ssize_t `rt dm_recvfrom` (int fd, void *buf, size_t len, int flags, struct sockaddr *from, socklen_t *fromlen)
Receive message from socket.
- ssize_t `rt dm_recv` (int fd, void *buf, size_t len, int flags)
Receive message from socket.
- ssize_t `rt dm_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 for incoming connection requests.
- `int rtdm_accept` (int fd, struct sockaddr *addr, socklen_t *addrlen)
Accept a connection requests.
- `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.

5.6.1 Function Documentation

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

Accept a connection requests.

Refer to `rt_dev_accept()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.2 `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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.3 `int rtdm_close (int fd)`

Close a device or socket.

Refer to `rt_dev_close()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.4 `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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.5 `struct rtdm_dev_context* rtdm_context_get (int fd)`

Resolve file descriptor to device context.

Parameters:

← *fd* File descriptor

Returns:

Pointer to associated device context, or NULL on error

Note:

The device context has to be unlocked using [rtdm_context_unlock\(\)](#) when it is no longer referenced.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine

- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.6.1.6 void `rtdm_context_lock` (struct `rtdm_dev_context` * *context*)

Increment context reference counter.

Parameters:

← *context* Device context

Note:

`rtdm_context_get()` automatically increments the lock counter. You only need to call this function in special scenarios.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.6.1.7 void `rtdm_context_unlock` (struct `rtdm_dev_context` * *context*)

Decrement context reference counter.

Parameters:

← *context* Device context

Note:

Every successful call to `rtdm_context_get()` must be matched by a `rtdm_context_unlock()` invocation.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.6.1.8 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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.9 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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.10 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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.11 int rtdm_ioctl (int *fd*, int *request*, ...)

Issue an IOCTL.

Refer to `rt_dev_ioctl()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.12 int rtdm_listen (int *fd*, int *backlog*)

Listen for incoming connection requests.

Refer to `rt_dev_listen()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

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

Open a device.

Refer to `rt_dev_open()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

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

Read from device.

Refer to `rt_dev_read()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.15 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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.16 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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.17 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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.18 `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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.19 `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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.20 `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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.21 `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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.22 `int rtdm_shutdown (int fd, int how)`

Shut down parts of a connection.

Refer to `rt_dev_shutdown()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.23 `int rtdm_socket (int protocol_family, int socket_type, int protocol)`

Create a socket.

Refer to `rt_dev_socket()` for parameters and return values

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.6.1.24 `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

Environments:

Depends on driver implementation, see [Device Profiles](#).

Rescheduling: possible.

5.7 Device Registration Services

Collaboration diagram for Device Registration Services:



Data Structures

- struct `rtm_operations`
Device operations.
- struct `rtm_dev_context`
Device context.
- struct `rtm_device`
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.

Context Flags

Dynamic flags describing the state of an open RTDM device (bit numbers)

- #define `RTDM_CREATED_IN_NRT` 0
Set by RTDM if the device instance was created in non-real-time context.
- #define `RTDM_CLOSING` 1
Set by RTDM when the device is being closed.
- #define `RTDM_USER_CONTEXT_FLAG` 8
Lowest bit number the driver developer can use freely.

Driver Versioning

Current revisions of RTDM structures, encoding of driver versions. See [API Versioning](#) for the interface revision.

- `#define RTDM_DEVICE_STRUCT_VER 4`
Version of struct `rtdm_device`.
- `#define RTDM_CONTEXT_STRUCT_VER 3`
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.

Operation Handler Prototypes

- `typedef int(* rtdm_open_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, int oflag)`
Named device open handler.
- `typedef int(* rtdm_socket_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, int protocol)`
Socket creation handler for protocol devices.
- `typedef int(* rtdm_close_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info)`
Close handler.
- `typedef int(* rtdm_ioctl_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, unsigned int request, void *arg)`
IOCTL handler.
- `typedef ssize_t(* rtdm_read_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, void *buf, size_t nbyte)`
Read handler.

- typedef ssize_t(* [rt dm_write_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, const void *buf, size_t nbyte)
Write handler.
- typedef ssize_t(* [rt dm_rcvmsg_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, struct msghdr *msg, int flags)
Receive message handler.
- typedef ssize_t(* [rt dm_sendmsg_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, const struct msghdr *msg, int flags)
Transmit message handler.

Functions

- int [rt dm_dev_register](#) (struct [rt dm_device](#) *device)
Register a RTDM device.
- int [rt dm_dev_unregister](#) (struct [rt dm_device](#) *device, unsigned int poll_delay)
Unregisters a RTDM device.

5.7.1 Typedef Documentation

- 5.7.1.1 typedef int(* [rt dm_close_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info)

Close handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

Returns:

0 on success, otherwise negative error code

See also:

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

- 5.7.1.2 typedef int(* [rt dm_ioctl_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, unsigned int request, void *arg)

IOCTL handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

← *request* Request number as passed by the user

↔ *arg* Request argument as passed by the user

Returns:

Positive value on success, otherwise negative error code

See also:

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

5.7.1.3 `typedef int(* rtdm_open_handler_t)(struct rtdm_dev_context *context,
rtdm_user_info_t *user_info, int oflag)`

Named device open handler.

Parameters:

← *context* Context structure associated with opened device instance

← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

← *oflag* Open flags as passed by the user

Returns:

0 on success, otherwise negative error code

See also:

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

5.7.1.4 `typedef ssize_t(* rtdm_read_handler_t)(struct rtdm_dev_context *context,
rtdm_user_info_t *user_info, void *buf, size_t nbyte)`

Read handler.

Parameters:

← *context* Context structure associated with opened device instance

← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

→ *buf* Input buffer as passed by the user

← *nbyte* Number of bytes the user requests to read

Returns:

On success, the number of bytes read, otherwise negative error code

See also:

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

5.7.1.5 `typedef ssize_t(* rtdm_recvmmsg_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, struct msghdr *msg, int flags)`

Receive message handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call
- ↔ *msg* Message descriptor as passed by the user, automatically mirrored to safe kernel memory in case of user mode call
- ← *flags* Message flags as passed by the user

Returns:

On success, the number of bytes received, otherwise negative error code

See also:

recvmmsg() in IEEE Std 1003.1, <http://www.opengroup.org/onlinepubs/009695399>

5.7.1.6 `typedef ssize_t(* rtdm_sendmsg_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, const struct msghdr *msg, int flags)`

Transmit message handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call
- ← *msg* Message descriptor as passed by the user, automatically mirrored to safe kernel memory in case of user mode call
- ← *flags* Message flags as passed by the user

Returns:

On success, the number of bytes transmitted, otherwise negative error code

See also:

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

5.7.1.7 `typedef int(* rtdm_socket_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, int protocol)`

Socket creation handler for protocol devices.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call

← *protocol* Protocol number as passed by the user

Returns:

0 on success, otherwise negative error code

See also:

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

5.7.1.8 `typedef ssize_t(* rtdm_write_handler_t)(struct rtdm_dev_context *context,
rtdm_user_info_t *user_info, const void *buf, size_t nbyte)`

Write handler.

Parameters:

- ← *context* Context structure associated with opened device instance
- ← *user_info* Opaque pointer to information about user mode caller, NULL if kernel mode call
- ← *buf* Output buffer as passed by the user
- ← *nbyte* Number of bytes the user requests to write

Returns:

On success, the number of bytes written, otherwise negative error code

See also:

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

5.7.2 Function Documentation

5.7.2.1 `int rtdm_dev_register (struct rtdm_device * device)`

Register a RTDM device.

Parameters:

- ← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

Rescheduling: never.

5.7.2.2 `int rtdm_dev_unregister (struct rtdm_device * device, unsigned int poll_delay)`

Unregisters a RTDM device.

Parameters:

- ← *device* Pointer to structure describing the device to be unregistered.
- ← *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*.

Environments:

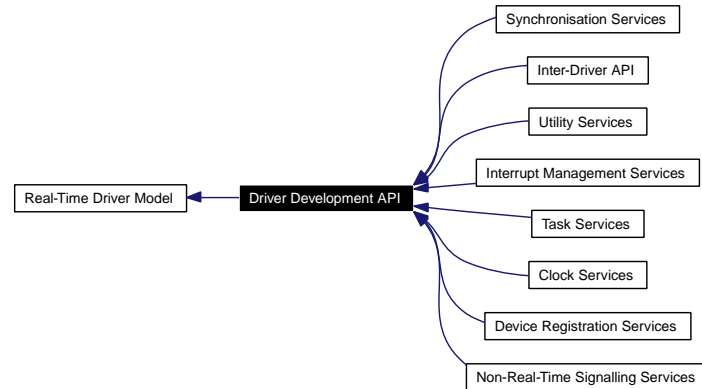
This service can be called from:

- Kernel module initialization/cleanup code

Rescheduling: never.

5.8 Driver Development API

Collaboration diagram for Driver Development API:



5.8.1 Detailed Description

This is the lower interface of RTDM provided to device drivers, currently limited to kernel-space. Real-time drivers should only use functions of this interface in order to remain portable.

Files

- file [rtdm_driver.h](#)
Real-Time Driver Model for Xenomai, driver API header.

Modules

- [Inter-Driver API](#)
- [Device Registration Services](#)
- [Clock Services](#)
- [Task Services](#)
- [Synchronisation Services](#)
- [Interrupt Management Services](#)
- [Non-Real-Time Signalling Services](#)
- [Utility Services](#)

5.9 Clock Services

Collaboration diagram for Clock Services:



Functions

- `nanosecs_abs_t rtdm_clock_read (void)`
Get system time.

5.9.1 Function Documentation

5.9.1.1 `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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.10 Task Services

Collaboration diagram for Task Services:



Task Priority Range

Maximum and minimum task priorities

- `#define RTDM_TASK_LOWEST_PRIORITY XNCORE_LOW_PRIO`
- `#define RTDM_TASK_HIGHEST_PRIORITY XNCORE_HIGH_PRIO`

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 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.
- `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.

- `rt dm_task_t * rtdm_task_current` (void)
Get current real-time task.
- void `rtdm_task_join_nrt` (rt dm_task_t *task, unsigned int poll_delay)
Wait on a real-time task to terminate.
- 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.
- void `rtdm_task_busy_sleep` (nanosecs_rel_t delay)
Busy-wait a specified amount of time.

5.10.1 Typedef Documentation

5.10.1.1 typedef void(* `rtdm_task_proc_t`)(void *arg)

Real-time task procedure.

Parameters:

↔ *arg* argument as passed to `rtdm_task_init()`

5.10.2 Function Documentation

5.10.2.1 void `rtdm_task_busy_sleep` (`nanosecs_rel_t delay`)

Busy-wait a specified amount of time.

Parameters:

← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine (should be avoided or kept short)
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never (except due to external interruptions).

5.10.2.2 `rtm_task_t* rtdm_task_current (void)`

Get current real-time task.

Returns:

Pointer to task handle

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.10.2.3 `void rtdm_task_destroy (rtm_task_t * task)`

Destroy a real-time task.

Parameters:

↔ *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.10.2.4 `int rtdm_task_init (rtm_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_nrt\(\)](#) was invoked.

Parameters:

↔ *task* Task handle

← *name* Optional task name

← *task_proc* Procedure to be executed by the task

- ← *arg* Custom argument passed to `task_proc()` on entry
- ← *priority* Priority of the task, see also [Task Priority Range](#)
- ← *period* Period in nanoseconds of a cyclic task, 0 for non-cyclic mode

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.10.2.5 `void rtdm_task_join_nrt (rtdm_task_t * task, unsigned int poll_delay)`

Wait on a real-time task to terminate.

Parameters:

- ↔ *task* Task handle as returned by [rtdm_task_init\(\)](#)
- ← *poll_delay* Delay in milliseconds between periodic tests for the state of the real-time task.
This parameter is ignored if the termination is internally realised without polling.

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_nrt\(\)](#) will never return.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task (non-RT)

Rescheduling: possible.

5.10.2.6 `int rtdm_task_set_period (rtdm_task_t * task, nanosecs_rel_t period)`

Adjust real-time task period.

Parameters:

- ↔ *task* Task handle as returned by [rtdm_task_init\(\)](#)
- ← *period* New period in nanoseconds of a cyclic task, 0 for non-cyclic mode

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.10.2.7 void `rtdm_task_set_priority` (`rtdm_task_t * task`, `int priority`)

Adjust real-time task priority.

Parameters:

- ↔ *task* Task handle as returned by [rtdm_task_init\(\)](#)
- ← *priority* New priority of the task, see also [Task Priority Range](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.10.2.8 int `rtdm_task_sleep` ([nanosecs_rel_t](#) *delay*)

Sleep a specified amount of time.

Parameters:

- ← *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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: always.

5.10.2.9 `int rtdm_task_sleep_until (nanosecs_abs_t wakeup_time)`

Sleep until a specified absolute time.

Parameters:

← *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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: always, unless the specified time already passed.

5.10.2.10 `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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.10.2.11 `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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: always, unless a timer overrun occurred.

5.11 Synchronisation Services

Collaboration diagram for Synchronisation Services:



Global Lock across Scheduler Invocation

- #define `RTDM_EXECUTE_ATOMICALLY`(code_block)
Execute code block atomically.

Spinlock with Preemption Deactivation

- #define `RTDM_LOCK_UNLOCKED` `RTHAL_SPIN_LOCK_UNLOCKED`
Static lock initialisation.
- #define `rtdm_lock_init`(lock) `rthal_spin_lock_init`(lock)
Dynamic lock initialisation.
- #define `rtdm_lock_get`(lock) `rthal_spin_lock`(lock)
Acquire lock from non-preemptible contexts.
- #define `rtdm_lock_put`(lock) `rthal_spin_unlock`(lock)
Release lock without preemption restoration.
- #define `rtdm_lock_get_irqsave`(lock, context) `rthal_spin_lock_irqsave`(lock, context)
Acquire lock and disable preemption.
- #define `rtdm_lock_put_irqrestore`(lock, context) `rthal_spin_unlock_irqrestore`(lock, context)
Release lock and restore preemption state.
- #define `rtdm_lock_irqsave`(context) `rthal_local_irq_save`(context)
Disable preemption locally.
- #define `rtdm_lock_irqrestore`(context) `rthal_local_irq_restore`(context)
Restore preemption state.
- typedef `rthal_spinlock_t` `rtdm_lock_t`
Lock variable.
- typedef unsigned long `rtdm_lockctx_t`
Variable to save the context while holding a lock.

Timeout Sequence Management

- void `rt dm_toseq_init` (`rt dm_toseq_t *timeout_seq`, `nanosecs_rel_t` timeout)
Initialise a timeout sequence.

