Xenomai RTDM skin API

2.5.6.1

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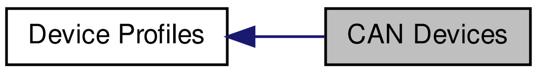


Data Structures

- 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.

Files

- file rtcan.h

    Real-Time Driver Model for RT-Socket-CAN, CAN device profile header.

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 struct can_filter can_filter_t

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

    Raw CAN frame.

Enumerations

- enum CAN_BITTIME_TYPE { CAN_BITTIME_STD, CAN_BITTIME_BT-R }

    Supported CAN bit-time types.

CAN ID masks

Bit masks for masking CAN IDs

- #define CAN_EFF_MASK 0x1FFFFFFF

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

  Bit mask for standard CAN IDs.

CAN ID flags

Flags within a CAN ID indicating special CAN frame attributes

- #define CAN_EFF_FLAG 0x80000000

  Extended frame.
- #define CAN_RTR_FLAG 0x40000000

  Remote transmission frame.
- #define CAN_ERR_FLAG 0x20000000

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

  Invert CAN filter definition, only valid in struct can_filter.

Particular CAN protocols

Possible protocols for the PF_CAN protocol family

Currently only the RAW protocol is supported.

- #define CAN_RAW 1

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

CAN operation modes

Modes into which CAN controllers can be set

- enum CAN_MODE { CAN_MODE_STOP = 0, CAN_MODE_START, C-AN_MODE_SLEEP }

CAN controller modes

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

Note

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

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

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, CA-N_STATE_SLEEPING }

Timestamp switches

Arguments to pass to RTCAN_RTIOC_TAKE_TIMESTAMP

- #define RTCAN_TAKE_NO_TIMESTAMPS 0

  Switch off taking timestamps.
- #define RTCAN_TAKE_TIMESTAMPS 1

  Do take timestamps.

RAW socket options

Setting and getting CAN RAW socket options.

- #define CAN_RAW_FILTER 0x1

  CAN filter definition.
- #define CAN_RAW_ERR_FILTER 0x2

  CAN error mask.
- #define CAN_RAW_LOOPBACK 0x3

  CAN TX loopback.
- #define CAN_RAW_RECV_OWN_MSGS 0x4

  CAN receive own messages.

IOCTLs

CAN device IOCTLs

- #define SIOCGIFINDEX defined_by_kernel_header_file

Get CAN interface index by name.

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

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

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

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

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

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

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

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

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

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

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

  Specify a transmission timeout for a socket.

Error mask

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

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

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

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

- #define CAN_ERR_TX_TIMEOUT 0x00000001U

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

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

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

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

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

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

  Bus off.
- #define CAN_ERR_BUSERROR 0x00000080U

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

  Controller restarted.
- #define CAN_ERR_MASK 0x1FFFFFFFU

  Omit EFF, RTR, ERR flags.

Arbitration lost error

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

- #define CAN_ERR_LOSTARB_UNSPEC 0x00

  unspecified

Controller problems

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

- #define CAN_ERR_CRTL_UNSPEC 0x00

  unspecified
- #define CAN_ERR_CRTL_RX_OVERFLOW 0x01

  RX buffer overflow.
- #define CAN_ERR_CRTL_TX_OVERFLOW 0x02

TX buffer overflow.

- #define CAN_ERR_CRTL_RX_WARNING 0x04

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

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

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

  reached passive level for TX errors

Protocol error type

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

- #define CAN_ERR_PROT_UNSPEC 0x00

  unspecified
- #define CAN_ERR_PROT_BIT 0x01

  single bit error
- #define CAN_ERR_PROT_FORM 0x02

  frame format error
- #define CAN_ERR_PROT_STUFF 0x04

  bit stuffing error
- #define CAN_ERR_PROT_BIT0 0x08

  unable to send dominant bit
- #define CAN_ERR_PROT_BIT1 0x10

  unable to send recessive bit
- #define CAN_ERR_PROT_OVERLOAD 0x20

  bus overload
- #define CAN_ERR_PROT_ACTIVE 0x40

  active error announcement
- #define CAN_ERR_PROT_TX 0x80

  error occured on transmission

Protocol error location

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

- #define CAN_ERR_PROT_LOC_UNSPEC 0x00

  unspecified
- #define CAN_ERR_PROT_LOC_SOF 0x03

  start of frame
- #define CAN_ERR_PROT_LOC_ID28_21 0x02

ID bits 28 - 21 (SFF: 10 - 3)

- #define CAN_ERR_PROT_LOC_ID20_18 0x06

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

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

  identifier extension
- #define CAN_ERR_PROT_LOC_ID17_13 0x07

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

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

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

  RTR.
- #define CAN_ERR_PROT_LOC_RES1 0x0D

  reserved bit 1
- #define CAN_ERR_PROT_LOC_RES0 0x09

  reserved bit 0
- #define CAN_ERR_PROT_LOC_DLC 0x0B

  data length code
- #define CAN_ERR_PROT_LOC_DATA 0x0A

  data section
- #define CAN_ERR_PROT_LOC_CRC_SEQ 0x08

  CRC sequence.
- #define CAN_ERR_PROT_LOC_CRC_DEL 0x18

  CRC delimiter.
- #define CAN_ERR_PROT_LOC_ACK 0x19

  ACK slot.
- #define CAN_ERR_PROT_LOC_ACK_DEL 0x1B

  ACK delimiter.
- #define CAN_ERR_PROT_LOC_EOF 0x1A

  end of frame
- #define CAN_ERR_PROT_LOC_INTERM 0x12

  intermission
- #define CAN_ERR_TRX_UNSPEC 0x00

  0000 0000
- #define CAN_ERR_TRX_CANH_NO_WIRE 0x04

  0000 0100
- #define CAN_ERR_TRX_CANH_SHORT_TO_BAT 0x05

  0000 0101
- #define CAN_ERR_TRX_CANH_SHORT_TO_VCC 0x06

  0000 0110

- #define CAN_ERR_TRX_CANH_SHORT_TO_GND 0x07

  0000 0111
- #define CAN_ERR_TRX_CANL_NO_WIRE 0x40

  0100 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_BAT 0x50

  0101 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_VCC 0x60

  0110 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_GND 0x70

  0111 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_CANH 0x80

  1000 0000

5.1.1 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, deprecated)
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, deprecated)
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 Sockopts), it will be used upon reception of CAN frames to decide whether the bound socket will

receive a frame. If no filter has been defined, the socket will receive **all** CAN frames on the specified interface(s).
Binding to special interface index `0` will make the socket receive CAN frames from all CAN interfaces.
Binding to an interface index is also relevant for the Send functions because they will transmit a message over the interface the socket is bound to when no socket address is given to them.
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 msghdr` if it points to a valid memory location with size of nanosecs_abs_t. If this is a NULL pointer the timestamp will be discarded silently.
Note: A `msg_controllen` of `0` upon completion of the function call indicates that no timestamp is available for that message.
Supported Flags [in]:

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

Supported Flags [out]: none
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.

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_ERR_LOSTARB_UNSPEC 0x00

unspecified

else bit number in bitstream

5.1.2.4 #define CAN_RAW_ERR_FILTER 0x2

CAN error mask.

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

Parameters

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

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.

5.1.2.5 #define CAN_RAW_FILTER 0x1

CAN filter definition.

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

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

Parameters

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

5.1.2.6 #define CAN_RAW_LOOPBACK 0x3

CAN TX loopback.

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

Note

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

Parameters

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

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.

5.1.2.7 #define CAN_RAW_RECV_OWN_MSGS 0x4

CAN receive own messages.

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

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

Specify a reception timeout for a socket.

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

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

Note

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

Parameters

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

Returns

0 on success, otherwise:

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

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.

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

Specify a transmission timeout for a socket.

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

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

Note

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

Parameters

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

Returns

0 on success, otherwise:

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

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.

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

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

A newly created socket takes no timestamps by default.

Parameters

`in`	*arg*	int variable, see Timestamp switches

Returns

0 on success.

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.

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

Get baud rate.

Parameters

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

Returns

0 on success, otherwise:

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

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 **SIOCGCANCTRLMODE** _IOWR(RTIOC_TYPE_CAN, 0x08, struct ifreq)

Get special controller modes.

Parameters

`in`	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). `ifr_name` must hold a valid C-AN 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.

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

Get custum bit-time parameters.

Parameters

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

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: never.

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

Get current state of CAN controller.

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

Parameters

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

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: possible.

5.1.2.15 #define SIOCGIFINDEX defined_by_kernel_header_file

Get CAN interface index by name.