Event Services

- void `rt dm_event_init` (`rt dm_event_t *event`, unsigned long pending)
Initialise an event.
- void `rt dm_event_destroy` (`rt dm_event_t *event`)
Destroy an event.
- void `rt dm_event_pulse` (`rt dm_event_t *event`)
Signal an event occurrence to currently listening waiters.
- void `rt dm_event_signal` (`rt dm_event_t *event`)
Signal an event occurrence.
- int `rt dm_event_wait` (`rt dm_event_t *event`)
Wait on event occurrence.
- int `rt dm_event_timedwait` (`rt dm_event_t *event`, `nanosecs_rel_t` timeout, `rt dm_toseq_t *timeout_seq`)
Wait on event occurrence with timeout.
- void `rt dm_event_clear` (`rt dm_event_t *event`)
Clear event state.

Semaphore Services

- void `rt dm_sem_init` (`rt dm_sem_t *sem`, unsigned long value)
Initialise a semaphore.
- void `rt dm_sem_destroy` (`rt dm_sem_t *sem`)
Destroy a semaphore.
- int `rt dm_sem_down` (`rt dm_sem_t *sem`)
Decrement a semaphore.
- int `rt dm_sem_timeddown` (`rt dm_sem_t *sem`, `nanosecs_rel_t` timeout, `rt dm_toseq_t *timeout_seq`)
Decrement a semaphore with timeout.
- void `rt dm_sem_up` (`rt dm_sem_t *sem`)
Increment a semaphore.

Mutex Services

- void [rt dm_mutex_init](#) (rt dm_mutex_t *mutex)
Initialise a mutex.
- void [rt dm_mutex_destroy](#) (rt dm_mutex_t *mutex)
Destroy a mutex.
- void [rt dm_mutex_unlock](#) (rt dm_mutex_t *mutex)
Release a mutex.
- int [rt dm_mutex_lock](#) (rt dm_mutex_t *mutex)
Request a mutex.
- int [rt dm_mutex_timedlock](#) (rt dm_mutex_t *mutex, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Request a mutex with timeout.

5.11.1 Define Documentation

5.11.1.1 #define RTDM_EXECUTE_ATOMICALY(code_block)

Value:

```
{
    spl_t    s;
    xnlock_get_irqsave(&nklock, s);
    code_block;
    xnlock_put_irqrestore(&nklock, s);
}
```

Execute code block atomically.

Generally, it is illegal to suspend the current task by calling [rt dm_task_sleep\(\)](#), [rt dm_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_ATOMICALY\(\)](#) 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 block. 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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible, depends on functions called within *code_block*.

5.11.1.2 **#define rtdm_lock_get(lock) rthal_spin_lock(lock)**

Acquire lock from non-preemptible contexts.

Parameters:

lock Address of lock variable

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.3 **#define rtdm_lock_get_irqsave(lock, context) rthal_spin_lock_irqsave(lock, context)**

Acquire lock and disable preemption.

Parameters:

lock Address of lock variable

context name of local variable to store the context in

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.4 **#define rtdm_lock_init(lock) rthal_spin_lock_init(lock)**

Dynamic lock initialisation.

Parameters:

lock Address of lock variable

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.5 **#define rtdm_lock_irqrestore(context) rthal_local_irq_restore(context)**

Restore preemption state.

Parameters:

context name of local variable which stored the context

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.1.6 **#define rtdm_lock_irqsave(context) rthal_local_irq_save(context)**

Disable preemption locally.

Parameters:

context name of local variable to store the context in

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.7 `#define rtdm_lock_put(lock) rthal_spin_unlock(lock)`

Release lock without preemption restoration.

Parameters:

lock Address of lock variable

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.1.8 `#define rtdm_lock_put_irqrestore(lock, context) rthal_spin_unlock_irqrestore(lock, context)`

Release lock and restore preemption state.

Parameters:

lock Address of lock variable

context name of local variable which stored the context

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2 Function Documentation

5.11.2.1 void rtdm_event_clear (rtdm_event_t * *event*)

Clear event state.

Parameters:

↔ *event* Event handle as returned by [rtdm_event_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.2.2 void rtdm_event_destroy (rtdm_event_t * *event*)

Destroy an event.

Parameters:

↔ *event* Event handle as returned by [rtdm_event_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

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

Initialise an event.

Parameters:

↔ *event* Event handle

← *pending* Non-zero if event shall be initialised as set, 0 otherwise

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.2.4 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:

↔ *event* Event handle as returned by [rtdm_event_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.5 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:

↔ *event* Event handle as returned by [rtdm_event_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.6 `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 occurrence of the given event, taking the provided timeout into account. On successful return, the event is reset.

Parameters:

- ↔ *event* Event handle as returned by [rtdm_event_init\(\)](#)
- ← *timeout* Relative timeout in nanoseconds, see [RTDM_TIMEOUT_xxx](#) for special values
- ↔ *timeout_seq* Handle of a timeout sequence as returned by [rtdm_toseq_init\(\)](#) or [rtdm_toseq_absinit\(\)](#), or NULL

Returns:

0 on success, otherwise:

- -ETIMEDOUT is returned 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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.7 `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:

- ↔ *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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.8 void rtdm_mutex_destroy (rtdm_mutex_t * mutex)

Destroy a mutex.

Parameters:

↔ *mutex* Mutex handle as returned by [rtdm_mutex_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.9 void rtdm_mutex_init (rtdm_mutex_t * mutex)

Initialise a mutex.

This function initialises a basic mutex with priority inversion protection. "Basic", as it does not allow a mutex owner to recursively lock the same mutex again.

Parameters:

↔ *mutex* Mutex handle

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.2.10 `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:

↔ *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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.11 `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:

↔ *mutex* Mutex handle as returned by [rtdm_mutex_init\(\)](#)

← *timeout* Relative timeout in nanoseconds, see [RTDM_TIMEOUT_xxx](#) for special values

↔ *timeout_seq* Handle of a timeout sequence as returned by [rtdm_toseq_init\(\)](#) or [rtdm_toseq_absinit\(\)](#), or NULL

Returns:

0 on success, otherwise:

- -ETIMEDOUT is returned 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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.12 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:

↔ *mutex* Mutex handle as returned by [`rtdm_mutex_init\(\)`](#)

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.13 void `rtdm_sem_destroy` (`rtdm_sem_t * sem`)

Destroy a semaphore.

Parameters:

↔ *sem* Semaphore handle as returned by [`rtdm_sem_init\(\)`](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.14 `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:

↔ *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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.15 `void rtdm_sem_init (rtdm_sem_t * sem, unsigned long value)`

Initialise a semaphore.

Parameters:

↔ *sem* Semaphore handle

← *value* Initial value of the semaphore

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.11.2.16 `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 semaphore's value if it is positive on entry. If not, the caller is blocked unless non-blocking operation was selected.

Parameters:

- ↔ *sem* Semaphore handle as returned by [rtdm_sem_init\(\)](#)
- ↔ *timeout* Relative timeout in nanoseconds, see [RTDM_TIMEOUT_xxx](#) for special values
- ↔ *timeout_seq* Handle of a timeout sequence as returned by [rtdm_toseq_init\(\)](#) or [rtdm_toseq_absinit\(\)](#), or NULL

Returns:

0 on success, otherwise:

- -ETIMEDOUT is returned 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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: possible.

5.11.2.17 `void rtdm_sem_up (rtdm_sem_t * sem)`

Increment a semaphore.

This function increments the given semaphore's value, waking up a potential waiter which was blocked upon [rtdm_sem_down\(\)](#).

Parameters:

- ↔ *sem* Semaphore handle as returned by [rtdm_sem_init\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.11.2.18 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:

- ↔ *timeout_seq* Timeout sequence handle
- ← *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.

Environments:

This service can be called from:

- Kernel-based task
- User-space task (RT)

Rescheduling: never.

5.12 Interrupt Management Services

Collaboration diagram for Interrupt Management Services:



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.

Defines

- #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 [rt dm_irq_free](#) (rt dm_irq_t *irq_handle)
Release an interrupt handler.
- int [rt dm_irq_enable](#) (rt dm_irq_t *irq_handle)
Enable interrupt line.
- int [rt dm_irq_disable](#) (rt dm_irq_t *irq_handle)
Disable interrupt line.

5.12.1 Define Documentation

5.12.1.1 #define rt dm_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 [rt dm_irq_request\(\)](#) is returned, type-casted to the specified *type*.

Environments:

This service can be called from:

- Interrupt service routine

Rescheduling: never.

5.12.2 Typedef Documentation

5.12.2.1 typedef int(* [rt dm_irq_handler_t](#))(rt dm_irq_t *irq_handle)

Interrupt handler.

Parameters:

← *irq_handle* IRQ handle as returned by [rt dm_irq_request\(\)](#)

Returns:

0 or a combination of [RTDM_IRQ_XXX](#) flags

5.12.3 Function Documentation

5.12.3.1 int [rt dm_irq_disable](#) (rt dm_irq_t * *irq_handle*)

Disable interrupt line.

Parameters:

↔ *irq_handle* IRQ handle as returned by [rt dm_irq_request\(\)](#)

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.12.3.2 int rt dm_irq_enable (rt dm_irq_t * *irq_handle*)

Enable interrupt line.

Parameters:

↔ *irq_handle* IRQ handle as returned by [rt dm_irq_request\(\)](#)

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: possible.

5.12.3.3 int rt dm_irq_free (rt dm_irq_t * *irq_handle*)

Release an interrupt handler.

Parameters:

↔ *irq_handle* IRQ handle as returned by [rt dm_irq_request\(\)](#)

Returns:

0 on success, otherwise negative error code

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.12.3.4 `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:

- ↔ *irq_handle* IRQ handle
- ← *irq_no* Line number of the addressed IRQ
- ← *handler* Interrupt handler
- ← *flags* Registration flags, see [RTDM_IRQTYPE_xxx](#) for details
- ← *device_name* Device name to show up in real-time IRQ lists
- ← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.13 Non-Real-Time Signalling Services

Collaboration diagram for Non-Real-Time Signalling Services:



5.13.1 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.

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)
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.

5.13.2 Typedef Documentation

5.13.2.1 typedef void(* [rtdm_nrtsig_handler_t](#))(rtdm_nrtsig_t nrt_sig, void *arg)

Non-real-time signal handler.

Parameters:

← *nrt_sig* signal handle as returned by [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.

5.13.3 Function Documentation

5.13.3.1 void rtdm_nrtsig_destroy (rtdm_nrtsig_t * *nrt_sig*)

Release a non-realtime signal handler.

Parameters:

↔ *nrt_sig* Signal handle

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.13.3.2 int rtdm_nrtsig_init (rtdm_nrtsig_t * *nrt_sig*, [rtdm_nrtsig_handler_t](#) *handler*)

Register a non-real-time signal handler.

Parameters:

↔ *nrt_sig* Signal handle

← *handler* Non-real-time signal handler

Returns:

0 on success, otherwise:

- -EAGAIN is returned if no free signal slot is available.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.13.3.3 void rtdm_nrtsig_pend (rtdm_nrtsig_t * *nrt_sig*)

Trigger non-real-time signal.

Parameters:

↔ *nrt_sig* Signal handle

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never in real-time context, possible in non-real-time environments.

5.14 Utility Services

Collaboration diagram for Utility Services:



Functions

- `int rtdm_mmap_to_user` (`rtdm_user_info_t *user_info`, `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` (`rtdm_user_info_t *user_info`, `unsigned long 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` (`rtdm_user_info_t *user_info`, `void *ptr`, `size_t len`)
Unmap a user memory range.
- `void rtdm_printk` (`const char *format`,...)
Real-time safe message printing on kernel console.
- `void * rtdm_malloc` (`size_t size`)
Allocate memory block in real-time context.
- `void rtdm_free` (`void *ptr`)
Release real-time memory block.
- `int rtdm_read_user_ok` (`rtdm_user_info_t *user_info`, `const void __user *ptr`, `size_t size`)
Check if read access to user-space memory block is safe.
- `int rtdm_rw_user_ok` (`rtdm_user_info_t *user_info`, `const void __user *ptr`, `size_t size`)
Check if read/write access to user-space memory block is safe.
- `int rtdm_copy_from_user` (`rtdm_user_info_t *user_info`, `void *dst`, `const void __user *src`, `size_t size`)
Copy user-space memory block to specified buffer.
- `int rtdm_safe_copy_from_user` (`rtdm_user_info_t *user_info`, `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` (`rtdm_user_info_t *user_info`, `void __user *dst`, `const void *src`, `size_t size`)
Copy specified buffer to user-space memory block.
- `int rtdm_safe_copy_to_user` (`rtdm_user_info_t *user_info`, `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` (`rtdm_user_info_t *user_info`, `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.

5.14.1 Function Documentation

5.14.1.1 `int rtdm_copy_from_user` (`rtdm_user_info_t * user_info`, `void * dst`, `const void __user * src`, `size_t size`)

Copy user-space memory block to specified buffer.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *dst* Destination buffer address
- ← *src* Address of the user-space memory block
- ← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.2 `int rtdm_copy_to_user` (`rtdm_user_info_t * user_info`, `void __user * dst`, `const void * src`, `size_t size`)

Copy specified buffer to user-space memory block.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler

- ← *dst* Address of the user-space memory block
- ← *src* Source buffer address
- ← *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 [rtm_rw_user_ok\(\)](#) that the provided user-space address can securely be accessed.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.3 void rtdm_free (void * ptr)

Release real-time memory block.

Parameters:

- ← *ptr* Pointer to memory block as returned by [rtdm_malloc\(\)](#)

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine (consider the overhead!)
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.4 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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.5 `int rtdm_iomap_to_user (rtdm_user_info_t * user_info, unsigned long 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:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *src_addr* physical I/O address to be mapped
- ← *len* Length of the memory range
- ← *prot* Protection flags for the user's memory range, typically either PROT_READ or PROT_READ|PROT_WRITE
- ↔ *pptr* Address of a pointer containing the desired user address or NULL on entry and the finally assigned address on return
- ← *vm_ops* vm_operations to be executed on the vma_area of the user memory range or NULL
- ← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task (non-RT)

Rescheduling: possible.

5.14.1.6 `void* rtdm_malloc (size_t size)`

Allocate memory block in real-time context.

Parameters:

← *size* Requested size of the memory block

Returns:

The pointer to the allocated block is returned on success, NULL otherwise.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine (consider the overhead!)
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.7 `int rtdm_mmap_to_user (rtdm_user_info_t * user_info, 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:

← *user_info* User information pointer as passed to the invoked device operation handler

← *src_addr* Kernel virtual address to be mapped

← *len* Length of the memory range

← *prot* Protection flags for the user's memory range, typically either PROT_READ or PROT_READ|PROT_WRITE

↔ *pptr* Address of a pointer containing the desired user address or NULL on entry and the finally assigned address on return

← *vm_ops* vm_operations to be executed on the vma_area of the user memory range or NULL

← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task (non-RT)

Rescheduling: possible.

5.14.1.8 `int rtdm_munmap (rtdm_user_info_t * user_info, void * ptr, size_t len)`

Unmap a user memory range.

Parameters:

- ← *user_info* User information pointer as passed to `rtdm_mmap_to_user()` when requesting to map the memory range
- ← *ptr* User address or the memory range
- ← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- User-space task (non-RT)

Rescheduling: possible.

5.14.1.9 void rtdm_printk (const char * *format*, ...)

Real-time safe message printing on kernel console.

Parameters:

- ← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Interrupt service routine (consider the overhead!)
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never in real-time context, possible in non-real-time environments.

5.14.1.10 int rtdm_read_user_ok (rtdm_user_info_t * *user_info*, const void __user * *ptr*, size_t *size*)

Check if read access to user-space memory block is safe.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *ptr* Address of the user-provided memory block
- ← *size* Size of the memory block

Returns:

Non-zero is return when it is safe to read from the specified memory block, 0 otherwise.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.11 `int rtdm_rw_user_ok (rtdm_user_info_t * user_info, const void __user * ptr, size_t size)`

Check if read/write access to user-space memory block is safe.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *ptr* Address of the user-provided memory block
- ← *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.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.12 `int rtdm_safe_copy_from_user (rtdm_user_info_t * user_info, 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:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *dst* Destination buffer address
- ← *src* Address of the user-space memory block
- ← *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`.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.13 `int rtdm_safe_copy_to_user (rtdm_user_info_t * user_info, 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:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *dst* Address of the user-space memory block
- ← *src* Source buffer address
- ← *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`.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.14.1.14 `int rtdm_strncpy_from_user (rtdm_user_info_t * user_info, char * dst, const char __user * src, size_t count)`

Copy user-space string to specified buffer.

Parameters:

- ← *user_info* User information pointer as passed to the invoked device operation handler
- ← *dst* Destination buffer address
- ← *src* Address of the user-space string
- ← *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.

Environments:

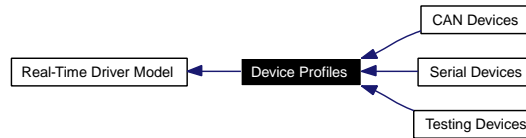
This service can be called from:

- Kernel module initialization/cleanup code
- Kernel-based task
- User-space task (RT, non-RT)

Rescheduling: never.

5.15 Device Profiles

Collaboration diagram for Device Profiles:



5.15.1 Detailed Description

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.

Modules

- [CAN Devices](#)
- [Serial Devices](#)
- [Testing Devices](#)

Data Structures

- struct [rtdm_device_info](#)
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_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 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 rtdm_device_info rtdm_device_info_t`
Device information.

5.15.2 Define Documentation

5.15.2.1 `#define RTIOC_DEVICE_INFO _IOR(RTIOC_TYPE_COMMON, 0x00, struct rtdm_device_info)`

Retrieve information about a device or socket.

Parameters:

→ *arg* Pointer to information buffer (struct `rtdm_device_info`)

5.15.2.2 `#define RTIOC_PURGE _IOW(RTIOC_TYPE_COMMON, 0x10, int)`

Purge internal device or socket buffers.

Parameters:

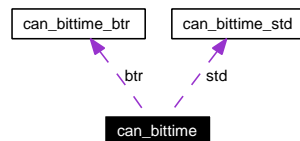
← *arg* Purge mask, see `RTDM_PURGE_XXX_BUFFER`

Chapter 6

Xenomai RTDM skin API Data Structure Documentation

6.1 `can_bittime` Struct Reference

Collaboration diagram for `can_bittime`:



6.1.1 Detailed Description

Custom CAN bit-time definition.

Examples:

[rtcanconfig.c](#).

Data Fields

- [can_bittime_type_t](#) `type`
Type of bit-time definition.
- [can_bittime_std](#) `std`
Standard bit-time.
- [can_bittime_btr](#) `btr`
Hardware-specific BTR bit-time.

The documentation for this struct was generated from the following file:

- `include/rtdm/rtcan.h`

6.2 can_bittime_btr Struct Reference

6.2.1 Detailed Description

Hardware-specific BTR bit-times.

Data Fields

- `uint8_t btr0`
Bus timing register 0.
- `uint8_t btr1`
Bus timing register 1.

The documentation for this struct was generated from the following file:

- `include/rtdm/rtcan.h`

6.3 can_bittime_std Struct Reference

6.3.1 Detailed Description

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

The documentation for this struct was generated from the following file:

- include/rtdm/[rtcan.h](#)

6.4 can_filter Struct Reference

6.4.1 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:

`rtcan_rtt.c`.

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.

6.4.2 Field Documentation

6.4.2.1 `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:

`rtcan_rtt.c`, and `rtcanrecv.c`.

6.4.2.2 `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.

Examples:

`rtcan_rtt.c`, and `rtcanrecv.c`.

The documentation for this struct was generated from the following file:

- include/rtdm/[rtcan.h](#)

6.5 can_frame Struct Reference

6.5.1 Detailed Description

Raw CAN frame.

Central structure for receiving and sending CAN frames.

Examples:

[rtcan_rtt.c](#), [rtcanrecv.c](#), and [rtcansend.c](#).

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.

6.5.2 Field Documentation

6.5.2.1 `can_id_t can_frame::can_id`

CAN ID of the frame.

See [CAN ID flags](#) for special bits.

Examples:

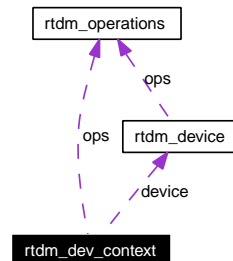
[rtcan_rtt.c](#).

The documentation for this struct was generated from the following file:

- `include/rtdm/rtcan.h`

6.6 rtdm_dev_context Struct Reference

Collaboration diagram for rtdm_dev_context:



6.6.1 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.

Data Fields

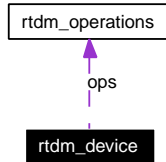
- unsigned long [context_flags](#)
Context flags, see [Context Flags](#) for details.
- int [fd](#)
Associated file descriptor.
- atomic_t [close_lock_count](#)
Lock counter of context, held while structure is referenced by an operation handler.
- [rtdm_operations](#) * [ops](#)
Set of active device operation handlers.
- [rtdm_device](#) * [device](#)
Reference to owning device.
- 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.

The documentation for this struct was generated from the following file:

- [include/rtdm/rtdm_driver.h](#)

6.7 rtdm_device Struct Reference

Collaboration diagram for rtdm_device:



6.7.1 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.

Data Fields

- `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_rt`
Named device instance creation for real-time contexts, optional if `open_nrt` is non-NULL, ignored for protocol devices.
- `rtdm_open_handler_t open_nrt`
Named device instance creation for non-real-time contexts, optional if `open_rt` is non-NULL, ignored for protocol devices.
- `rtdm_socket_handler_t socket_rt`
Protocol socket creation for real-time contexts, optional if `socket_nrt` is non-NULL, ignored for named devices.

- [rtdm_socket_handler_t socket_nrt](#)
Protocol socket creation for non-real-time contexts, optional if socket_rt is non-NULL, ignored for named devices.
- [rtdm_operations 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.
- [proc_dir_entry * proc_entry](#)
Set to device's /proc root entry after registration, do not modify.
- [int device_id](#)
Driver definable device ID.
- [rtdm_dev_reserved reserved](#)
Data stored by RTDM inside a registered device (internal use only).

The documentation for this struct was generated from the following file:

- [include/rtdm/rtdm_driver.h](#)

6.8 rtdm_device_info Struct Reference

6.8.1 Detailed Description

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.

The documentation for this struct was generated from the following file:

- [include/rtdm/rtdm.h](#)

6.9 rtdm_operations Struct Reference

6.9.1 Detailed Description

Device operations.

Data Fields

Common Operations

- [rtdm_close_handler_t close_rt](#)
Close handler for real-time contexts (optional).
- [rtdm_close_handler_t close_nrt](#)
Close handler for non-real-time contexts (required).
- [rtdm_ioctl_handler_t ioctl_rt](#)
IOCTL from real-time context (optional).
- [rtdm_ioctl_handler_t ioctl_nrt](#)
IOCTL from non-real-time context (optional).

Stream-Oriented Device Operations

- [rtdm_read_handler_t read_rt](#)
Read handler for real-time context (optional).
- [rtdm_read_handler_t read_nrt](#)
Read handler for non-real-time context (optional).
- [rtdm_write_handler_t write_rt](#)
Write handler for real-time context (optional).
- [rtdm_write_handler_t write_nrt](#)
Write handler for non-real-time context (optional).

Message-Oriented Device Operations

- [rtdm_recvmsg_handler_t recvmsg_rt](#)
Receive message handler for real-time context (optional).
- [rtdm_recvmsg_handler_t recvmsg_nrt](#)
Receive message handler for non-real-time context (optional).
- [rtdm_sendmsg_handler_t sendmsg_rt](#)
Transmit message handler for real-time context (optional).
- [rtdm_sendmsg_handler_t sendmsg_nrt](#)
Transmit message handler for non-real-time context (optional).

The documentation for this struct was generated from the following file:

- [include/rtdm/rtdm_driver.h](#)

6.10 rtser_config Struct Reference

6.10.1 Detailed Description

Serial device configuration.

Examples:

[cross-link.c](#).

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](#)

The documentation for this struct was generated from the following file:

- [include/rtdm/rtserial.h](#)

6.11 rtser_event Struct Reference

6.11.1 Detailed Description

Additional information about serial device events.

Examples:

[cross-link.c](#).

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

The documentation for this struct was generated from the following file:

- `include/rtdm/rtserial.h`

6.12 rtser_status Struct Reference

6.12.1 Detailed Description

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](#)

The documentation for this struct was generated from the following file:

- [include/rtdm/rtserial.h](#)

6.13 sockaddr_can Struct Reference

6.13.1 Detailed Description

Socket address structure for the CAN address family.

Examples:

[rtcan_rtt.c](#), [rtcanrecv.c](#), and [rtcansend.c](#).

Data Fields

- `sa_family_t can_family`
CAN address family, must be AF_CAN.
- `int can_ifindex`
Interface index of CAN controller.

6.13.2 Field Documentation

6.13.2.1 `int sockaddr_can::can_ifindex`

Interface index of CAN controller.

See [SIOCGIFINDEX](#).

Examples:

[rtcan_rtt.c](#), and [rtcanrecv.c](#).

The documentation for this struct was generated from the following file:

- `include/rtdm/rtcan.h`

Chapter 7

Xenomai RTDM skin API File Documentation

7.1 include/rtdm/rtdm.h File Reference

7.1.1 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

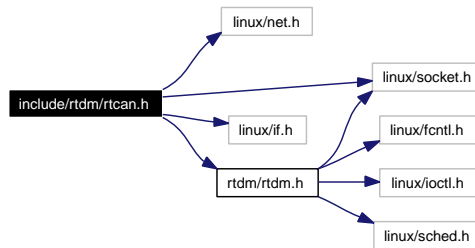
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Include dependency graph for rtdm.h:



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.

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

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.

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 `SIOCSCTRLMODE` `_IOW(RTIOC_TYPE_CAN, 0x07, struct ifreq)`
Set special controller modes.
- #define `SIOGCANCTRLMODE` `_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 occurred, 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 else bit number in bitstream

Controller problems

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

- #define `CAN_ERR_CTRL_UNSPEC` 0x00
unspecified
- #define `CAN_ERR_CTRL_RX_OVERFLOW` 0x01
RX buffer overflow.
- #define `CAN_ERR_CTRL_TX_OVERFLOW` 0x02
TX buffer overflow.
- #define `CAN_ERR_CTRL_RX_WARNING` 0x04
reached warning level for RX errors
- #define `CAN_ERR_CTRL_TX_WARNING` 0x08
reached warning level for TX errors
- #define `CAN_ERR_CTRL_RX_PASSIVE` 0x10
reached passive level for RX errors
- #define `CAN_ERR_CTRL_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 occurred on transmission

Protocol error location

Error in the data[3] 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

Protocol error location

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

- #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

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_ACTIVE](#) = 0, [CAN_STATE_BUS_WARNING](#), [CAN_STATE_BUS_PASSIVE](#),
[CAN_STATE_BUS_OFF](#),
[CAN_STATE_SCANNING_BAUDRATE](#), [CAN_STATE_STOPPED](#), [CAN_STATE_SLEEPING](#) }

Defines

- #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 [can_filter](#) [can_filter_t](#)
Filter for reception of CAN messages.
- typedef [can_frame](#) [can_frame_t](#)
Raw CAN frame.

Enumerations

- enum [CAN_BITTIME_TYPE](#) { [CAN_BITTIME_STD](#), [CAN_BITTIME_BTR](#) }
Supported CAN bit-time types.

7.2 include/rtdm/rtdm.h File Reference

7.2.1 Detailed Description

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

Note:

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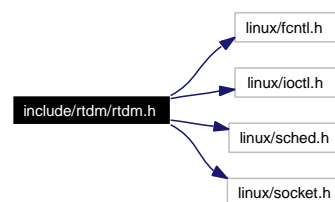
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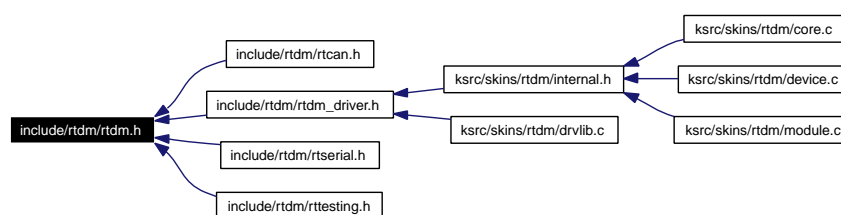
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Include dependency graph for rtdm.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct [rtdm_device_info](#)

Device information.

API Versioning

- #define [RTDM_API_VER](#) 6

Common user and driver API version.

- #define `RTDM_API_MIN_COMPAT_VER` 6

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_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 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 [rtdm_device_info](#) [rtdm_device_info_t](#)
Device information.

7.3 include/rtdm/rtdm_driver.h File Reference

7.3.1 Detailed Description

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

Note:

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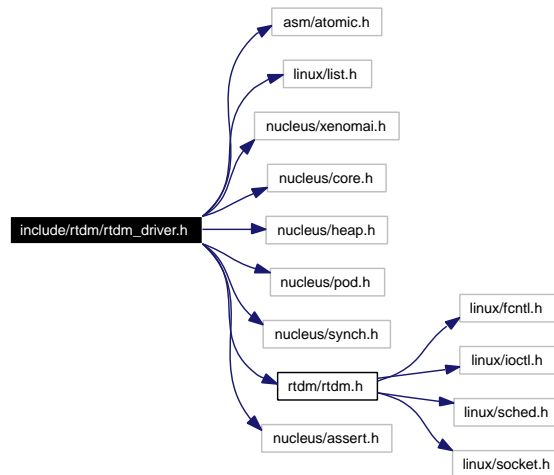
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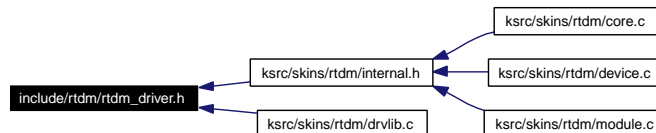
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Include dependency graph for rtdm_driver.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct [rtdm_operations](#)
Device operations.