Parameters

`in,out`	*arg*	Pointer to interface request structure buffer (`struct ifreq` from linux/if.h). If `ifr_name` holds a valid CA-N 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.

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

Set baud rate.

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

Parameters

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

Returns

0 on success, otherwise:

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

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.

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

Set special controller modes.

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

Parameters

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

Returns

0 on success, otherwise:

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

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.

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

Set custom bit time parameter.

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

Parameters

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

Returns

0 on success, otherwise:

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

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.

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

Set operation mode of CAN controller.

See CAN controller modes for available modes.

Parameters

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

Returns

0 on success, otherwise:

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

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.

5.1.2.20 #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.

Examples:

rtcanrecv.c.

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.

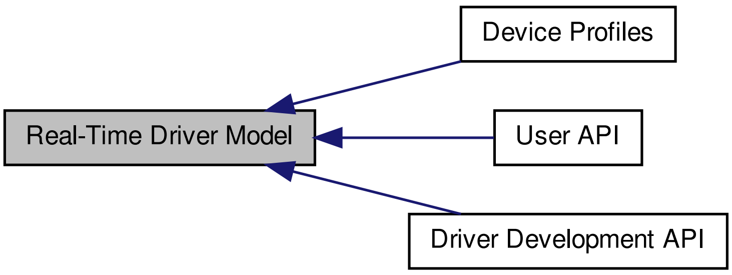
CAN_STATE_SCANNING_BAUDRATE CAN controller is scanning to get the baudrate.

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:



Modules

- User API
- Driver Development API
- Device Profiles

Typedefs

- typedef uint64_t nanosecs_abs_t

  RTDM type for representing absolute dates.
- typedef int64_t nanosecs_rel_t

  RTDM type for representing relative intervals.

API Versioning

- #define RTDM_API_VER 8

  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.

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: 8

5.2.2 Define Documentation

5.2.2.1 #define RTDM_TIMEOUT_INFINITE 0

Block forever.

5.2.2.2 #define RTDM_TIMEOUT_NONE (-1)

Any negative timeout means non-blocking.

5.2.3 Typedef Documentation

5.2.3.1 typedef uint64_t nanosecs_abs_t

RTDM type for representing absolute dates.

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

Examples:

rtcanrecv.c.

5.2.3.2 typedef int64_t nanosecs_rel_t

RTDM type for representing relative intervals.

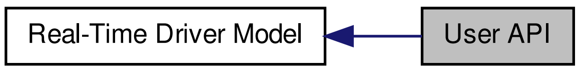
Its base type is a 64 bit signed integer. The unit is 1 nanosecond. Relative intervals can also encode the special timeouts "infinite" and "non-blocking", see RTDM_TIMEOUT_xxx.

Examples:

rtcanrecv.c.

5.3 User API

Collaboration diagram for User API:



Files

- file rtdm.h

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

Functions

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

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

  Create a socket.
- int rt_dev_close (int fd)

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

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

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

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

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

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

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

  Transmit message to socket.

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

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

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

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

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

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

  Accept 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.

5.3.1 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.

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

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

Returns

0 on success, otherwise negative error code

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

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

Returns

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see Device Profiles.

Rescheduling: possible.

See also

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

Examples:

rtcanrecv.c, and rtcansend.c.

5.3.2.3 int rt_dev_close (int *fd*)

Close a device or socket.

Parameters

in	*fd*	File descriptor as returned by rt_dev_open() or rt_dev-_socket()

Returns

0 on success, otherwise a negative error code.

Note

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

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

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

Returns

0 on success, otherwise negative error code

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

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

Returns

0 on success, otherwise negative error code

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

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

Returns

0 on success, otherwise negative error code

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

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

Returns

0 on success, otherwise negative error code

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

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

Returns

Positiv value on success, otherwise negative error code

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 incomming connection requests.

Parameters

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

Returns

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see Device Profiles.

Rescheduling: possible.

See also

`lsiten()` 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

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

Returns

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

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

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

Returns

Number of bytes read, otherwise negative error code

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

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

Returns

Number of bytes received, otherwise negative error code

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

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

Returns

Number of bytes received, otherwise negative error code

Environments:

Depends on driver implementation, see Device Profiles.

Rescheduling: possible.

See also

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

References rt_dev_recvfrom().

Referenced by rt_dev_recvfrom().

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

Receive message from socket.

Parameters

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

Returns

Number of bytes received, otherwise negative error code

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

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

Returns

Number of bytes sent, otherwise negative error code

Environments:

Depends on driver implementation, see Device Profiles.

Rescheduling: possible.

See also

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

Examples:

rtcansend.c.

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

Transmit message to socket.

Parameters

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

Returns

Number of bytes sent, otherwise negative error code

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

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

Returns

Number of bytes sent, otherwise negative error code

Environments:

Depends on driver implementation, see Device Profiles.

Rescheduling: possible.

See also

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

Examples:

rtcansend.c.

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

Set socket option.

Parameters

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

Returns

0 on success, otherwise negative error code

Environments:

Depends on driver implementation, see Device Profiles.

Rescheduling: possible.

See also

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

Examples:

rtcanrecv.c, and rtcansend.c.

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

Shut down parts of a connection.

Parameters

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

Returns

0 on success, otherwise negative error code

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

`in`	*protocol_-family*	Protocol family (`PF_xxx`)
`in`	*socket_-type*	Socket type (`SOCK_xxx`)
`in`	*protocol*	Protocol ID, 0 for default

Returns

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

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

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

Returns

Number of bytes written, otherwise negative error code

Environments:

Depends on driver implementation, see Device Profiles.

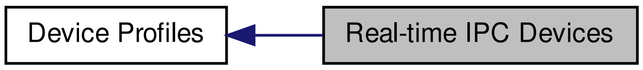
Rescheduling: possible.

See also

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

5.4 Real-time IPC Devices

Collaboration diagram for Real-time IPC Devices:



Files

- file rtipc.h

  This file is part of the Xenomai project.

5.4.1 Detailed Description

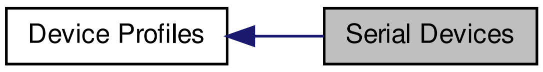
Profile Revision: 1

Device Characteristics

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

5.5 Serial Devices

Collaboration diagram for Serial Devices:



Data Structures

- struct rtser_config

  Serial device configuration.
- struct rtser_status

  Serial device status.
- struct rtser_event

  Additional information about serial device events.

Files

- file rtserial.h

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

Defines

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

  Set or clear break on UART output line.

RTSER_DEF_BAUD

Default baud rate

- #define **RTSER_DEF_BAUD** 9600

RTSER_xxx_PARITY

Number of parity bits

- #define **RTSER_NO_PARITY** 0x00
- #define **RTSER_ODD_PARITY** 0x01
- #define **RTSER_EVEN_PARITY** 0x03
- #define **RTSER_DEF_PARITY** RTSER_NO_PARITY

RTSER_xxx_BITS

Number of data bits

- #define **RTSER_5_BITS** 0x00
- #define **RTSER_6_BITS** 0x01
- #define **RTSER_7_BITS** 0x02
- #define **RTSER_8_BITS** 0x03
- #define **RTSER_DEF_BITS** RTSER_8_BITS

RTSER_xxx_STOPB

Number of stop bits

- #define RTSER_1_STOPB 0x00

  valid only in combination with 5 data bits
- #define RTSER_1_5_STOPB 0x01

  valid only in combination with 5 data bits
- #define RTSER_2_STOPB 0x01

  valid only in combination with 5 data bits
- #define RTSER_DEF_STOPB RTSER_1_STOPB

  valid only in combination with 5 data bits

RTSER_xxx_HAND

Handshake mechanisms

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

RTSER_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_EMTPY** 0x20
- #define **RTSER_LSR_TRANSM_EMPTY** 0x40
- #define **RTSER_LSR_FIFO_ERR** 0x80
- #define **RTSER_SOFT_OVERRUN_ERR** 0x0100

RTSER_MSR_xxx

Modem status bits

- #define **RTSER_MSR_DCTS** 0x01
- #define **RTSER_MSR_DDSR** 0x02
- #define **RTSER_MSR_TERI** 0x04
- #define **RTSER_MSR_DDCD** 0x08
- #define **RTSER_MSR_CTS** 0x10
- #define **RTSER_MSR_DSR** 0x20
- #define **RTSER_MSR_RI** 0x40
- #define **RTSER_MSR_DCD** 0x80

RTSER_MCR_xxx

Modem control bits

- #define **RTSER_MCR_DTR** 0x01
- #define **RTSER_MCR_RTS** 0x02
- #define **RTSER_MCR_OUT1** 0x04
- #define **RTSER_MCR_OUT2** 0x08
- #define **RTSER_MCR_LOOP** 0x10

RTSER_BREAK_xxx

Break control

- typedef struct rtser_config rtser_config_t

    Serial device configuration.
- typedef struct rtser_status rtser_status_t

    Serial device status.
- typedef struct rtser_event rtser_event_t

    Additional information about serial device events.
- #define RTSER_BREAK_CLR 0x00

    Serial device configuration.
- #define RTSER_BREAK_SET 0x01

    Serial device configuration.
- #define RTIOC_TYPE_SERIAL RTDM_CLASS_SERIAL

    Serial device configuration.

Sub-Classes of RTDM_CLASS_SERIAL

- #define **RTDM_SUBCLASS_16550A** 0

IOCTLs

Serial device IOCTLs

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

    Get serial device configuration.
- #define RTSER_RTIOC_SET_CONFIG _IOW(RTIOC_TYPE_SERIAL, 0x01, struct rtser_config)

    Set serial device configuration.
- #define RTSER_RTIOC_GET_STATUS _IOR(RTIOC_TYPE_SERIAL, 0x02, struct rtser_status)

    Get serial device status.
- #define RTSER_RTIOC_GET_CONTROL _IOR(RTIOC_TYPE_SERIA-L, 0x03, int)

    Get serial device's modem contol register.
- #define RTSER_RTIOC_SET_CONTROL _IOW(RTIOC_TYPE_SERIA-L, 0x04, int)

    Set serial device's modem contol register.
- #define RTSER_RTIOC_WAIT_EVENT _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_event)

    Wait on serial device events according to previously set mask.

5.5.1 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: 3

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

5.5.2 Define Documentation

5.5.2.1 #define RTSER_RTIOC_BREAK_CTL _IOR(RTIOC_TYPE_SERIAL, 0x06, int)

Set or clear break on UART output line.

Parameters

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

Returns

0 on success, otherwise negative error code

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.

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

Get serial device configuration.

Parameters

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

Returns

0 on success, otherwise negative error code

Environments:

This service can be called from:

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

Rescheduling: never.

5.5.2.3 #define RTSER_RTIOC_GET_CONTROL _IOR(RTIOC_TYPE_SERIAL, 0x03, int)

Get serial device's modem contol register.

Parameters

`out`	*arg*	Pointer to variable receiving the content (int, see RT-SER_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.

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

Get serial device status.

Parameters

`out`	*arg*	Pointer to status buffer (struct rtser_status)

Returns

0 on success, otherwise negative error code

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 occured during previous read accesses to the device will be saved for being reported via this IOCTL. Upon return from `RTSER_RTIOC_GET_STATUS`, the saved state will be cleared.

Rescheduling: never.

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

Set serial device configuration.

Parameters

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

Returns

0 on success, otherwise:

- -EPERM is returned if the caller's context is invalid, see note below.
- -ENOMEM is returned if a new history buffer for timestamps cannot be allocated.

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.

5.5.2.6 #define RTSER_RTIOC_SET_CONTROL _IOW(RTIOC_TYPE_SERIAL, 0x04, int)

Set serial device's modem contol register.

Parameters

in	*arg*	New control register content (int, see RTSER_MCR_-xxx)

Returns

0 on success, otherwise negative error code

Environments:

This service can be called from:

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

Rescheduling: never.

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

Wait on serial device events according to previously set mask.

Parameters

out	*arg*	Pointer to event information buffer (struct rtser_event)

Returns

0 on success, otherwise:

- -EBUSY is returned if another task is already waiting on events of this device.
- -EBADF is returned if the file descriptor is invalid or the device has just been closed.

Environments:

This service can be called from:

- Kernel-based task

- User-space task (RT)

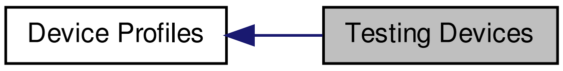
Rescheduling: possible.

Examples:

cross-link.c.

5.6 Testing Devices

Collaboration diagram for Testing Devices:



Files

- file rttesting.h

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

Sub-Classes of RTDM_CLASS_TESTING

- #define RTDM_SUBCLASS_TIMERBENCH 0

  subclass name: "timerbench"
- #define RTDM_SUBCLASS_IRQBENCH 1

  subclass name: "irqbench"
- #define RTDM_SUBCLASS_SWITCHTEST 2

  subclass name: "switchtest"
- #define RTDM_SUBCLASS_RTDMTEST 3

  subclase name: "rtdm"

IOCTLs

Testing device IOCTLs

- #define **RTTST_RTIOC_INTERM_BENCH_RES** _IOWR(RTIOC_TYPE_TESTING, 0x00, struct rttst_interm_bench_res)
- #define **RTTST_RTIOC_TMBENCH_START** _IOW(RTIOC_TYPE_TESTING, 0x10, struct rttst_tmbench_config)
- #define **RTTST_RTIOC_TMBENCH_STOP** _IOWR(RTIOC_TYPE_TESTING, 0x11, struct rttst_overall_bench_res)
- #define **RTTST_RTIOC_IRQBENCH_START** _IOW(RTIOC_TYPE_TESTING, 0x20, struct rttst_irqbench_config)
- #define **RTTST_RTIOC_IRQBENCH_STOP** _IO(RTIOC_TYPE_TESTING, 0x21)

- #define **RTTST_RTIOC_IRQBENCH_GET_STATS** _IOR(RTIOC_TYPE_TESTING, 0x22, struct rttst_irqbench_stats)
- #define **RTTST_RTIOC_IRQBENCH_WAIT_IRQ** _IO(RTIOC_TYPE_TESTING, 0x23)
- #define **RTTST_RTIOC_IRQBENCH_REPLY_IRQ** _IO(RTIOC_TYPE_TESTING, 0x24)
- #define **RTTST_RTIOC_SWTEST_SET_TASKS_COUNT** _IOW(RTIOC_TYPE_TESTING, 0x30, unsigned long)
- #define **RTTST_RTIOC_SWTEST_SET_CPU** _IOW(RTIOC_TYPE_TESTING, 0x31, unsigned long)
- #define **RTTST_RTIOC_SWTEST_REGISTER_UTASK** _IOW(RTIOC_TYPE_TESTING, 0x32, struct rttst_swtest_task)
- #define **RTTST_RTIOC_SWTEST_CREATE_KTASK** _IOWR(RTIOC_TYPE_TESTING, 0x33, struct rttst_swtest_task)
- #define **RTTST_RTIOC_SWTEST_PEND** _IOR(RTIOC_TYPE_TESTING, 0x34, struct rttst_swtest_task)
- #define **RTTST_RTIOC_SWTEST_SWITCH_TO** _IOR(RTIOC_TYPE_TESTING, 0x35, struct rttst_swtest_dir)
- #define **RTTST_RTIOC_SWTEST_GET_SWITCHES_COUNT** _IOR(RTIOC_TYPE_TESTING, 0x36, unsigned long)
- #define **RTTST_RTIOC_SWTEST_GET_LAST_ERROR** _IOR(RTIOC_TYPE_TESTING, 0x37, struct rttst_swtest_error)
- #define **RTTST_RTIOC_SWTEST_SET_PAUSE** _IOW(RTIOC_TYPE_TESTING, 0x38, unsigned long)
- #define **RTTST_RTIOC_RTDM_DEFER_CLOSE** _IOW(RTIOC_TYPE_TESTING, 0x40, unsigned long)

5.6.1 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: 2

Device Characteristics

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

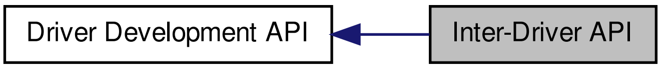
Supported Operations

Open
Environments: non-RT (RT optional, deprecated)
Specific return values: none
Close
Environments: non-RT (RT optional, deprecated)

Specific return values: none
IOCTL
Mandatory Environments: see TSTIOCTLs below
Specific return values: see TSTIOCTLs below

5.7 Inter-Driver API

Collaboration diagram for Inter-Driver API:



Functions

- struct rtdm_dev_context ∗ rtdm_context_get (int fd)

  Retrieve and lock a device context.
- int rtdm_select_bind (int fd, rtdm_selector_t ∗selector, enum rtdm_-selecttype type, unsigned fd_index)

  Bind a selector to specified event types of a given file descriptor.
- 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.
- void rtdm_context_put (struct rtdm_dev_context ∗context)

  Release a device context obtained via rtdm_context_get()
- int rtdm_open (const char ∗path, int oflag,...)

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

  Create a socket.
- int rtdm_close (int fd)

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

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

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

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

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

  Receive message from socket.