- struct [rtdm_dev_context](#)

Device context.

- struct [rtdm_device](#)

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.

Context Flags

Dynamic flags describing the state of an open RTDM device (bit numbers)

- #define [RTDM_CREATED_IN_NRT](#) 0

Set by RTDM if the device instance was created in non-real-time context.

- #define [RTDM_CLOSING](#) 1

Set by RTDM when the device is being closed.

- #define [RTDM_USER_CONTEXT_FLAG](#) 8

Lowest bit number the driver developer can use freely.

Driver Versioning

Current revisions of RTDM structures, encoding of driver versions. See [API Versioning](#) for the interface revision.

- #define [RTDM_DEVICE_STRUCT_VER](#) 4

Version of struct [rtdm_device](#).

- #define [RTDM_CONTEXT_STRUCT_VER](#) 3

Version of struct `rtm_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.

Global Lock across Scheduler Invocation

- `#define RTDM_EXECUTE_ATOMICALLY(code_block)`
Execute code block atomically.

Spinlock with Preemption Deactivation

- `#define RTDM_LOCK_UNLOCKED RTHAL_SPIN_LOCK_UNLOCKED`
Static lock initialisation.
- `#define rtdm_lock_init(lock) rthal_spin_lock_init(lock)`
Dynamic lock initialisation.
- `#define rtdm_lock_get(lock) rthal_spin_lock(lock)`
Acquire lock from non-preemptible contexts.
- `#define rtdm_lock_put(lock) rthal_spin_unlock(lock)`
Release lock without preemption restoration.
- `#define rtdm_lock_get_irqsave(lock, context) rthal_spin_lock_irqsave(lock, context)`
Acquire lock and disable preemption.
- `#define rtdm_lock_put_irqrestore(lock, context) rthal_spin_unlock_irqrestore(lock, context)`
Release lock and restore preemption state.
- `#define rtdm_lock_irqsave(context) rthal_local_irq_save(context)`
Disable preemption locally.

- #define `rtdm_lock_irqrestore`(context) `rthal_local_irq_restore`(context)
Restore preemption state.
- typedef `rthal_spinlock_t` `rtdm_lock_t`
Lock variable.
- typedef unsigned long `rtdm_lockctx_t`
Variable to save the context while holding a lock.

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` `XNCORE_LOW_PRIO`
- #define `RTDM_TASK_HIGHEST_PRIORITY` `XNCORE_HIGH_PRIO`

Task Priority Modification

Raise or lower task priorities by one level

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

Operation Handler Prototypes

- typedef int(* [rt dm_open_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, int oflag)
Named device open handler.
- typedef int(* [rt dm_socket_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, int protocol)
Socket creation handler for protocol devices.
- typedef int(* [rt dm_close_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info)
Close handler.
- typedef int(* [rt dm_ioctl_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, unsigned int request, void *arg)
IOCTL handler.
- typedef ssize_t(* [rt dm_read_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, void *buf, size_t nbyte)
Read handler.
- typedef ssize_t(* [rt dm_write_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, const void *buf, size_t nbyte)
Write handler.
- typedef ssize_t(* [rt dm_recvmmsg_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, struct msghdr *msg, int flags)
Receive message handler.
- typedef ssize_t(* [rt dm_sendmsg_handler_t](#))(struct [rt dm_dev_context](#) *context, [rt dm_user_info_t](#) *user_info, const struct msghdr *msg, int flags)
Transmit message handler.

Defines

- #define [rt dm_irq_get_arg](#)(irq_handle, type) ((type *)irq_handle → cookie)
Retrieve IRQ handler argument.

Typedefs

- typedef int(* [rt dm_irq_handler_t](#))(rt dm_irq_t *irq_handle)
Interrupt handler.
- typedef void(* [rt dm_nrtsig_handler_t](#))(rt dm_nrtsig_t nrt_sig, void *arg)
Non-real-time signal handler.
- typedef void(* [rt dm_task_proc_t](#))(void *arg)

Real-time task procedure.

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.
- `rtdm_dev_context * rtdm_context_get (int fd)`
Resolve file descriptor to device context.
- `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_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.
- `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.
- `void rtdm_task_busy_sleep (nanosecs_rel_t delay)`
Busy-wait a specified amount of time.
- `void rtdm_toseq_init (rtdm_toseq_t *timeout_seq, nanosecs_rel_t timeout)`
Initialise a timeout sequence.
- `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 [rt dm _sem _init](#) (rt dm _sem _t *sem, unsigned long value)
Initialise a semaphore.
- int [rt dm _sem _down](#) (rt dm _sem _t *sem)
Decrement a semaphore.
- int [rt dm _sem _timeddown](#) (rt dm _sem _t *sem, [nanosecs _rel _t](#) timeout, rt dm _toseq _t *timeout _seq)
Decrement a semaphore with timeout.
- void [rt dm _sem _up](#) (rt dm _sem _t *sem)
Increment a semaphore.
- void [rt dm _mutex _init](#) (rt dm _mutex _t *mutex)
Initialise a mutex.
- int [rt dm _mutex _lock](#) (rt dm _mutex _t *mutex)
Request a mutex.
- int [rt dm _mutex _timedlock](#) (rt dm _mutex _t *mutex, [nanosecs _rel _t](#) timeout, rt dm _toseq _t *timeout _seq)
Request a mutex with timeout.

7.4 include/rtdm/rtserial.h File Reference

7.4.1 Detailed Description

Real-Time Driver Model for Xenomai, serial device profile header.

Note:

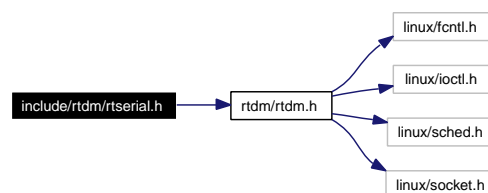
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Include dependency graph for rtserial.h:



Data Structures

- struct [rtser_config](#)
Serial device configuration.
- struct [rtser_status](#)
Serial device status.
- struct [rtser_event](#)
Additional information about serial device events.

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
- #define RTSER_1_5_STOPB 0x01
 - valid only in combination with 5 data bits*
- #define RTSER_2_STOPB 0x01
- #define RTSER_DEF_STOPB RTSER_1_STOPB

RTSER_xxx_HAND

Handshake mechanisms

- #define RTSER_NO_HAND 0x00
- #define RTSER_RTSCTS_HAND 0x01
- #define RTSER_DEF_HAND RTSER_NO_HAND

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_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

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_EMPTY 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_DDSD 0x02`
- `#define RTSER_MSR_TERI 0x04`
- `#define RTSER_MSR_DDSD 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`

RTSER_BREAK_xxx

Break control

- `#define RTSER_BREAK_CLR 0x00`
- `#define RTSER_BREAK_SET 0x01`
- `#define RTIOC_TYPE_SERIAL RTDM_CLASS_SERIAL`
- `typedef rtser_config rtser_config_t`
Serial device configuration.
- `typedef rtser_status rtser_status_t`
Serial device status.
- `typedef rtser_event rtser_event_t`
Additional information about serial device events.

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 control register.
- #define [RTSER_RTIOC_SET_CONTROL](#) _IOW(RTIOC_TYPE_SERIAL, 0x04, int)
Set serial device's modem control register.
- #define [RTSER_RTIOC_WAIT_EVENT](#) _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_event)
Wait on serial device events according to previously set mask.

Defines

- #define [RTSER_RTIOC_BREAK_CTL](#) _IOR(RTIOC_TYPE_SERIAL, 0x06, int)
Set or clear break on UART output line.

7.5 include/rtdm/rtesting.h File Reference

7.5.1 Detailed Description

Real-Time Driver Model for Xenomai, testing device profile header.

Note:

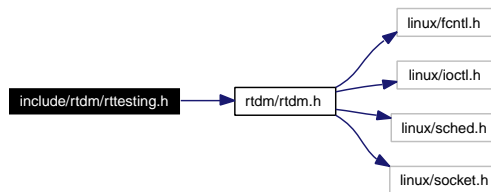
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Include dependency graph for rtesting.h:



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)`

7.6 ksrc/skins/rtdm/device.c File Reference

7.6.1 Detailed Description

Real-Time Driver Model for Xenomai, device management.

Note:

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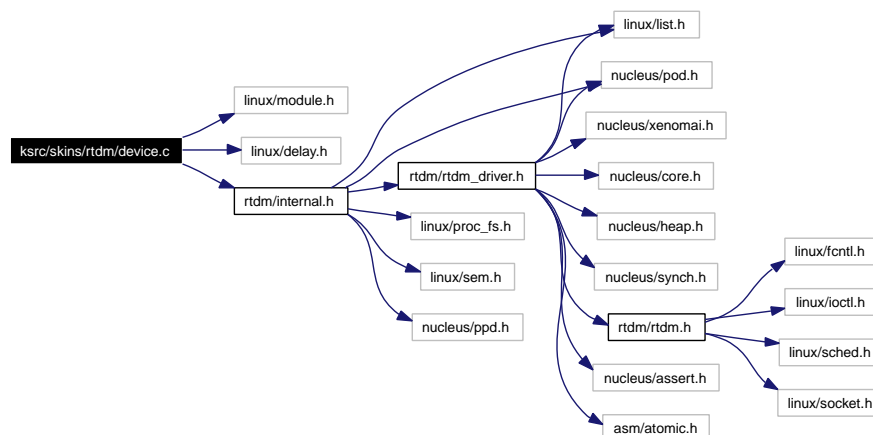
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Include dependency graph for device.c:



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.

7.7 ksrc/skins/rtdm/drvlib.c File Reference

7.7.1 Detailed Description

Real-Time Driver Model for Xenomai, driver library.

Note:

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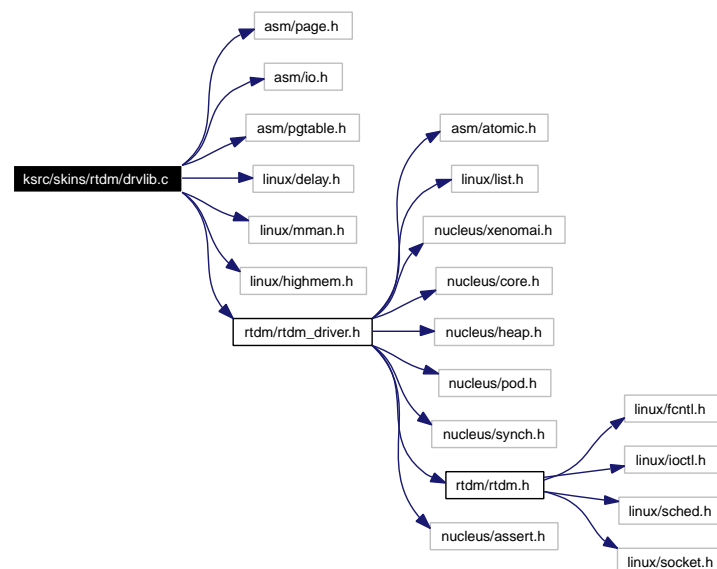
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Include dependency graph for drvlib.c:



Timeout Sequence Management

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

Event Services

- void [rtdm_event_init](#) (rtdm_event_t *event, unsigned long pending)

Initialise an event.

- void [rt dm_event_destroy](#) (rt dm_event_t *event)
Destroy an event.
- void [rt dm_event_pulse](#) (rt dm_event_t *event)
Signal an event occurrence to currently listening waiters.
- void [rt dm_event_signal](#) (rt dm_event_t *event)
Signal an event occurrence.
- int [rt dm_event_wait](#) (rt dm_event_t *event)
Wait on event occurrence.
- int [rt dm_event_timedwait](#) (rt dm_event_t *event, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Wait on event occurrence with timeout.
- void [rt dm_event_clear](#) (rt dm_event_t *event)
Clear event state.

Semaphore Services

- void [rt dm_sem_init](#) (rt dm_sem_t *sem, unsigned long value)
Initialise a semaphore.
- void [rt dm_sem_destroy](#) (rt dm_sem_t *sem)
Destroy a semaphore.
- int [rt dm_sem_down](#) (rt dm_sem_t *sem)
Decrement a semaphore.
- int [rt dm_sem_timeddown](#) (rt dm_sem_t *sem, [nanosecs_rel_t](#) timeout, rt dm_toseq_t *timeout_seq)
Decrement a semaphore with timeout.
- void [rt dm_sem_up](#) (rt dm_sem_t *sem)
Increment a semaphore.

Mutex Services

- void [rt dm_mutex_init](#) (rt dm_mutex_t *mutex)
Initialise a mutex.
- void [rt dm_mutex_destroy](#) (rt dm_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.

Functions

- [nanosecs_abs_t](#) [rtdm_clock_read](#) (void)
Get system time.
- 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)
Intialise and start a real-time task.
- void [rtdm_task_destroy](#) (rtdm_task_t *task)
Destroy a real-time task.
- 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.
- void [rtdm_task_join_nrt](#) (rtdm_task_t *task, unsigned int poll_delay)
Wait on a real-time task to terminate.
- 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.
- void [rtdm_task_busy_sleep](#) ([nanosecs_rel_t](#) delay)
Busy-wait a specified amount of time.

- int [rt dm_irq_request](#) (rt dm_irq_t *irq_handle, unsigned int irq_no, [rt dm_irq_handler_t](#) handler, unsigned long flags, const char *device_name, void *arg)
Register an interrupt handler.
- int [rt dm_irq_free](#) (rt dm_irq_t *irq_handle)
Release an interrupt handler.
- int [rt dm_irq_enable](#) (rt dm_irq_t *irq_handle)
Enable interrupt line.
- int [rt dm_irq_disable](#) (rt dm_irq_t *irq_handle)
Disable interrupt line.
- int [rt dm_nrtsig_init](#) (rt dm_nrtsig_t *nrt_sig, [rt dm_nrtsig_handler_t](#) handler)
Register a non-real-time signal handler.
- void [rt dm_nrtsig_destroy](#) (rt dm_nrtsig_t *nrt_sig)
Release a non-realtime signal handler.
- void [rt dm_nrtsig_pend](#) (rt dm_nrtsig_t *nrt_sig)
Trigger non-real-time signal.
- int [rt dm_mmap_to_user](#) (rt dm_user_info_t *user_info, 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 [rt dm_iomap_to_user](#) (rt dm_user_info_t *user_info, unsigned long 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 [rt dm_munmap](#) (rt dm_user_info_t *user_info, void *ptr, size_t len)
Unmap a user memory range.
- void [rt dm_printk](#) (const char *format,...)
Real-time safe message printing on kernel console.
- void * [rt dm_malloc](#) (size_t size)
Allocate memory block in real-time context.
- void [rt dm_free](#) (void *ptr)
Release real-time memory block.
- int [rt dm_read_user_ok](#) (rt dm_user_info_t *user_info, const void __user *ptr, size_t size)
Check if read access to user-space memory block is safe.
- int [rt dm_rw_user_ok](#) (rt dm_user_info_t *user_info, const void __user *ptr, size_t size)
Check if read/write access to user-space memory block is safe.
- int [rt dm_copy_from_user](#) (rt dm_user_info_t *user_info, void *dst, const void __user *src, size_t size)

Copy user-space memory block to specified buffer.