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

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

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

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

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

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

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

  Listen for incomming 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.

5.7.1 Function Documentation

5.7.1.1 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.

5.7.1.2 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.

5.7.1.3 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.

5.7.1.4 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.

5.7.1.5 struct **rtdm_dev_context*** **rtdm_context_get** (int *fd*) `[read]`

Retrieve and lock a device context.

Parameters

`in`	*fd*	File descriptor

Returns

Pointer to associated device context, or NULL on error

Note

The device context has to be unlocked using rtdm_context_put() 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.

References rtdm_dev_context::close_lock_count, and rtdm_dev_context::fd.

Referenced by rtdm_select_bind().

5.7.1.6 void **rtdm_context_lock** (struct **rtdm_dev_context** * *context*)

Increment context reference counter.

Parameters

in	*context*	Device context

Note

rtdm_context_get() automatically increments the lock counter. You only need to call this function in special scenarios, e.g. when keeping additional references to the context structure that have different lifetimes. Only use rtdm_context_lock() on contexts that are currently locked via an earlier rtdm_context_get()/rtdm_contex_lock() or while running a device operation handler.

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.

5.7.1.7 void **rtdm_context_put** (struct **rtdm_dev_context** * *context*)

Release a device context obtained via rtdm_context_get()

Parameters

in	*context*	Device context

Note

Every successful call to rtdm_context_get() must be matched by a rtdm_-context_put() 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.

5.7.1.8 void **rtdm_context_unlock** (struct **rtdm_dev_context** ∗ *context*)

Decrement context reference counter.

Parameters

in	*context*	Device context

Note

Every call to rtdm_context_locked() 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.

Referenced by rtdm_select_bind().

5.7.1.9 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.

5.7.1.10 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.

5.7.1.11 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.

5.7.1.12 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.

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

Listen for incomming connection requests.

Refer to rt_dev_listen() for parameters and return values

Environments:

Depends on driver implementation, see Device Profiles.

Rescheduling: possible.

5.7.1.14 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.

5.7.1.15 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.

5.7.1.16 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.

5.7.1.17 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.

5.7.1.18 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.

5.7.1.19 int rtdm_select_bind (int *fd*, rtdm_selector_t ∗ *selector*, enum rtdm_selecttype *type*, unsigned *fd_index*)

Bind a selector to specified event types of a given file descriptor.

This function is invoked by higher RTOS layers implementing select-like services. It shall not be called directly by RTDM drivers.

Parameters

`in`	*fd*	File descriptor to bind to
`in,out`	*selector*	Selector object that shall be bound to the given event
`in`	*type*	Event type the caller is interested in
`in`	*fd_index*	Index in the file descriptor set of the caller

Returns

0 on success, otherwise:

- -EBADF is returned if the file descriptor *fd* cannot be resolved.
- -EINVAL is returned if *type* or *fd_index* are invalid.

Environments:

This service can be called from:

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

Rescheduling: never.

References rtdm_dev_context::ops, rtdm_context_get(), rtdm_context_unlock(), and rtdm_operations::select_bind.

5.7.1.20 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.

5.7.1.21 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.

5.7.1.22 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.

5.7.1.23 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.

5.7.1.24 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.

5.7.1.25 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.

5.7.1.26 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.

5.8 Device Registration Services

Collaboration diagram for Device Registration Services:

Driver Development API
Device Registration Services
Synchronisation Services

Data Structures

- struct rtdm_operations

  Device operations.
- struct rtdm_dev_context

  Device context.
- struct rtdm_device

  RTDM device.

Modules

- Synchronisation Services

Functions

- static void * rtdm_context_to_private (struct rtdm_dev_context *context)

  Locate the driver private area associated to a device context structure.
- static struct rtdm_dev_context * rtdm_private_to_context (void *dev_-private)

  Locate a device context structure from its driver private area.
- int rtdm_dev_register (struct rtdm_device *device)

  Register a RTDM device.
- int rtdm_dev_unregister (struct rtdm_device *device, unsigned int poll_-delay)

  Unregisters a RTDM device.

Device Flags

Static flags describing a RTDM device

- #define RTDM_EXCLUSIVE 0x0001

  If set, only a single instance of the device can be requested by an application.
- #define RTDM_NAMED_DEVICE 0x0010

  If set, the device is addressed via a clear-text name.
- #define RTDM_PROTOCOL_DEVICE 0x0020

  If set, the device is addressed via a combination of protocol ID and socket type.
- #define RTDM_DEVICE_TYPE_MASK 0x00F0

  Mask selecting the device type.

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 /* first user-definable flag */

  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 5

  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 __user ∗arg)

  IOCTL handler.
- typedef int(∗ rtdm_select_bind_handler_t)(struct rtdm_dev_context ∗context, rtdm_selector_t ∗selector, enum rtdm_selecttype type, unsigned fd_index)

  Select binding 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(∗ rtdm_write_handler_t)(struct rtdm_dev_context ∗context, rtdm_user_info_t ∗user_info, const void ∗buf, size_t nbyte)

  Write handler.
- typedef ssize_t(∗ rtdm_recvmsg_handler_t)(struct rtdm_dev_context ∗context, rtdm_user_info_t ∗user_info, struct msghdr ∗msg, int flags)

  Receive message handler.
- 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.

5.8.1 Define Documentation

5.8.1.1 #define RTDM_CLOSING 1

Set by RTDM when the device is being closed.

5.8.1.2 #define RTDM_CREATED_IN_NRT 0

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

5.8.1.3 #define RTDM_DEVICE_TYPE_MASK 0x00F0

Mask selecting the device type.

Referenced by rtdm_dev_register(), and rtdm_dev_unregister().

5.8.1.4 #define RTDM_EXCLUSIVE 0x0001

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

Referenced by rtdm_dev_register().

5.8.1.5 #define RTDM_NAMED_DEVICE 0x0010

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

Referenced by rtdm_dev_register(), and rtdm_dev_unregister().

5.8.1.6 #define RTDM_PROTOCOL_DEVICE 0x0020

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

Referenced by rtdm_dev_register().

5.8.2 Typedef Documentation

5.8.2.1 typedef int(∗ rtdm_close_handler_t)(struct rtdm_dev_context ∗context, rtdm_user_info_t ∗user_info)

Close handler.

Parameters

`in`	*context*	Context structure associated with opened device instance
`in`	*user_info*	Opaque pointer to information about user mode caller, NULL if kernel mode or deferred user mode call

Returns

0 on success. On failure return either -ENOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, -EAGAIN to request a recall after a grace period, or a valid negative error code according to IEEE Std 1003.1.

Note

Drivers must be prepared for that case that the close handler is invoked more than once per open context (even if the handler already completed an earlier run successfully). The driver has to avoid releasing resources twice as well as returning false errors on successive close invocations.

See also

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

5.8.2.2 typedef int(* **rtdm_ioctl_handler_t**)(struct **rtdm_dev_context** *context, rtdm_user_info_t *user_info, unsigned int request, void __user *arg)

IOCTL handler.

Parameters

`in`	*context*	Context structure associated with opened device instance
`in`	*user_info*	Opaque pointer to information about user mode caller, NULL if kernel mode call
`in`	*request*	Request number as passed by the user
`in,out`	*arg*	Request argument as passed by the user

Returns

A positive value or 0 on success. On failure return either -ENOSYS, to request that the function be called again from the opposite realtime/non-realtime context, or another negative error code.

See also

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

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

Named device open handler.

Parameters

`in`	*context*	Context structure associated with opened device instance
`in`	*user_info*	Opaque pointer to information about user mode caller, NULL if kernel mode call
`in`	*oflag*	Open flags as passed by the user

Returns

0 on success. On failure return either -ENOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, or another negative error code.

See also

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

5.8.2.4 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

`in`	*context*	Context structure associated with opened device instance
`in`	*user_info*	Opaque pointer to information about user mode caller, NULL if kernel mode call
`out`	*buf*	Input buffer as passed by the user
`in`	*nbyte*	Number of bytes the user requests to read

Returns

On success, the number of bytes read. On failure return either -ENOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, or another negative error code.

See also

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

5.8.2.5 typedef ssize_t(* rtdm_recvmsg_handler_t)(struct rtdm_dev_context *context, rtdm_user_info_t *user_info, struct msghdr *msg, int flags)

Receive message handler.

Parameters

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

Returns

On success, the number of bytes received. On failure return either -E-NOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, or another negative error code.

See also

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

5.8.2.6 typedef int(* rtdm_select_bind_handler_t)(struct rtdm_dev_context *context, rtdm_selector_t *selector, enum rtdm_selecttype type, unsigned fd_index)

Select binding handler.

Parameters

`in`	*context*	Context structure associated with opened device instance
`in,out`	*selector*	Object that shall be bound to the given event
`in`	*type*	Event type the selector is interested in
`in`	*fd_index*	Opaque value, to be passed to rtdm_event_select_bind or rtdm_sem_select_bind unmodfied

Returns

0 on success. On failure return either -ENOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, or another negative error code.

5.8.2.7 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

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

Returns

On success, the number of bytes transmitted. On failure return either --ENOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, or another negative error code.

See also

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

5.8.2.8 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

`in`	*context*	Context structure associated with opened device instance
`in`	*user_info*	Opaque pointer to information about user mode caller, NULL if kernel mode call
`in`	*protocol*	Protocol number as passed by the user

Returns

0 on success. On failure return either -ENOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, or another negative error code.

See also

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

5.8.2.9 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

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

Returns

On success, the number of bytes written. On failure return either -ENOSYS, to request that this handler be called again from the opposite realtime/non-realtime context, or another negative error code.

See also

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

5.8.3 Function Documentation

5.8.3.1 static void* **rtdm_context_to_private** (struct **rtdm_dev_context** * *context*) `[inline, static]`

Locate the driver private area associated to a device context structure.

Parameters

`in`	*context*	Context structure associated with opened device instance

Returns

The address of the private driver area associated to *context*.

References rtdm_dev_context::dev_private.

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

Register a RTDM device.

Parameters

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

Returns

0 is returned upon success. Otherwise:

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

- -EAGAIN is returned if some /proc entry cannot be created.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

Rescheduling: never.

References rtdm_operations::close_nrt, rtdm_operations::close_rt, rtdm_-device::context_size, rtdm_device::device_class, rtdm_device::device_flags, rtdm_device::device_name, rtdm_device::device_sub_class, rtdm_device-::driver_version, rtdm_device::open_rt, rtdm_device::ops, rtdm_device::proc-_name, rtdm_device::profile_version, rtdm_device::protocol_family, rtdm_-device::reserved, RTDM_DEVICE_STRUCT_VER, RTDM_DEVICE_TYPE-_MASK, RTDM_EXCLUSIVE, RTDM_NAMED_DEVICE, RTDM_PROTOC-OL_DEVICE, rtdm_operations::select_bind, rtdm_device::socket_rt, rtdm_-device::socket_type, and rtdm_device::struct_version.

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

Unregisters a RTDM device.

Parameters

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

Returns

0 is returned upon success. Otherwise:

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

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

Rescheduling: never.

References rtdm_device::device_flags, rtdm_device::device_name, rtdm_-device::proc_entry, rtdm_device::proc_name, rtdm_device::protocol_family, rtdm_device::reserved, RTDM_DEVICE_TYPE_MASK, RTDM_NAMED_DE-VICE, and rtdm_device::socket_type.

5.8.3.4 static struct **rtdm_dev_context*** **rtdm_private_to_context** (void * *dev_private*) [static, read]

Locate a device context structure from its driver private area.

Parameters

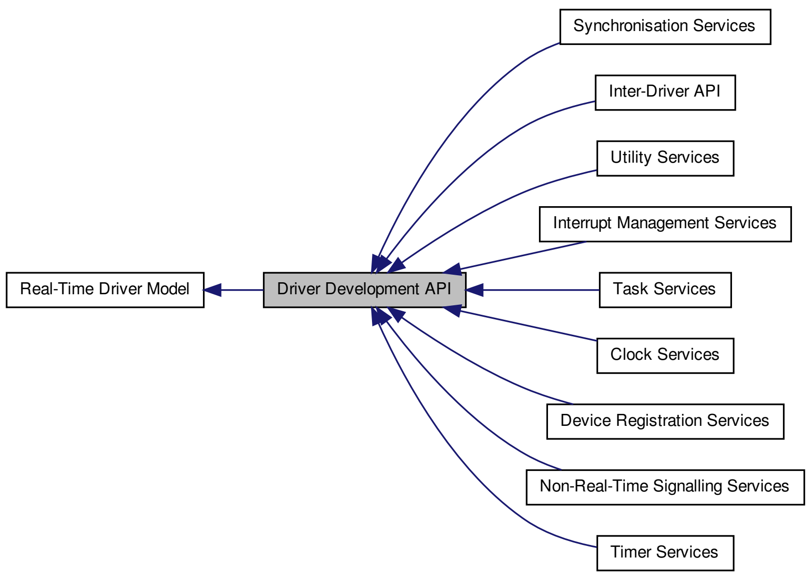
in	*dev_private*	Address of a private context area

Returns

The address of the device context structure defining *dev_private*.

5.9 Driver Development API

Collaboration diagram for Driver Development API:



Modules

- Inter-Driver API
- Device Registration Services
- Clock Services
- Task Services
- Timer Services
- Synchronisation Services
- Interrupt Management Services
- Non-Real-Time Signalling Services
- Utility Services

Files

- file rtdm_driver.h

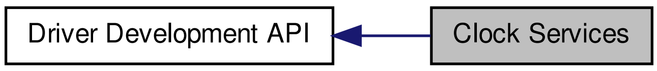
  Real-Time Driver Model for Xenomai, driver API header.

5.9.1 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.

5.10 Clock Services

Collaboration diagram for Clock Services:



Functions

- nanosecs_abs_t rtdm_clock_read (void)

  Get system time.
- nanosecs_abs_t rtdm_clock_read_monotonic (void)

  Get monotonic time.

5.10.1 Function Documentation

5.10.1.1 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.

5.10.1.2 nanosecs_abs_t rtdm_clock_read_monotonic (void)

Get monotonic time.

Returns

The monotonic time in nanoseconds is returned

Note

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

Environments:

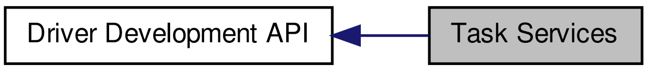
This service can be called from:

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

Rescheduling: never.

5.11 Task Services

Collaboration diagram for Task Services:



Typedefs

- typedef void(∗ rtdm_task_proc_t)(void ∗arg)

  Real-time task procedure.

Functions

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

  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.
- int rtdm_task_sleep (nanosecs_rel_t delay)

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

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

  Sleep until a specified absolute time.

- void rtdm_task_join_nrt (rtdm_task_t *task, unsigned int poll_delay)

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

  Busy-wait a specified amount of time.

Task Priority Range

Maximum and minimum task priorities

- #define **RTDM_TASK_LOWEST_PRIORITY** XNSCHED_LOW_PRIO
- #define **RTDM_TASK_HIGHEST_PRIORITY** XNSCHED_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)

5.11.1 Typedef Documentation

5.11.1.1 typedef void(* rtdm_task_proc_t)(void *arg)

Real-time task procedure.

Parameters

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

5.11.2 Function Documentation

5.11.2.1 void rtdm_task_busy_sleep (nanosecs_rel_t *delay*)

Busy-wait a specified amount of time.

Parameters

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

Note

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

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).

5.11.2.2 rtdm_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.

5.11.2.3 void **rtdm_task_destroy** (rtdm_task_t * *task*)

Destroy a real-time task.

Parameters

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

Note

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

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 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.

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

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

Returns

0 on success, otherwise negative error code

Environments:

This service can be called from:

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

Rescheduling: possible.

5.11.2.5 void **rtdm_task_join_nrt** (rtdm_task_t * *task*, unsigned int *poll_delay*)

Wait on a real-time task to terminate.

Parameters

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

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

Adjust real-time task period.

Parameters

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

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.

5.11.2.7 void **rtdm_task_set_priority** (rtdm_task_t * *task*, int *priority*)

Adjust real-time task priority.

Parameters

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

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.

5.11.2.8 int rtdm_task_sleep (nanosecs_rel_t *delay*)

Sleep a specified amount of time.

Parameters

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

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: always.

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

Sleep until a specified absolute time.

Parameters

in	*wakeup_-time*	Absolute timeout in nanoseconds
in	*mode*	Selects the timer mode, see RTDM_TIMERMODE_-xxx for details

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: always, unless the specified time already passed.

5.11.2.10 int **rtdm_task_sleep_until** (**nanosecs_abs_t** *wakeup_time*)

Sleep until a specified absolute time.

Deprecated Use rtdm_task_sleep_abs instead!

Parameters

in	*wakeup_-time*	Absolute timeout in nanoseconds

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: always, unless the specified time already passed.

5.11.2.11 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.