- int [rtdm_safe_copy_from_user](#) (rtdm_user_info_t *user_info, 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](#) (rtdm_user_info_t *user_info, void __user *dst, const void *src, size_t size)

Copy specified buffer to user-space memory block.

- int [rtdm_safe_copy_to_user](#) (rtdm_user_info_t *user_info, 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](#) (rtdm_user_info_t *user_info, 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.

7.8 ksrc/skins/rtdm/module.c File Reference

7.8.1 Detailed Description

Real-Time Driver Model for Xenomai.

Note:

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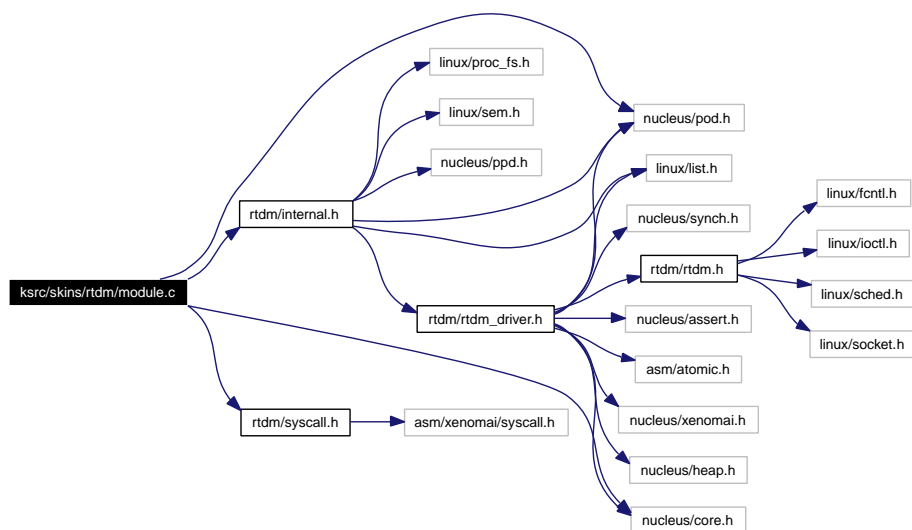
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Include dependency graph for module.c:



7.9 ksrc/skins/rtdm/core.c File Reference

7.9.1 Detailed Description

Real-Time Driver Model for Xenomai, device operation multiplexing.

Note:

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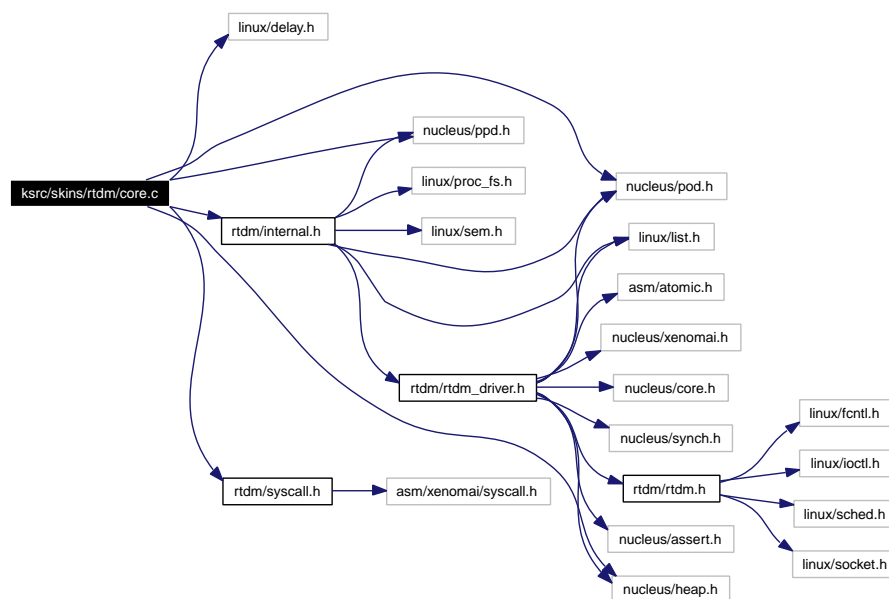
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Include dependency graph for core.c:



Functions

- `rtdm_dev_context * rtdm_context_get` (int fd)
Resolve file descriptor to device context.
- void `rtdm_context_lock` (struct `rtdm_dev_context` *context)
Increment context reference counter.

- void [rtdm_context_unlock](#) (struct [rtdm_dev_context](#) *context)
Decrement context reference counter.
- 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_recvmmsg](#) (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_sendmmsg](#) (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 for incoming connection requests.

- int [rtdm_accept](#) (int fd, struct sockaddr *addr, socklen_t *addrlen)
Accept a connection requests.
- 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.
- 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_recvmmsg](#) (int fd, struct mshdr *msg, int flags)
Receive message from socket.
- ssize_t [rt_dev_rcvfrom](#) (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 mshdr *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 incoming connection requests.
- `int rt_dev_accept` (int fd, struct sockaddr *addr, socklen_t *addrlen)
Accept a 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.

Chapter 8

Xenomai RTDM skin API Example Documentation

8.1 cross-link.c

```
1 /*
2  * cross-link.c
3  *
4  * Userspace test program (Xenomai native skin) for RTDM-based UART drivers
5  * Copyright 2005 by Joerg Langenberg <joergel75@gmx.net>
6  *
7  * Updates by Jan Kiszka <jan.kiszka@web.de>
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20 * along with this program; if not, write to the Free Software
21 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
22 */
23 #include <stdio.h>
24 #include <signal.h>
25 #include <unistd.h>
26 #include <sys/mman.h>
27
28 #include <native/task.h>
29 #include <native/timer.h>
30
31 #include <rtdm/rtserial.h>
32
33 #define MAIN_PREFIX    "main : "
34 #define WTASK_PREFIX   "write_task: "
35 #define RTASK_PREFIX   "read_task: "
36
37 #define WRITE_FILE      "rtser0"
38 #define READ_FILE       "rtser1"
39
40 int read_fd = -1;
```

```

41 int write_fd = -1;
42
43 #define STATE_FILE_OPENED      1
44 #define STATE_TASK_CREATED    2
45
46 unsigned int read_state = 0;
47 unsigned int write_state = 0;
48
49 /*          --s-ms-us-ns */
50 RTIME write_task_period_ns = 100000000llu;
51 RT_TASK write_task;
52 RT_TASK read_task;
53
54 static const struct rtser_config read_config = {
55     .config_mask      = 0xFFFF,
56     .baud_rate        = 115200,
57     .parity            = RTSER_DEF_PARITY,
58     .data_bits        = RTSER_DEF_BITS,
59     .stop_bits        = RTSER_DEF_STOPB,
60     .handshake        = RTSER_DEF_HAND,
61     .fifo_depth       = RTSER_DEF_FIFO_DEPTH,
62     .rx_timeout       = RTSER_DEF_TIMEOUT,
63     .tx_timeout       = RTSER_DEF_TIMEOUT,
64     .event_timeout    = 1000000000, /* 1 s */
65     .timestamp_history = RTSER_RX_TIMESTAMP_HISTORY,
66     .event_mask       = RTSER_EVENT_RXPEND,
67 };
68
69 static const struct rtser_config write_config = {
70     .config_mask      = RTSER_SET_BAUD | RTSER_SET_TIMESTAMP_HISTORY,
71     .baud_rate        = 115200,
72     .timestamp_history = RTSER_DEF_TIMESTAMP_HISTORY,
73     /* the rest implicitly remains default */
74 };
75
76 static int close_file( int fd, char *name)
77 {
78     int err, i=0;
79
80     do {
81         i++;
82         err = rt_dev_close(fd);
83         switch (err) {
84             case -EAGAIN:
85                 printf(MAIN_PREFIX "%s -> EAGAIN (%d times)\n",
86                     name, i);
87                 rt_task_sleep(50000); /* wait 50us */
88                 break;
89             case 0:
90                 printf(MAIN_PREFIX "%s -> closed\n", name);
91                 break;
92             default:
93                 printf(MAIN_PREFIX "%s -> %s\n", name,
94                     strerror(-err));
95                 break;
96         }
97     } while (err == -EAGAIN && i < 10);
98
99     return err;
100 }
101
102 void cleanup_all(void)
103 {
104     if (read_state & STATE_FILE_OPENED) {
105         close_file(read_fd, READ_FILE" (read)");
106         read_state &= ~STATE_FILE_OPENED;
107     }

```

```

108
109     if (write_state & STATE_FILE_OPENED) {
110         close_file(write_fd, WRITE_FILE " (write)");
111         write_state &= ~STATE_FILE_OPENED;
112     }
113
114     if (write_state & STATE_TASK_CREATED) {
115         printf(MAIN_PREFIX "delete write_task\n");
116         rt_task_delete(&write_task);
117         write_state &= ~STATE_TASK_CREATED;
118     }
119
120     if (read_state & STATE_TASK_CREATED) {
121         printf(MAIN_PREFIX "delete read_task\n");
122         rt_task_delete(&read_task);
123         read_state &= ~STATE_TASK_CREATED;
124     }
125 }
126
127 void catch_signal(int sig)
128 {
129     cleanup_all();
130     printf(MAIN_PREFIX "exit\n");
131     return;
132 }
133
134 void write_task_proc(void *arg)
135 {
136     int err;
137     RTIME write_time;
138     ssize_t sz = sizeof(RTIME);
139     ssize_t written = 0;
140
141     err = rt_task_set_periodic(NULL, TM_NOW,
142                               rt_timer_ns2ticks(write_task_period_ns));
143     if (err) {
144         printf(WTASK_PREFIX "error on set periodic, %s\n",
145               strerror(-err));
146         goto exit_write_task;
147     }
148
149     while (1) {
150         err = rt_task_wait_period(NULL);
151         if (err) {
152             printf(WTASK_PREFIX
153                   "error on rt_task_wait_period, %s\n",
154                   strerror(-err));
155             break;
156         }
157
158         write_time = rt_timer_read();
159
160         written = rt_dev_write(write_fd, &write_time, sz);
161         if (written < 0) {
162             printf(WTASK_PREFIX "error on rt_dev_write, %s\n",
163                   strerror(-err));
164             break;
165         } else if (written != sz) {
166             printf(WTASK_PREFIX "only %d / %d byte transmitted\n",
167                   written, sz);
168             break;
169         }
170     }
171
172 exit_write_task:
173     if ((write_state & STATE_FILE_OPENED) &&
174         close_file(write_fd, WRITE_FILE " (write)") == 0)

```

```

175         write_state &= ~STATE_FILE_OPENED;
176
177         printf(WTASK_PREFIX "exit\n");
178     }
179
180 void read_task_proc(void *arg)
181 {
182     int err;
183     int nr = 0;
184     RTIME read_time = 0;
185     RTIME write_time = 0;
186     RTIME irq_time = 0;
187     ssize_t sz = sizeof(RTIME);
188     ssize_t read = 0;
189     struct rtser_event rx_event;
190
191     printf("Nr |   write->irq   |   irq->read   |   write->read   |\n");
192     printf("-----\n");
193
194     /*
195      * We are in secondary mode now due to printf, the next
196      * blocking Xenomai or driver call will switch us back
197      * (here: RTSER_RTIOC_WAIT_EVENT).
198      */
199
200     while (1) {
201         /* waiting for event */
202         err = rt_dev_ioctl(read_fd, RTSER_RTIOC_WAIT_EVENT, &rx_event);
203         if (err) {
204             printf(RTASK_PREFIX
205                  "error on RTSER_RTIOC_WAIT_EVENT, %s\n",
206                  strerror(-err));
207             if (err == -ETIMEDOUT)
208                 continue;
209             break;
210         }
211
212         irq_time = rx_event.rxpnd_timestamp;
213         read = rt_dev_read(read_fd, &write_time, sz);
214         if (read == sz) {
215             read_time = rt_timer_read();
216             printf("%3d |%16llu |%16llu |%16llu\n", nr,
217                  irq_time - write_time,
218                  read_time - irq_time,
219                  read_time - write_time);
220             nr++;
221         } else if (read < 0) {
222             printf(RTASK_PREFIX "error on rt_dev_read, code %s\n",
223                  strerror(-err));
224             break;
225         } else {
226             printf(RTASK_PREFIX "only %d / %d byte received \n",
227                  read, sz);
228             break;
229         }
230     }
231
232     if ((read_state & STATE_FILE_OPENED) &&
233         close_file(read_fd, READ_FILE " (read)") == 0)
234         read_state &= ~STATE_FILE_OPENED;
235
236     printf(RTASK_PREFIX "exit\n");
237 }
238
239 int main(int argc, char* argv[])
240 {
241     int err = 0;

```



```
242
243     signal(SIGTERM, catch_signal);
244     signal(SIGINT, catch_signal);
245
246     /* no memory-swapping for this program */
247     mlockall(MCL_CURRENT | MCL_FUTURE);
248
249     /* open rtser0 */
250     write_fd = rt_dev_open( WRITE_FILE, 0);
251     if (write_fd < 0) {
252         printf(MAIN_PREFIX "can't open %s (write), %s\n", WRITE_FILE,
253             strerror(-write_fd));
254         goto error;
255     }
256     write_state |= STATE_FILE_OPENED;
257     printf(MAIN_PREFIX "write-file opened\n");
258
259     /* writing write-config */
260     err = rt_dev_ioctl(write_fd, RTSER_RTIOC_SET_CONFIG, &write_config);
261     if (err) {
262         printf(MAIN_PREFIX "error while RTSER_RTIOC_SET_CONFIG, %s\n",
263             strerror(-err));
264         goto error;
265     }
266     printf(MAIN_PREFIX "write-config written\n");
267
268     /* open rtser1 */
269     read_fd = rt_dev_open( READ_FILE, 0 );
270     if (read_fd < 0) {
271         printf(MAIN_PREFIX "can't open %s (read), %s\n", READ_FILE,
272             strerror(-read_fd));
273         goto error;
274     }
275     read_state |= STATE_FILE_OPENED;
276     printf(MAIN_PREFIX "read-file opened\n");
277
278     /* writing read-config */
279     err = rt_dev_ioctl(read_fd, RTSER_RTIOC_SET_CONFIG, &read_config);
280     if (err) {
281         printf(MAIN_PREFIX "error while rt_dev_ioctl, %s\n",
282             strerror(-err));
283         goto error;
284     }
285     printf(MAIN_PREFIX "read-config written\n");
286
287     /* create write_task */
288     err = rt_task_create(&write_task, "write_task", 0, 50, 0);
289     if (err) {
290         printf(MAIN_PREFIX "failed to create write_task, %s\n",
291             strerror(-err));
292         goto error;
293     }
294     write_state |= STATE_TASK_CREATED;
295     printf(MAIN_PREFIX "write-task created\n");
296
297     /* create read_task */
298     err = rt_task_create(&read_task, "read_task", 0, 51, 0);
299     if (err) {
300         printf(MAIN_PREFIX "failed to create read_task, %s\n",
301             strerror(-err));
302         goto error;
303     }
304     read_state |= STATE_TASK_CREATED;
305     printf(MAIN_PREFIX "read-task created\n");
306
307     /* start write_task */
308     printf(MAIN_PREFIX "starting write-task\n");
```

```
309     err = rt_task_start(&write_task, &write_task_proc, NULL);
310     if (err) {
311         printf(MAIN_PREFIX "failed to start write_task, %s\n",
312             strerror(-err));
313         goto error;
314     }
315
316     /* start read_task */
317     printf(MAIN_PREFIX "starting read-task\n");
318     err = rt_task_start(&read_task,&read_task_proc,NULL);
319     if (err) {
320         printf(MAIN_PREFIX "failed to start read_task, %s\n",
321             strerror(-err));
322         goto error;
323     }
324
325     pause();
326     return 0;
327
328 error:
329     cleanup_all();
330     return err;
331 }
```