5.11.2.12 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:

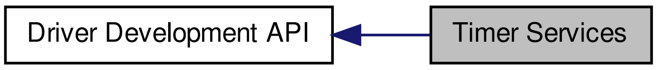
This service can be called from:

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

Rescheduling: always, unless a timer overrun occured.

5.12 Timer Services

Collaboration diagram for Timer Services:



Typedefs

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

  Timer handler.

Functions

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

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

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

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

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

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

  Stop a timer from inside a timer handler.

RTDM_TIMERMODE_xxx

Timer operation modes

- enum rtdm_timer_mode { RTDM_TIMERMODE_RELATIVE = XN_REL-ATIVE, RTDM_TIMERMODE_ABSOLUTE = XN_ABSOLUTE, RTDM_-TIMERMODE_REALTIME = XN_REALTIME }

5.12.1 Typedef Documentation

5.12.1.1 typedef void(∗ rtdm_timer_handler_t)(rtdm_timer_t ∗timer)

Timer handler.

Parameters

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

5.12.2 Enumeration Type Documentation

5.12.2.1 enum rtdm_timer_mode

Enumerator:

RTDM_TIMERMODE_RELATIVE Monotonic timer with relative timeout.

RTDM_TIMERMODE_ABSOLUTE Monotonic timer with absolute timeout.

RTDM_TIMERMODE_REALTIME Adjustable timer with absolute timeout.

5.12.3 Function Documentation

5.12.3.1 void rtdm_timer_destroy (rtdm_timer_t ∗ *timer*)

Destroy a timer.

Parameters

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

Environments:

This service can be called from:

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

Rescheduling: never.

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

Initialise a timer.

Parameters

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

Returns

0 on success, otherwise negative error code

Environments:

This service can be called from:

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

Rescheduling: never.

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

Start a timer.

Parameters

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

Returns

0 on success, otherwise:

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

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.

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

Start a timer from inside a timer handler.

Parameters

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

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

- Timer handler

Rescheduling: never.

5.12.3.5 void **rtdm_timer_stop** (rtdm_timer_t * *timer*)

Stop a timer.

Parameters

`in,out`	*timer*	Timer handle as returned by rtdm_timer_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.

5.12.3.6 void **rtdm_timer_stop_in_handler** (rtdm_timer_t * *timer*)

Stop a timer from inside a timer handler.

Parameters

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

Environments:

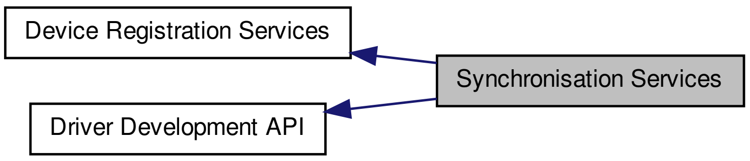
This service can be called from:

- Timer handler

Rescheduling: never.

5.13 Synchronisation Services

Collaboration diagram for Synchronisation Services:



Functions

- int rtdm_select_bind (int fd, rtdm_selector_t ∗selector, enum rtdm_-selecttype type, unsigned fd_index)

  Bind a selector to specified event types of a given file descriptor.

RTDM_SELECTTYPE_xxx

Event types select can bind to

- enum rtdm_selecttype { RTDM_SELECTTYPE_READ = XNSELECT_R-EAD, RTDM_SELECTTYPE_WRITE = XNSELECT_WRITE, RTDM_SE-LECTTYPE_EXCEPT = XNSELECT_EXCEPT }

Global Lock across Scheduler Invocation

- #define RTDM_EXECUTE_ATOMICALLY(code_block)

  Execute code block atomically.

Spinlock with Preemption Deactivation

- typedef rthal_spinlock_t rtdm_lock_t

  Lock variable.
- typedef unsigned long rtdm_lockctx_t

  Variable to save the context while holding a lock.
- #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.

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 rtdm_event_destroy (rtdm_event_t *event)

  Destroy an event.
- void rtdm_event_pulse (rtdm_event_t *event)

  Signal an event occurrence to currently listening waiters.
- void rtdm_event_signal (rtdm_event_t *event)

  Signal an event occurrence.
- int rtdm_event_wait (rtdm_event_t *event)

  Wait on event occurrence.
- int rtdm_event_timedwait (rtdm_event_t *event, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)

  Wait on event occurrence with timeout.
- void rtdm_event_clear (rtdm_event_t *event)

  Clear event state.
- int rtdm_event_select_bind (rtdm_event_t *event, rtdm_selector_-t *selector, enum rtdm_selecttype type, unsigned fd_index)

  Bind a selector to an event.

Semaphore Services

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

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

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

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

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

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

  Bind a selector to a semaphore.

Mutex Services

- void rtdm_mutex_init (rtdm_mutex_t *mutex)

  Initialise a mutex.
- void rtdm_mutex_destroy (rtdm_mutex_t *mutex)

  Destroy a mutex.
- void rtdm_mutex_unlock (rtdm_mutex_t *mutex)

  Release a mutex.
- int rtdm_mutex_lock (rtdm_mutex_t *mutex)

  Request a mutex.
- int rtdm_mutex_timedlock (rtdm_mutex_t *mutex, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)

  Request a mutex with timeout.

5.13.1 Define Documentation

5.13.1.1 #define RTDM_EXECUTE_ATOMICALLY(*code_block*)

Value:

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

Execute code block atomically.

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

Parameters

code_block	Commands to be executed atomically

Note

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

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*.

5.13.1.2 #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.

5.13.1.3 #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.

5.13.1.4 #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.

5.13.1.5 #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.

5.13.1.6 #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.

5.13.1.7 #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.

5.13.1.8 #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.

5.13.2 Enumeration Type Documentation

5.13.2.1 enum rtdm_selecttype

Enumerator:

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

5.13.3 Function Documentation

5.13.3.1 void **rtdm_event_clear** (rtdm_event_t * *event*)

Clear event state.

Parameters

`in,out`	*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.

5.13.3.2 void **rtdm_event_destroy** (rtdm_event_t * *event*)

Destroy an event.

Parameters

`in,out`	*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.

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

Initialise an event.

Parameters

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

Environments:

This service can be called from:

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

Rescheduling: never.

5.13.3.4 void **rtdm_event_pulse** (rtdm_event_t ∗ *event*)

Signal an event occurrence to currently listening waiters.

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

Parameters

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

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.

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

Bind a selector to an event.

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

Parameters

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

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: never.

5.13.3.6 void **rtdm_event_signal** (rtdm_event_t * *event*)

Signal an event occurrence.

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

Parameters

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

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.

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

Wait on event occurrence with timeout.

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

Parameters

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

Returns

0 on success, otherwise:

- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.
- -EINTR is returned if calling task has been unblock by a signal or explicitly via rtdm_task_unblock().
- -EIDRM is returned if *event* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.
- -EWOULDBLOCK is returned if a negative *timeout* (i.e., non-blocking operation) has been specified.

Environments:

This service can be called from:

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

Rescheduling: possible.

Referenced by rtdm_event_wait().

5.13.3.8 int **rtdm_event_wait** (rtdm_event_t * *event*)

Wait on event occurrence.

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

Parameters

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

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: possible.

References rtdm_event_timedwait().

5.13.3.9 void **rtdm_mutex_destroy** (rtdm_mutex_t * *mutex*)

Destroy a mutex.

Parameters

`in,out`	*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.

5.13.3.10 void **rtdm_mutex_init** (rtdm_mutex_t * *mutex*)

Initialise a mutex.

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

Parameters

`in,out`	*mutex*	Mutex handle

Environments:

This service can be called from:

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

Rescheduling: never.

5.13.3.11 int **rtdm_mutex_lock** (rtdm_mutex_t * *mutex*)

Request a mutex.

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

Parameters

`in,out`	*mutex*	Mutex handle as returned by rtdm_mutex_init()

Returns

0 on success, otherwise:

- -EIDRM is returned if *mutex* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

- Kernel-based task

- User-space task (RT)

Rescheduling: possible.

References rtdm_mutex_timedlock().

5.13.3.12 int **rtdm_mutex_timedlock** (rtdm_mutex_t * *mutex*, nanosecs_rel_t *timeout*, rtdm_toseq_t * *timeout_seq*)

Request a mutex with timeout.

This function tries to acquire the given mutex. If it is not available, the caller is blocked unless non-blocking operation was selected.

Parameters

`in,out`	*mutex*	Mutex handle as returned by rtdm_mutex_init()
`in`	*timeout*	Relative timeout in nanoseconds, see RTDM_TIMEO-UT_xxx for special values
`in,out`	*timeout_-seq*	Handle of a timeout sequence as returned by rtdm_-toseq_init() or NULL

Returns

0 on success, otherwise:

- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.
- -EWOULDBLOCK is returned if *timeout* is negative and the semaphore value is currently not positive.
- -EIDRM is returned if *mutex* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

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

Rescheduling: possible.