8.2 rtcan_rtt.c

```

1 /*
2  * Round-Trip-Time Test - sends and receives messages and measures the
3  *                        time in between.
4  *
5  * Copyright (C) 2006 Wolfgang Grandegger <wg@grandegger.com>
6  *
7  * Based on RTnet's examples/xenomai/posix/rtt-sender.c.
8  *
9  * Copyright (C) 2002 Ulrich Marx <marx@kammer.uni-hannover.de>
10 *      2002 Marc Kleine-Budde <kleine-budde@gmx.de>
11 *      2006 Jan Kiszka <jan.kiszka@web.de>
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24 * along with this program; if not, write to the Free Software
25 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
26 *
27 *
28 * The program sends out CAN messages periodically and copies the current
29 * time-stamp to the payload. At reception, that time-stamp is compared
30 * with the current time to determine the round-trip time. The jitter
31 * values are printed out regularly. Concurrent tests can be carried out
32 * by starting the program with different message identifiers. It is also
33 * possible to use this program on a remote system as simple repeater to
34 * loopback messages.
35 */
36
37 #include <errno.h>
38 #include <mqueue.h>
39 #include <signal.h>
40 #include <pthread.h>
41 #include <stdio.h>
42 #include <stdlib.h>
43 #include <string.h>
44 #include <unistd.h>
45 #include <limits.h>
46 #include <getopt.h>
47 #include <netinet/in.h>
48 #include <sys/mman.h>
49
50 #include <rtdm/rtcan.h>
51
52 #define NSEC_PER_SEC 1000000000
53
54 static unsigned int cycle = 10000; /* 10 ms */
55 static can_id_t can_id = 0x1;
56
57 static pthread_t txthread, rxthread;
58 static int txsock, rxsock;
59 static mqd_t mq;
60 static int txcount, rxcount;
61 static int overruns;
62 static int repeater;
63
64 struct rtt_stat {
65     long long rtt;

```

```

66     long long rtt_min;
67     long long rtt_max;
68     long long rtt_sum;
69     long long rtt_sum_last;
70     int counts_per_sec;
71 };
72
73 static void print_usage(char *prg)
74 {
75     fprintf(stderr,
76         "Usage: %s [Options] <tx-can-interface> <rx-can-interface>\n"
77         "Options:\n"
78         "  -h, --help      This help\n"
79         "  -r, --repeater  Repeater, send back received messages\n"
80         "  -i, --id=ID     CAN Identifier (default = 0x1)\n"
81         "  -c, --cycle     Cycle time in us (default = 10000us)\n",
82         prg);
83 }
84
85 void *transmitter(void *arg)
86 {
87     struct sched_param param = { .sched_priority = 80 };
88     struct timespec next_period;
89     struct timespec time;
90     struct can_frame frame;
91     long long *rtt_time = (long long *)&frame.data;
92
93     /* Pre-fill CAN frame */
94     frame.can_id = can_id;
95     frame.can_dlc = sizeof(*rtt_time);
96
97     pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);
98
99     clock_gettime(CLOCK_MONOTONIC, &next_period);
100
101     while(1) {
102         next_period.tv_nsec += cycle * 1000;
103         while (next_period.tv_nsec >= NSEC_PER_SEC) {
104             next_period.tv_nsec -= NSEC_PER_SEC;
105             next_period.tv_sec++;
106         }
107
108         clock_nanosleep(CLOCK_MONOTONIC, TIMER_ABSTIME, &next_period, NULL);
109
110         if (rxcount != txcount) {
111             overruns++;
112             continue;
113         }
114
115         clock_gettime(CLOCK_MONOTONIC, &time);
116         *rtt_time = time.tv_sec * NSEC_PER_SEC + time.tv_nsec;
117
118         /* Transmit the message containing the local time */
119         if (send(txsock, (void *)&frame, sizeof(can_frame_t), 0) < 0) {
120             if (errno == EBADF)
121                 printf("terminating transmitter thread\n");
122             else
123                 perror("send failed");
124             return NULL;
125         }
126         txcount++;
127     }
128 }
129
130
131 void *receiver(void *arg)
132 {

```

```

133     struct sched_param param = { .sched_priority = 82 };
134     struct timespec time;
135     struct can_frame frame;
136     long long *rtt_time = (long long *)frame.data;
137     struct rtt_stat rtt_stat = {0, 10000000000000000LL, -10000000000000000LL,
138                               0, 0, 0};
139     pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);
140
141     rtt_stat.counts_per_sec = 1000000 / cycle;
142
143     while (1) {
144         if (recv(rxsock, (void *)&frame, sizeof(can_frame_t), 0) < 0) {
145             if (errno == EBADF)
146                 printf("terminating receiver thread\n");
147             else
148                 perror("recv failed");
149             return NULL;
150         }
151         if (repeater) {
152             /* Transmit the message back as is */
153             if (send(txsock, (void *)&frame, sizeof(can_frame_t), 0) < 0) {
154                 if (errno == EBADF)
155                     printf("terminating transmitter thread\n");
156                 else
157                     perror("send failed");
158                 return NULL;
159             }
160             txcount++;
161         } else {
162             clock_gettime(CLOCK_MONOTONIC, &time);
163             if (rxcount > 0) {
164                 rtt_stat.rtt = (time.tv_sec * 1000000000LL +
165                               time.tv_nsec - *rtt_time);
166                 rtt_stat.rtt_sum += rtt_stat.rtt;
167                 if (rtt_stat.rtt < rtt_stat.rtt_min)
168                     rtt_stat.rtt_min = rtt_stat.rtt;
169                 if (rtt_stat.rtt > rtt_stat.rtt_max)
170                     rtt_stat.rtt_max = rtt_stat.rtt;
171             }
172         }
173         rxcount++;
174
175         if ((rxcount % rtt_stat.counts_per_sec) == 0) {
176             mq_send(mq, (char *)&rtt_stat, sizeof(rtt_stat), 0);
177             rtt_stat.rtt_sum_last = rtt_stat.rtt_sum;
178         }
179     }
180 }
181
182 void catch_signal(int sig)
183 {
184     mq_close(mq);
185 }
186
187
188 int main(int argc, char *argv[])
189 {
190     struct sched_param param = { .sched_priority = 1 };
191     pthread_attr_t thattr;
192     struct mq_attr mqattr;
193     struct sockaddr_can rxaddr, txaddr;
194     struct can_filter rxfilter[1];
195     struct rtt_stat rtt_stat;
196     char mqname[32];
197     char *txdev, *rxdev;
198     struct ifreq ifr;
199     int ret, opt;

```

```

200
201 struct option long_options[] = {
202     { "id", required_argument, 0, 'i'},
203     { "cycle", required_argument, 0, 'c'},
204     { "repeater", required_argument, 0, 'r'},
205     { "help", no_argument, 0, 'h'},
206     { 0, 0, 0, 0},
207 };
208
209 while ((opt = getopt_long(argc, argv, "hri:c:",
210                             long_options, NULL)) != -1) {
211     switch (opt) {
212     case 'c':
213         cycle = atoi(optarg);
214         break;
215
216     case 'i':
217         can_id = strtoul(optarg, NULL, 0);
218         break;
219
220     case 'r':
221         repeater = 1;
222         break;
223
224     default:
225         fprintf(stderr, "Unknown option %c\n", opt);
226     case 'h':
227         print_usage(argv[0]);
228         exit(-1);
229     }
230 }
231
232 printf("%d %d\n", optind, argc);
233 if (optind + 2 != argc) {
234     print_usage(argv[0]);
235     exit(0);
236 }
237
238 txdev = argv[optind];
239 rxdev = argv[optind + 1];
240
241 /* Create and configure RX socket */
242 if ((rxsock = socket(PF_CAN, SOCK_RAW, CAN_RAW)) < 0) {
243     perror("RX socket failed");
244     return -1;
245 }
246
247 strncpy(ifr.ifr_name, rxdev, IFNAMSIZ);
248 printf("RX rxsock=%d, ifr_name=%s\n", rxsock, ifr.ifr_name);
249
250 if (ioctl(rxsock, SIOCGIFINDEX, &ifr) < 0) {
251     perror("RX ioctl SIOCGIFINDEX failed");
252     goto failure1;
253 }
254
255 /* We only want to receive our own messages */
256 rxfilter[0].can_id = can_id;
257 rxfilter[0].can_mask = 0x3ff;
258 if (setsockopt(rxsock, SOL_CAN_RAW, CAN_RAW_FILTER,
259               &rxfilter, sizeof(struct can_filter)) < 0) {
260     perror("RX setsockopt CAN_RAW_FILTER failed");
261     goto failure1;
262 }
263 memset(&rxaddr, 0, sizeof(rxaddr));
264 rxaddr.can_ifindex = ifr.ifr_ifindex;
265 rxaddr.can_family = AF_CAN;
266 if (bind(rxsock, (struct sockaddr *)&rxaddr, sizeof(rxaddr)) < 0) {

```

```

267     perror("RX bind failed\n");
268     goto failure1;
269 }
270
271 /* Create and configure TX socket */
272
273 if (strcmp(rxdev, txdev) == 0) {
274     txsock = rxsock;
275 } else {
276     if ((txsock = socket(PF_CAN, SOCK_RAW, 0)) < 0) {
277         perror("TX socket failed");
278         goto failure1;
279     }
280
281     strncpy(ifr.ifr_name, txdev, IFNAMSIZ);
282     printf("TX txsock=%d, ifr_name=%s\n", txsock, ifr.ifr_name);
283
284     if (ioctl(txsock, SIOCGIFINDEX, &ifr) < 0) {
285         perror("TX ioctl SIOCGIFINDEX failed");
286         goto failure2;
287     }
288
289     /* Suppress definiton of a default receive filter list */
290     if (setsockopt(txsock, SOL_CAN_RAW, CAN_RAW_FILTER, NULL, 0) < 0) {
291         perror("TX setsockopt CAN_RAW_FILTER failed");
292         goto failure2;
293     }
294
295     memset(&txaddr, 0, sizeof(txaddr));
296     txaddr.can_ifindex = ifr.ifr_ifindex;
297     txaddr.can_family = AF_CAN;
298
299     if (bind(txsock, (struct sockaddr *)&txaddr, sizeof(txaddr)) < 0) {
300         perror("TX bind failed\n");
301         goto failure2;
302     }
303 }
304
305 signal(SIGTERM, catch_signal);
306 signal(SIGINT, catch_signal);
307 signal(SIGHUP, catch_signal);
308 mlockall(MCL_CURRENT|MCL_FUTURE);
309
310 printf("Round-Trip-Time test %s -> %s with CAN ID 0x%x\n",
311        argv[optind], argv[optind + 1], can_id);
312 printf("Cycle time: %d us\n", cycle);
313 printf("All RTT timing figures are in us.\n");
314
315 /* Create statistics message queue */
316 snprintf(mqname, sizeof(mqname), "/rtcan_rtt-%d", getpid());
317 mqattr.mq_flags = 0;
318 mqattr.mq_maxmsg = 100;
319 mqattr.mq_msgsize = sizeof(struct rtt_stat);
320 mq = mq_open(mqname, O_RDWR | O_CREAT | O_EXCL, 0600, &mqattr);
321 if (mq == (mqd_t)-1) {
322     perror("opening mqueue failed");
323     goto failure2;
324 }
325
326 /* Create receiver RT-thread */
327 pthread_attr_init(&thattr);
328 pthread_attr_setdetachstate(&thattr, PTHREAD_CREATE_JOINABLE);
329 pthread_attr_setstacksize(&thattr, PTHREAD_STACK_MIN);
330 ret = pthread_create(&rxthread, &thattr, &receiver, NULL);
331 if (ret) {
332     fprintf(stderr, "%s: pthread_create(receiver) failed\n",
333            strerror(-ret));

```

```

334     goto failure3;
335 }
336
337 if (!repeater) {
338     /* Create transitter RT-thread */
339     ret = pthread_create(&txthread, &thattr, &transmitter, NULL);
340     if (ret) {
341         fprintf(stderr, "%s: pthread_create(transmitter) failed\n",
342             strerror(-ret));
343         goto failure4;
344     }
345 }
346
347 pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);
348
349 if (repeater)
350     printf("Messages\n");
351 else
352     printf("Messages RTTlast RTT_avg RTT_min RTT_max Overruns\n");
353
354 while (1) {
355     long long rtt_avg;
356
357     ret = mq_receive(mq, (char *)&rtt_stat, sizeof(rtt_stat), NULL);
358     if (ret != sizeof(rtt_stat)) {
359         if (ret < 0) {
360             if (errno == EBADF)
361                 printf("terminating mq_receive\n");
362             else
363                 perror("mq_receive failed");
364         } else
365             fprintf(stderr,
366                 "mq_receive returned invalid length %d\n", ret);
367         break;
368     }
369
370     if (repeater) {
371         printf("%8d\n", rxcount);
372     } else {
373         rtt_avg = ((rtt_stat.rtt_sum - rtt_stat.rtt_sum_last) /
374             rtt_stat.counts_per_sec);
375         printf("%8d %7ld %7ld %7ld %7ld %8d\n", rxcount,
376             (long)(rtt_stat.rtt / 1000), (long)(rtt_avg / 1000),
377             (long)(rtt_stat.rtt_min / 1000),
378             (long)(rtt_stat.rtt_max / 1000),
379             overruns);
380     }
381 }
382
383 /* This call also leaves primary mode, required for socket cleanup. */
384 printf("shutting down\n");
385
386 /* Important: First close the sockets! */
387 while ((close(rxsock) < 0) && (errno == EAGAIN)) {
388     printf("RX socket busy - waiting...\n");
389     sleep(1);
390 }
391 while ((close(txsock) < 0) && (errno == EAGAIN)) {
392     printf("TX socket busy - waiting...\n");
393     sleep(1);
394 }
395
396 pthread_join(txthread, NULL);
397 pthread_kill(rxthread, SIGHUP);
398 pthread_join(rxthread, NULL);
399
400 return 0;

```



```
401
402 failure4:
403     pthread_kill(rxthread, SIGHUP);
404     pthread_join(rxthread, NULL);
405 failure3:
406     mq_close(mq);
407 failure2:
408     close(txsock);
409 failure1:
410     close(rxsock);
411
412     return 1;
413 }
```

8.3 rtcanconfig.c

```

1 /*
2  * Program to configuring the CAN controller
3  *
4  * Copyright (C) 2006 Wolfgang Grandegger <wg@grandegger.com>
5  *
6  * Copyright (C) 2005, 2006 Sebastian Smolorz
7  *                               <Sebastian.Smolorz@stud.uni-hannover.de>
8  *
9  *
10 * This program is free software; you can redistribute it and/or modify
11 * it under the terms of the GNU General Public License as published by
12 * the Free Software Foundation; either version 2 of the License, or
13 * (at your option) any later version.
14 *
15 * This program is distributed in the hope that it will be useful,
16 * but WITHOUT ANY WARRANTY; without even the implied warranty of
17 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
18 * GNU General Public License for more details.
19 *
20 * You should have received a copy of the GNU General Public License
21 * along with this program; if not, write to the Free Software
22 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
23 */
24
25 #include <stdio.h>
26 #include <stdlib.h>
27 #include <signal.h>
28 #include <unistd.h>
29 #include <string.h>
30 #include <time.h>
31 #include <errno.h>
32 #include <getopt.h>
33 #include <sys/mman.h>
34
35 #include <rtdm/rtcan.h>
36
37 static void print_usage(char *prg)
38 {
39     fprintf(stderr,
40             "Usage: %s <can-interface> [Options] [up|down|start|stop|sleep]\n"
41             "Options:\n"
42             "  -v, --verbose           be verbose\n"
43             "  -h, --help             this help\n"
44             "  -c, --ctrlmode=CTRLMODE listenonly, loopback or none\n"
45             "  -b, --baudrate=BPS      baudrate in bits/sec\n"
46             "  -B, --bittime=BTR0:BTR1 BTR or standard bit-time\n"
47             "  -B, --bittime=BRP:PROP_SEG:PHASE_SEG1:PHASE_SEG2:SJW:SAM\n",
48             prg);
49 }
50
51 can_baudrate_t string_to_baudrate(char *str)
52 {
53     can_baudrate_t baudrate;
54     if (sscanf(str, "%i", &baudrate) != 1)
55         return -1;
56     return baudrate;
57 }
58
59 int string_to_mode(char *str)
60 {
61     if ( !strcmp(str, "up") || !strcmp(str, "start") )
62         return CAN_MODE_START;
63     else if ( !strcmp(str, "down") || !strcmp(str, "stop") )
64         return CAN_MODE_STOP;
65     else if ( !strcmp(str, "sleep") )

```

```

66         return CAN_MODE_SLEEP;
67     return -EINVAL;
68 }
69
70 int string_to_ctrlmode(char *str)
71 {
72     if ( !strcmp(str, "listenonly") )
73         return CAN_CTRLMODE_LISTENONLY;
74     else if ( !strcmp(str, "loopback") )
75         return CAN_CTRLMODE_LOOPBACK;
76     else if ( !strcmp(str, "none") )
77         return 0;
78
79     return -1;
80 }
81
82 int main(int argc, char *argv[])
83 {
84     char    ifname[16];
85     int     can_fd = -1;
86     int     new_baudrate = -1;
87     int     new_mode = -1;
88     int     new_ctrlmode = 0, set_ctrlmode = 0;
89     int     verbose = 0;
90     int     bittime_count = 0, bittime_data[6];
91     struct  ifreq ifr;
92     can_baudrate_t *baudrate;
93     can_ctrlmode_t *ctrlmode;
94     can_mode_t *mode;
95     struct  can_bittime *bittime;
96     int     opt, ret;
97     char*   ptr;
98
99     struct option long_options[] = {
100         { "help", no_argument, 0, 'h' },
101         { "verbose", no_argument, 0, 'v' },
102         { "baudrate", required_argument, 0, 'b' },
103         { "bittime", required_argument, 0, 'B' },
104         { "ctrlmode", required_argument, 0, 'c' },
105         { 0, 0, 0, 0 },
106     };
107
108     while ((opt = getopt_long(argc, argv, "hvb:B:c:",
109                             long_options, NULL)) != -1) {
110         switch (opt) {
111             case 'h':
112                 print_usage(argv[0]);
113                 exit(0);
114
115             case 'v':
116                 verbose = 1;
117                 break;
118
119             case 'b':
120                 new_baudrate = string_to_baudrate(optarg);
121                 if (new_baudrate == -1) {
122                     print_usage(argv[0]);
123                     exit(0);
124                 }
125                 break;
126
127             case 'B':
128                 ptr = optarg;
129                 while (1) {
130                     bittime_data[bittime_count++] = strtoul(ptr, NULL, 0);
131                     if (!(ptr = strchr(ptr, ':')))
132                         break;

```

```

133         ptr++;
134     }
135     if (bittime_count != 2 && bittime_count != 6) {
136         print_usage(argv[0]);
137         exit(0);
138     }
139     break;
140
141     case 'c':
142         ret = string_to_ctrlmode(optarg);
143         if (ret == -1) {
144             print_usage(argv[0]);
145             exit(0);
146         }
147         new_ctrlmode |= ret;
148         set_ctrlmode = 1;
149         break;
150
151         break;
152
153     default:
154         fprintf(stderr, "Unknown option %c\n", opt);
155         break;
156 }
157 }
158
159 /* Get CAN interface name */
160 if (optind != argc - 1 && optind != argc - 2) {
161     print_usage(argv[0]);
162     return 0;
163 }
164
165 strncpy(iframe, argv[optind], IFNAMSIZ);
166 strncpy(ifr.ifr_name, iframe, IFNAMSIZ);
167
168 if (optind == argc - 2) { /* Get mode setting */
169     new_mode = string_to_mode(argv[optind + 1]);
170     if (verbose)
171         printf("mode: %s (%#x)\n", argv[optind + 1], new_mode);
172     if (new_mode < 0) {
173         print_usage(argv[0]);
174         return 0;
175     }
176 }
177
178 can_fd = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
179 if (can_fd < 0) {
180     fprintf(stderr, "Cannot open RTDM CAN socket. Maybe driver not loaded? \n");
181     return can_fd;
182 }
183
184 ret = rt_dev_ioctl(can_fd, SIOCGIFINDEX, &ifr);
185 if (ret) {
186     fprintf(stderr, "Can't get interface index for %s, code = %d\n", iframe, ret);
187     return ret;
188 }
189
190
191 if (new_baudrate != -1) {
192     if (verbose)
193         printf("baudrate: %d\n", new_baudrate);
194     baudrate = (can_baudrate_t *)&ifr.ifr_ifru;
195     *baudrate = new_baudrate;
196     ret = rt_dev_ioctl(can_fd, SIOCSANBAUDRATE, &ifr);
197     if (ret) {
198         goto abort;
199     }

```

```

200     }
201
202     if (bittime_count) {
203         bittime = (struct can_bittime *)&ifr.ifr_ifru;
204         if (bittime_count == 2) {
205             bittime->type = CAN_BITTIME_BTR;
206             bittime->btr.btr0 = bittime_data[0];
207             bittime->btr.btr1 = bittime_data[1];
208             if (verbose)
209                 printf("bit-time: btr0=0x%02x btr1=0x%02x\n",
210                     bittime->btr.btr0, bittime->btr.btr1);
211         } else {
212             bittime->type = CAN_BITTIME_STD;
213             bittime->std.brp = bittime_data[0];
214             bittime->std.prop_seg = bittime_data[1];
215             bittime->std.phase_seg1 = bittime_data[2];
216             bittime->std.phase_seg2 = bittime_data[3];
217             bittime->std.sjw = bittime_data[4];
218             bittime->std.sam = bittime_data[5];
219             if (verbose)
220                 printf("bit-time: brp=%d prop_seg=%d phase_seg1=%d "
221                     "phase_seg2=%d sjw=%d sam=%d\n",
222                     bittime->std.brp,
223                     bittime->std.prop_seg,
224                     bittime->std.phase_seg1,
225                     bittime->std.phase_seg2,
226                     bittime->std.sjw,
227                     bittime->std.sam);
228         }
229
230         ret = rt_dev_ioctl(can_fd, SIOCSCANCUSTOMBITTIME, &ifr);
231         if (ret) {
232             goto abort;
233         }
234     }
235 }
236
237 if (set_ctrlmode != 0) {
238     ctrlmode = (can_ctrlmode_t *)&ifr.ifr_ifru;
239     *ctrlmode = new_ctrlmode;
240     if (verbose)
241         printf("ctrlmode: %#x\n", new_ctrlmode);
242     ret = rt_dev_ioctl(can_fd, SIOCSCANCTRLMODE, &ifr);
243     if (ret) {
244         goto abort;
245     }
246 }
247
248 if (new_mode != -1) {
249     mode = (can_mode_t *)&ifr.ifr_ifru;
250     *mode = new_mode;
251     ret = rt_dev_ioctl(can_fd, SIOCSCANMODE, &ifr);
252     if (ret) {
253         goto abort;
254     }
255 }
256
257 rt_dev_close(can_fd);
258 return 0;
259
260 abort:
261     rt_dev_close(can_fd);
262     return ret;
263 }

```

8.4 rtcanrecv.c

```

1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <signal.h>
4 #include <unistd.h>
5 #include <time.h>
6 #include <errno.h>
7 #include <getopt.h>
8 #include <sys/mman.h>
9
10 #include <native/task.h>
11 #include <native/pipe.h>
12
13 #include <rtkm/rtcan.h>
14
15 static void print_usage(char *prg)
16 {
17     fprintf(stderr,
18         "Usage: %s [<can-interface>] [Options]\n"
19         "Options:\n"
20         " -f --filter=id:mask[:id:mask]... apply filter\n"
21         " -e --error=mask      receive error messages\n"
22         " -t, --timeout=MS      timeout in ms\n"
23         " -T, --timestamp       with absolute timestamp\n"
24         " -R, --timestamp-rel   with relative timestamp\n"
25         " -v, --verbose         be verbose\n"
26         " -p, --print=MODULO    print every MODULO message\n"
27         " -h, --help           this help\n",
28         prg);
29 }
30
31
32 extern int optind, opterr, optopt;
33
34 static int s = -1, verbose = 0, print = 1;
35 static nanosecs_rel_t timeout = 0, with_timestamp = 0, timestamp_rel = 0;
36
37 RT_TASK rt_task_desc;
38
39 #define BUF_SIZ 255
40 #define MAX_FILTER 16
41
42 struct sockaddr_can recv_addr;
43 struct can_filter recv_filter[MAX_FILTER];
44 static int filter_count = 0;
45
46 int add_filter(u_int32_t id, u_int32_t mask)
47 {
48     if (filter_count >= MAX_FILTER)
49         return -1;
50     recv_filter[filter_count].can_id = id;
51     recv_filter[filter_count].can_mask = mask;
52     printf("Filter #d: id=0x%08x mask=0x%08x\n", filter_count, id, mask);
53     filter_count++;
54     return 0;
55 }
56
57 void cleanup(void)
58 {
59     int ret;
60
61     if (verbose)
62         printf("Cleaning up...\n");
63
64     if (s >= 0) {
65         ret = rt_dev_close(s);

```

```

66     s = -1;
67     if (ret) {
68         fprintf(stderr, "rt_dev_close: %s\n", strerror(-ret));
69     }
70     rt_task_delete(&rt_task_desc);
71 }
72 }
73
74 void cleanup_and_exit(int sig)
75 {
76     if (verbose)
77         printf("Signal %d received\n", sig);
78     cleanup();
79     exit(0);
80 }
81
82 void rt_task(void)
83 {
84     int i, ret, count = 0;
85     struct can_frame frame;
86     struct sockaddr_can addr;
87     socklen_t addrlen = sizeof(addr);
88     struct msghdr msg;
89     struct iovec iov;
90     nanosecs_abs_t timestamp, timestamp_prev = 0;
91
92     if (with_timestamp) {
93         msg.msg_iov = &iov;
94         msg.msg_iovlen = 1;
95         msg.msg_name = (void *)&addr;
96         msg.msg_namelen = sizeof(struct sockaddr_can);
97         msg.msg_control = (void *)&timestamp;
98         msg.msg_controllen = sizeof(nanosecs_abs_t);
99     }
100
101     while (1) {
102         if (with_timestamp) {
103             iov.iov_base = (void *)&frame;
104             iov.iov_len = sizeof(can_frame_t);
105             ret = rt_dev_recvmsg(s, &msg, 0);
106         } else
107             ret = rt_dev_recvfrom(s, (void *)&frame, sizeof(can_frame_t), 0,
108                                   (struct sockaddr *)&addr, &addrlen);
109
110         if (ret < 0) {
111             switch (ret) {
112                 case -ETIMEDOUT:
113                     if (verbose)
114                         printf("rt_dev_recv: timed out");
115                     continue;
116                 case -EBADF:
117                     if (verbose)
118                         printf("rt_dev_recv: aborted because socket was closed");
119                     break;
120                 default:
121                     fprintf(stderr, "rt_dev_recv: %s\n", strerror(-ret));
122             }
123             break;
124         }
125
126         if (print && (count % print) == 0) {
127             printf("#%d: (%d) ", count, addr.can_ifindex);
128             if (with_timestamp && msg.msg_controllen) {
129                 if (timestamp_rel) {
130                     printf("%lldns ", (long long)(timestamp - timestamp_prev));
131                     timestamp_prev = timestamp;
132                 } else
133                     printf("%lldns ", (long long)timestamp);