Referenced by rtdm_mutex_lock().

5.13.3.13 void **rtdm_mutex_unlock** (rtdm_mutex_t * *mutex*)

Release a mutex.

This function releases the given mutex, waking up a potential waiter which was blocked upon rtdm_mutex_lock() or rtdm_mutex_timedlock().

Parameters

`in,out`	*mutex*	Mutex handle as returned by rtdm_mutex_init()

Environments:

This service can be called from:

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

Rescheduling: possible.

5.13.3.14 int **rtdm_select_bind** (int *fd*, rtdm_selector_t * *selector*, enum **rtdm_selecttype** *type*, unsigned *fd_index*)

Bind a selector to specified event types of a given file descriptor.

This function is invoked by higher RTOS layers implementing select-like services. It shall not be called directly by RTDM drivers.

Parameters

`in`	*fd*	File descriptor to bind to
`in,out`	*selector*	Selector object that shall be bound to the given event
`in`	*type*	Event type the caller is interested in
`in`	*fd_index*	Index in the file descriptor set of the caller

Returns

0 on success, otherwise:

- -EBADF is returned if the file descriptor *fd* cannot be resolved.
- -EINVAL is returned if *type* or *fd_index* are invalid.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

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

Rescheduling: never.

References rtdm_dev_context::ops, rtdm_context_get(), rtdm_context_-unlock(), and rtdm_operations::select_bind.

5.13.3.15 void **rtdm_sem_destroy** (rtdm_sem_t * *sem*)

Destroy a semaphore.

Parameters

`in,out`	*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.

5.13.3.16 int **rtdm_sem_down** (rtdm_sem_t * *sem*)

Decrement a semaphore.

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

Parameters

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

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: possible.

References rtdm_sem_timeddown().

5.13.3.17 void **rtdm_sem_init** (rtdm_sem_t ∗ *sem*, unsigned long *value*)

Initialise a semaphore.

Parameters

`in,out`	*sem*	Semaphore handle
`in`	*value*	Initial value of the semaphore

Environments:

This service can be called from:

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

Rescheduling: never.

5.13.3.18 int **rtdm_sem_select_bind** (rtdm_sem_t ∗ *sem*, rtdm_selector_t ∗ *selector*, enum **rtdm_selecttype** *type*, unsigned *fd_index*)

Bind a selector to a semaphore.

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

Parameters

`in,out`	*sem*	Semaphore handle as returned by rtdm_sem_init()
`in,out`	*selector*	Selector as passed to the select binding handler
`in`	*type*	Type of the bound event as passed to the select binding handler
`in`	*fd_index*	File descriptor index as passed to the select binding handler

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: never.

5.13.3.19 int **rtdm_sem_timeddown** (rtdm_sem_t * *sem*, **nanosecs_rel_t** *timeout*, rtdm_toseq_t * *timeout_seq*)

Decrement a semaphore with timeout.

This function tries to decrement the given semphore's value if it is positive on entry. If not, the caller is blocked unless non-blocking operation was selected.

Parameters

`in,out`	*sem*	Semaphore handle as returned by rtdm_sem_init()
`in`	*timeout*	Relative timeout in nanoseconds, see RTDM_TIMEOUT_xxx for special values
`in,out`	*timeout_seq*	Handle of a timeout sequence as returned by rtdm_toseq_init() or NULL

Returns

0 on success, otherwise:

- -ETIMEDOUT is returned if the if the request has not been satisfied within the specified amount of time.
- -EWOULDBLOCK is returned if *timeout* is negative and the semaphore value is currently not positive.
- -EINTR is returned if calling task has been unblock by a signal or explicitly via rtdm_task_unblock().

- -EIDRM is returned if *sem* has been destroyed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

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

Rescheduling: possible.

Referenced by rtdm_sem_down().

5.13.3.20 void **rtdm_sem_up** (rtdm_sem_t * *sem*)

Increment a semaphore.

This function increments the given semphore's value, waking up a potential waiter which was blocked upon rtdm_sem_down().

Parameters

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

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.

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

Initialise a timeout sequence.

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

Parameters

in,out	*timeout_-seq*	Timeout sequence handle
in	*timeout*	Relative timeout in nanoseconds, see RTDM_TIMEO-UT_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:

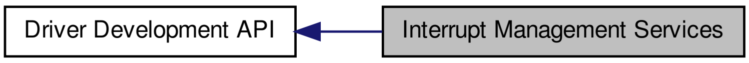
This service can be called from:

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

Rescheduling: never.

5.14 Interrupt Management Services

Collaboration diagram for Interrupt Management Services:



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 rtdm_irq_free (rtdm_irq_t *irq_handle)

  Release an interrupt handler.
- int rtdm_irq_enable (rtdm_irq_t *irq_handle)

  Enable interrupt line.
- int rtdm_irq_disable (rtdm_irq_t *irq_handle)

  Disable interrupt line.

RTDM_IRQTYPE_xxx

Interrupt registrations flags

- #define RTDM_IRQTYPE_SHARED XN_ISR_SHARED

Enable IRQ-sharing with other real-time drivers.
- #define RTDM_IRQTYPE_EDGE XN_ISR_EDGE

  Mark IRQ as edge-triggered, relevant for correct handling of shared edge-triggered IRQs.

RTDM_IRQ_xxx

Return flags of interrupt handlers

- #define RTDM_IRQ_NONE XN_ISR_NONE

  Unhandled interrupt.
- #define RTDM_IRQ_HANDLED XN_ISR_HANDLED

  Denote handled interrupt.

5.14.1 Define Documentation

5.14.1.1 #define **rtdm_irq_get_arg(** *irq_handle, type*) ((type *)irq_handle->cookie)

Retrieve IRQ handler argument.

Parameters

irq_handle	IRQ handle
type	Type of the pointer to return

Returns

The argument pointer registered on rtdm_irq_request() is returned, type-casted to the specified *type*.

Environments:

This service can be called from:

- Interrupt service routine

Rescheduling: never.

5.14.2 Typedef Documentation

5.14.2.1 typedef int(* **rtdm_irq_handler_t**)(rtdm_irq_t *irq_handle)

Interrupt handler.

Parameters

`in`	*irq_handle*	IRQ handle as returned by rtdm_irq_request()

Returns

0 or a combination of RTDM_IRQ_xxx flags

5.14.3 Function Documentation

5.14.3.1 int rtdm_irq_disable (rtdm_irq_t * *irq_handle*)

Disable interrupt line.

Parameters

`in,out`	*irq_handle*	IRQ handle as returned by rtdm_irq_request()

Returns

0 on success, otherwise negative error code

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.

5.14.3.2 int rtdm_irq_enable (rtdm_irq_t * *irq_handle*)

Enable interrupt line.

Parameters

`in,out`	*irq_handle*	IRQ handle as returned by rtdm_irq_request()

Returns

0 on success, otherwise negative error code

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.

5.14.3.3 int **rtdm_irq_free** (rtdm_irq_t * *irq_handle*)

Release an interrupt handler.

Parameters

`in,out`	*irq_handle*	IRQ handle as returned by rtdm_irq_request()

Returns

0 on success, otherwise negative error code

Environments:

This service can be called from:

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

Rescheduling: never.

5.14.3.4 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

`in,out`	*irq_handle*	IRQ handle
`in`	*irq_no*	Line number of the addressed IRQ
`in`	*handler*	Interrupt handler

in	*flags*	Registration flags, see RTDM_IRQTYPE_xxx for details
in	*device_-name*	Device name to show up in real-time IRQ lists
in	*arg*	Pointer to be passed to the interrupt handler on invocation

Returns

0 on success, otherwise:

- -EINVAL is returned if an invalid parameter was passed.
- -EBUSY is returned if the specified IRQ line is already in use.

Environments:

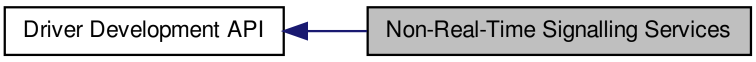
This service can be called from:

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

Rescheduling: never.

5.15 Non-Real-Time Signalling Services

Collaboration diagram for Non-Real-Time Signalling Services:



Typedefs

- typedef void(∗ rtdm_nrtsig_handler_t)(rtdm_nrtsig_t nrt_sig, void ∗arg)

  Non-real-time signal handler.