```

```

133         }
134         if (frame.can_id & CAN_ERR_FLAG)
135             printf("!0x%08x!", frame.can_id & CAN_ERR_MASK);
136         else if (frame.can_id & CAN EFF_FLAG)
137             printf("<0x%08x>", frame.can_id & CAN EFF_MASK);
138         else
139             printf("<0x%03x>", frame.can_id & CAN SFF_MASK);
140
141         printf(" [%d]", frame.can_dlc);
142         if (!(frame.can_id & CAN_RTR_FLAG))
143             for (i = 0; i < frame.can_dlc; i++) {
144                 printf(" %02x", frame.data[i]);
145             }
146         if (frame.can_id & CAN_ERR_FLAG) {
147             printf(" ERROR ");
148             if (frame.can_id & CAN_ERR_BUSOFF)
149                 printf("bus-off");
150             if (frame.can_id & CAN_ERR_CRTL)
151                 printf("controller problem");
152         } else if (frame.can_id & CAN_RTR_FLAG)
153             printf(" remote request");
154         printf("\n");
155     }
156     count++;
157 }
158 }
159
160 int main(int argc, char **argv)
161 {
162     int opt, ret;
163     u_int32_t id, mask;
164     u_int32_t err_mask = 0;
165     struct ifreq ifr;
166     char *ptr;
167     char name[32];
168
169     struct option long_options[] = {
170         { "help", no_argument, 0, 'h' },
171         { "verbose", no_argument, 0, 'v' },
172         { "filter", required_argument, 0, 'f' },
173         { "error", required_argument, 0, 'e' },
174         { "timeout", required_argument, 0, 't' },
175         { "timestamp", no_argument, 0, 'T' },
176         { "timestamp-rel", no_argument, 0, 'R' },
177         { 0, 0, 0, 0 },
178     };
179
180     mlockall(MCL_CURRENT | MCL_FUTURE);
181
182     signal(SIGTERM, cleanup_and_exit);
183     signal(SIGINT, cleanup_and_exit);
184
185     while ((opt = getopt_long(argc, argv, "hve:f:t:p:RT",
186                             long_options, NULL)) != -1) {
187         switch (opt) {
188             case 'h':
189                 print_usage(argv[0]);
190                 exit(0);
191
192             case 'p':
193                 print = strtoul(optarg, NULL, 0);
194                 break;
195
196             case 'v':
197                 verbose = 1;
198                 break;
199

```



```

200     case 'e':
201         err_mask = strtoul(optarg, NULL, 0);
202         break;
203
204     case 'f':
205         ptr = optarg;
206         while (1) {
207             id = strtoul(ptr, NULL, 0);
208             ptr = strchr(ptr, ':');
209             if (!ptr) {
210                 fprintf(stderr, "filter must be applied in the form id:mask[:id:mask]...\n");
211                 exit(1);
212             }
213             ptr++;
214             mask = strtoul(ptr, NULL, 0);
215             ptr = strchr(ptr, ':');
216             add_filter(id, mask);
217             if (!ptr)
218                 break;
219             ptr++;
220         }
221         break;
222
223     case 't':
224         timeout = (nanosecs_rel_t)strtoul(optarg, NULL, 0) * 1000000;
225         break;
226
227     case 'R':
228         timestamp_rel = 1;
229     case 'T':
230         with_timestamp = 1;
231         break;
232
233     default:
234         fprintf(stderr, "Unknown option %c\n", opt);
235         break;
236 }
237
238 ret = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
239 if (ret < 0) {
240     fprintf(stderr, "rt_dev_socket: %s\n", strerror(-ret));
241     return -1;
242 }
243 s = ret;
244
245 if (argv[optind] == NULL) {
246     if (verbose)
247         printf("interface all\n");
248     ifr.ifr_ifindex = 0;
249 } else {
250     if (verbose)
251         printf("interface %s\n", argv[optind]);
252     strncpy(ifr.ifr_name, argv[optind], IFNAMSIZ);
253     if (verbose)
254         printf("s=%d, ifr_name=%s\n", s, ifr.ifr_name);
255     ret = rt_dev_ioctl(s, SIOCGIFINDEX, &ifr);
256     if (ret < 0) {
257         fprintf(stderr, "rt_dev_ioctl GET_IFINDEX: %s\n", strerror(-ret));
258         goto failure;
259     }
260 }
261
262 if (err_mask) {

```

```

267     ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_ERR_FILTER,
268                             &err_mask, sizeof(err_mask));
269     if (ret < 0) {
270         fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
271         goto failure;
272     }
273     if (verbose)
274         printf("Using err_mask=0x%x\n", err_mask);
275 }
276
277 if (filter_count) {
278     ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_FILTER,
279                             &recv_filter, filter_count *
280                             sizeof(struct can_filter));
281     if (ret < 0) {
282         fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
283         goto failure;
284     }
285 }
286
287 recv_addr.can_family = AF_CAN;
288 recv_addr.can_ifindex = ifr.ifr_ifindex;
289 ret = rt_dev_bind(s, (struct sockaddr *)&recv_addr,
290                  sizeof(struct sockaddr_can));
291 if (ret < 0) {
292     fprintf(stderr, "rt_dev_bind: %s\n", strerror(-ret));
293     goto failure;
294 }
295
296 if (timeout) {
297     if (verbose)
298         printf("Timeout: %lld ns\n", (long long)timeout);
299     ret = rt_dev_ioctl(s, RTCAN_RTIOC_RCV_TIMEOUT, &timeout);
300     if (ret) {
301         fprintf(stderr, "rt_dev_ioctl RCV_TIMEOUT: %s\n", strerror(-ret));
302         goto failure;
303     }
304 }
305
306 if (with_timestamp) {
307     ret = rt_dev_ioctl(s, RTCAN_RTIOC_TAKE_TIMESTAMP, RTCAN_TAKE_TIMESTAMPS);
308     if (ret) {
309         fprintf(stderr, "rt_dev_ioctl TAKE_TIMESTAMP: %s\n", strerror(-ret));
310         goto failure;
311     }
312 }
313
314 snprintf(name, sizeof(name), "rtcanrecv-%d", getpid());
315 ret = rt_task_shadow(&rt_task_desc, name, 0, 0);
316 if (ret) {
317     fprintf(stderr, "rt_task_shadow: %s\n", strerror(-ret));
318     goto failure;
319 }
320
321 rt_task();
322 /* never returns */
323
324 failure:
325     cleanup();
326     return -1;
327 }

```

8.5 rtcansend.c

```

1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <signal.h>
4 #include <unistd.h>
5 #include <time.h>
6 #include <errno.h>
7 #include <getopt.h>
8 #include <sys/mman.h>
9
10 #include <native/task.h>
11 #include <native/timer.h>
12 #include <native/pipe.h>
13
14 #include <rtcm/rctan.h>
15
16 extern int optind, opterr, optopt;
17
18 static void print_usage(char *prg)
19 {
20     fprintf(stderr,
21         "Usage: %s <can-interface> [Options] <can-msg>\n"
22         "<can-msg> can consist of up to 8 bytes given as a space separated list\n"
23         "Options:\n"
24         " -i, --identifier=ID    CAN Identifier (default = 1)\n"
25         " -r --rtr               send remote request\n"
26         " -e --extended          send extended frame\n"
27         " -l --loop=COUNT       send message COUNT times\n"
28         " -c, --count            message count in data[0-3]\n"
29         " -d, --delay=MS         delay in ms (default = 1ms)\n"
30         " -s, --send             use send instead of sendto\n"
31         " -t, --timeout=MS       timeout in ms\n"
32         " -L, --loopback=0|1     switch local loopback off or on\n"
33         " -v, --verbose          be verbose\n"
34         " -p, --print=MODULO     print every MODULO message\n"
35         " -h, --help             this help\n",
36         prg);
37 }
38
39
40 RT_TASK rt_task_desc;
41
42 static int s=-1, dlc=0, rtr=0, extended=0, verbose=0, loops=1;
43 static SRTIME delay=1000000;
44 static int count=0, print=1, use_send=0, loopback=-1;
45 static nanosecs_rel_t timeout = 0;
46 static struct can_frame frame;
47 static struct sockaddr_can to_addr;
48
49
50 void cleanup(void)
51 {
52     int ret;
53
54     if (verbose)
55         printf("Cleaning up...\n");
56
57     usleep(100000);
58
59     if (s >= 0) {
60         ret = rt_dev_close(s);
61         s = -1;
62         if (ret) {
63             fprintf(stderr, "rt_dev_close: %s\n", strerror(-ret));
64         }
65         rt_task_delete(&rt_task_desc);

```

```

66     }
67 }
68
69 void cleanup_and_exit(int sig)
70 {
71     if (verbose)
72         printf("Signal %d received\n", sig);
73     cleanup();
74     exit(0);
75 }
76
77 void rt_task(void)
78 {
79     int i, j, ret;
80
81     for (i = 0; i < loops; i++) {
82         rt_task_sleep(rt_timer_ns2ticks(delay));
83         if (count)
84             memcpy(&frame.data[0], &i, sizeof(i));
85         /* Note: sendto avoids the definition of a receive filter list */
86         if (use_send)
87             ret = rt_dev_send(s, (void *)&frame, sizeof(can_frame_t), 0);
88         else
89             ret = rt_dev_sendto(s, (void *)&frame, sizeof(can_frame_t), 0,
90                                (struct sockaddr *)&to_addr, sizeof(to_addr));
91         if (ret < 0) {
92             switch (ret) {
93                 case -ETIMEDOUT:
94                     if (verbose)
95                         printf("rt_dev_send(to): timed out");
96                     break;
97                 case -EBADF:
98                     if (verbose)
99                         printf("rt_dev_send(to): aborted because socket was closed");
100                    break;
101                default:
102                    fprintf(stderr, "rt_dev_send: %s\n", strerror(-ret));
103                    break;
104            }
105            i = loops;          /* abort */
106            break;
107        }
108        if (verbose && (i % print) == 0) {
109            if (frame.can_id & CAN_EFF_FLAG)
110                printf("<0x%08x>", frame.can_id & CAN_EFF_MASK);
111            else
112                printf("<0x%03x>", frame.can_id & CAN_SFF_MASK);
113            printf(" [%d]", frame.can_dlc);
114            for (j = 0; j < frame.can_dlc; j++) {
115                printf(" %02x", frame.data[j]);
116            }
117            printf("\n");
118        }
119    }
120 }
121
122 int main(int argc, char **argv)
123 {
124     int i, opt, ret;
125     struct ifreq ifr;
126     char name[32];
127
128     struct option long_options[] = {
129         { "help", no_argument, 0, 'h' },
130         { "identifier", required_argument, 0, 'i' },
131         { "rtr", no_argument, 0, 'r' },
132         { "extended", no_argument, 0, 'e' },

```

```

133     { "verbose", no_argument, 0, 'v'},
134     { "count", no_argument, 0, 'c'},
135     { "print", required_argument, 0, 'p'},
136     { "loop", required_argument, 0, 'l'},
137     { "delay", required_argument, 0, 'd'},
138     { "send", no_argument, 0, 's'},
139     { "timeout", required_argument, 0, 't'},
140     { "loopback", required_argument, 0, 'L'},
141     { 0, 0, 0, 0},
142 };
143
144 mlockall(MCL_CURRENT | MCL_FUTURE);
145
146 signal(SIGTERM, cleanup_and_exit);
147 signal(SIGINT, cleanup_and_exit);
148
149 frame.can_id = 1;
150
151 while ((opt = getopt_long(argc, argv, "hvi:l:red:t:cp:sL:",
152                             long_options, NULL)) != -1) {
153     switch (opt) {
154     case 'h':
155         print_usage(argv[0]);
156         exit(0);
157
158     case 'p':
159         print = strtoul(optarg, NULL, 0);
160
161     case 'v':
162         verbose = 1;
163         break;
164
165     case 'c':
166         count = 1;
167         break;
168
169     case 'l':
170         loops = strtoul(optarg, NULL, 0);
171         break;
172
173     case 'i':
174         frame.can_id = strtoul(optarg, NULL, 0);
175         break;
176
177     case 'r':
178         rtr = 1;
179         break;
180
181     case 'e':
182         extended = 1;
183         break;
184
185     case 'd':
186         delay = strtoul(optarg, NULL, 0) * 1000000LL;
187         break;
188
189     case 's':
190         use_send = 1;
191         break;
192
193     case 't':
194         timeout = strtoul(optarg, NULL, 0) * 1000000LL;
195         break;
196
197     case 'L':
198         loopback = strtoul(optarg, NULL, 0);
199         break;

```

```

200
201     default:
202         fprintf(stderr, "Unknown option %c\n", opt);
203         break;
204     }
205 }
206
207 if (optind == argc) {
208     print_usage(argv[0]);
209     exit(0);
210 }
211
212 if (argv[optind] == NULL) {
213     fprintf(stderr, "No Interface supplied\n");
214     exit(-1);
215 }
216
217 if (verbose)
218     printf("interface %s\n", argv[optind]);
219
220 ret = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
221 if (ret < 0) {
222     fprintf(stderr, "rt_dev_socket: %s\n", strerror(-ret));
223     return -1;
224 }
225 s = ret;
226
227 if (loopback >= 0) {
228     ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_LOOPBACK,
229                             &loopback, sizeof(loopback));
230     if (ret < 0) {
231         fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
232         goto failure;
233     }
234     if (verbose)
235         printf("Using loopback=%d\n", loopback);
236 }
237
238 strncpy(ifr.ifr_name, argv[optind], IFNAMSIZ);
239 if (verbose)
240     printf("s=%d, ifr_name=%s\n", s, ifr.ifr_name);
241
242 ret = rt_dev_ioctl(s, SIOCGIFINDEX, &ifr);
243 if (ret < 0) {
244     fprintf(stderr, "rt_dev_ioctl: %s\n", strerror(-ret));
245     goto failure;
246 }
247
248 memset(&to_addr, 0, sizeof(to_addr));
249 to_addr.can_ifindex = ifr.ifr_ifindex;
250 to_addr.can_family = AF_CAN;
251 if (use_send) {
252     /* Suppress definition of a default receive filter list */
253     ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_FILTER, NULL, 0);
254     if (ret < 0) {
255         fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
256         goto failure;
257     }
258
259     ret = rt_dev_bind(s, (struct sockaddr *)&to_addr, sizeof(to_addr));
260     if (ret < 0) {
261         fprintf(stderr, "rt_dev_bind: %s\n", strerror(-ret));
262         goto failure;
263     }
264 }
265
266 if (count)

```

```
267     frame.can_dlc = sizeof(int);
268     else {
269         for (i = optind + 1; i < argc; i++) {
270             frame.data[dlc] = strtoul(argv[i], NULL, 0);
271             dlc++;
272             if( dlc == 8 )
273                 break;
274         }
275         frame.can_dlc = dlc;
276     }
277
278     if (rtr)
279         frame.can_id |= CAN_RTR_FLAG;
280
281     if (extended)
282         frame.can_id |= CAN_EFF_FLAG;
283
284     if (timeout) {
285         if (verbose)
286             printf("Timeout: %lld ns\n", (long long)timeout);
287         ret = rt_dev_ioctl(s, RTCAN_RTIOC_SND_TIMEOUT, &timeout);
288         if (ret) {
289             fprintf(stderr, "rt_dev_ioctl SND_TIMEOUT: %s\n", strerror(-ret));
290             goto failure;
291         }
292     }
293
294     snprintf(name, sizeof(name), "rtcansend-%d", getpid());
295     ret = rt_task_shadow(&rt_task_desc, name, 1, 0);
296     if (ret) {
297         fprintf(stderr, "rt_task_shadow: %s\n", strerror(-ret));
298         goto failure;
299     }
300
301     rt_task();
302
303     cleanup();
304     return 0;
305
306 failure:
307     cleanup();
308     return -1;
309 }
```

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