Functions

- int rtdm_nrtsig_init (rtdm_nrtsig_t ∗nrt_sig, rtdm_nrtsig_handler_t handler, void ∗arg)

  Register a non-real-time signal handler.
- void rtdm_nrtsig_destroy (rtdm_nrtsig_t ∗nrt_sig)

  Release a non-realtime signal handler.
- void rtdm_nrtsig_pend (rtdm_nrtsig_t ∗nrt_sig)

  Trigger non-real-time signal.

5.15.1 Detailed Description

These services provide a mechanism to request the execution of a specified handler in non-real-time context. The triggering can safely be performed in real-time context without suffering from unknown delays. The handler execution will be deferred until the next time the real-time subsystem releases the CPU to the non-real-time part.

5.15.2 Typedef Documentation

5.15.2.1 typedef void(∗ **rtdm_nrtsig_handler_t**)(rtdm_nrtsig_t nrt_sig, void ∗arg)

Non-real-time signal handler.

Parameters

in	*nrt_sig*	Signal handle as returned by rtdm_nrtsig_init()
in	*arg*	Argument as passed to rtdm_nrtsig_init()

Note

The signal handler will run in soft-IRQ context of the non-real-time subsystem. Note the implications of this context, e.g. no invocation of blocking operations.

5.15.3 Function Documentation

5.15.3.1 void **rtdm_nrtsig_destroy** (rtdm_nrtsig_t ∗ *nrt_sig*)

Release a non-realtime signal handler.

Parameters

in,out	*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.

5.15.3.2 int **rtdm_nrtsig_init** (rtdm_nrtsig_t ∗ *nrt_sig*, **rtdm_nrtsig_handler_t** *handler*, void ∗ *arg*)

Register a non-real-time signal handler.

Parameters

in,out	*nrt_sig*	Signal handle
in	*handler*	Non-real-time signal handler
in	*arg*	Custom argument passed to `handler()` on each invocation

Returns

0 on success, otherwise:

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

Environments:

This service can be called from:

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

Rescheduling: never.

5.15.3.3 void **rtdm_nrtsig_pend** (rtdm_nrtsig_t * *nrt_sig*)

Trigger non-real-time signal.

Parameters

`in,out`	*nrt_sig*	Signal handle

Environments:

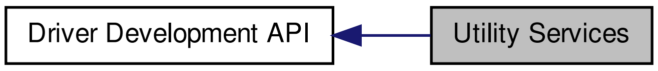
This service can be called from:

- 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.

5.16 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, phys_addr_t src_-addr, size_t len, int prot, void **pptr, struct vm_operations_struct *vm_-ops, void *vm_private_data)

  Map an I/O memory range into the address space of the user.
- int rtdm_munmap (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.
- int rtdm_rt_capable (rtdm_user_info_t ∗user_info)

    Test if the caller is capable of running in real-time context.

5.16.1 Function Documentation

5.16.1.1 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

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

Returns

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

Before invoking this service, verify via rtdm_read_user_ok() that the provided user-space address can securely be accessed.

Environments:

This service can be called from:

- Kernel module initialization/cleanup code

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

Rescheduling: never.

5.16.1.2 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

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

Returns

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

Before invoking this service, verify via rtdm_rw_user_ok() that the provided user-space address can securely be accessed.

Environments:

This service can be called from:

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

Rescheduling: never.

5.16.1.3 void **rtdm_free** (void * *ptr*)

Release real-time memory block.

Parameters

in	*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.

5.16.1.4 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.

5.16.1.5 int **rtdm_iomap_to_user** (rtdm_user_info_t * *user_info,* phys_addr_t *src_addr,* size_t *len,* int *prot,* void ** *pptr,* struct vm_operations_struct * *vm_ops,* void * *vm_private_data*)

Map an I/O memory range into the address space of the user.

Parameters

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

in	*vm_ops*	vm_operations to be executed on the vma_area of the user memory range or NULL
in	*vm_-private_-data*	Private data to be stored in the vma_area, primarily useful for vm_operation handlers

Returns

0 on success, otherwise (most common values):

- -EINVAL is returned if an invalid start address, size, or destination address was passed.
- -ENOMEM is returned if there is insufficient free memory or the limit of memory mapping for the user process was reached.
- -EAGAIN is returned if too much memory has been already locked by the user process.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Note

RTDM supports two models for unmapping the user memory range again. One is explicit unmapping via rtdm_munmap(), either performed when the user requests it via an IOCTL etc. or when the related device is closed. The other is automatic unmapping, triggered by the user invoking standard munmap() or by the termination of the related process. To track release of the mapping and therefore relinquishment of the referenced physical memory, the caller of rtdm_iomap_to_user() can pass a vm_operations-_struct on invocation, defining a close handler for the vm_area. See -Linux documentaion (e.g. Linux Device Drivers book) on virtual memory management for details.

Environments:

This service can be called from:

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

Rescheduling: possible.

5.16.1.6 void* **rtdm_malloc** (size_t *size*)

Allocate memory block in real-time context.

Parameters

in	*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.

5.16.1.7 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

in	*user_info*	User information pointer as passed to the invoked device operation handler
in	*src_addr*	Kernel virtual address to be mapped
in	*len*	Length of the memory range
in	*prot*	Protection flags for the user's memory range, typically either PROT_READ or PROT_READ|PROT_WRITE
in,out	*pptr*	Address of a pointer containing the desired user address or NULL on entry and the finally assigned address on return
in	*vm_ops*	vm_operations to be executed on the vma_area of the user memory range or NULL
in	*vm_private_data*	Private data to be stored in the vma_area, primarily useful for vm_operation handlers

Returns

0 on success, otherwise (most common values):

- -EINVAL is returned if an invalid start address, size, or destination address was passed.
- -ENOMEM is returned if there is insufficient free memory or the limit of memory mapping for the user process was reached.
- -EAGAIN is returned if too much memory has been already locked by the user process.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Note

This service only works on memory regions allocated via kmalloc() or vmalloc(). To map physical I/O memory to user-space use rtdm_iomap-_to_user() instead.
RTDM supports two models for unmapping the user memory range again. One is explicit unmapping via rtdm_munmap(), either performed when the user requests it via an IOCTL etc. or when the related device is closed. The other is automatic unmapping, triggered by the user invoking standard munmap() or by the termination of the related process. To track release of the mapping and therefore relinquishment of the referenced physical memory, the caller of rtdm_mmap_to_user() can pass a vm_operations-_struct on invocation, defining a close handler for the vm_area. See -Linux documentaion (e.g. Linux Device Drivers book) on virtual memory management for details.

Environments:

This service can be called from:

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

Rescheduling: possible.

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

Unmap a user memory range.

Parameters

`in`	*user_info*	User information pointer as passed to rtdm_mmap_-to_user() when requesting to map the memory range
`in`	*ptr*	User address or the memory range
`in`	*len*	Length of the memory range

Returns

0 on success, otherwise:

- -EINVAL is returned if an invalid address or size was passed.
- -EPERM *may* be returned if an illegal invocation environment is detected.

Environments:

This service can be called from:

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

Rescheduling: possible.

5.16.1.9 void **rtdm_printk** (const char ∗ *format,* *...*)

Real-time safe message printing on kernel console.

Parameters

`in`	*format*	Format string (conforming standard `printf()`)
	...	Arguments referred by *format*

Returns

On success, this service returns the number of characters printed. - Otherwise, a negative error code is returned.

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.

5.16.1.10 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

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

Returns

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

Environments:

This service can be called from:

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

Rescheduling: never.

5.16.1.11 int rtdm_rt_capable (rtdm_user_info_t * *user_info*)

Test if the caller is capable of running in real-time context.

Parameters

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

Returns

Non-zero is returned if the caller is able to execute in real-time context (independent of its current execution mode), 0 otherwise.

Note

This function can be used by drivers that provide different implementations for the same service depending on the execution mode of the caller. If a caller requests such a service in non-real-time context but is capable of running in real-time as well, it might be appropriate for the driver to reject the request via -ENOSYS so that RTDM can switch the caller and restart the request in real-time context.

Environments:

This service can be called from:

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

Rescheduling: never.

5.16.1.12 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

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

Returns

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

Environments:

This service can be called from:

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

Rescheduling: never.

5.16.1.13 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

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

Returns

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

This service is a combination of rtdm_read_user_ok and rtdm_copy_from_user.

Environments:

This service can be called from:

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

Rescheduling: never.

5.16.1.14 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

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

Returns

0 on success, otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

This service is a combination of rtdm_rw_user_ok and rtdm_copy_to_user.

Environments:

This service can be called from:

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

Rescheduling: never.

5.16.1.15 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

in	*user_info*	User information pointer as passed to the invoked device operation handler
in	*dst*	Destination buffer address
in	*src*	Address of the user-space string
in	*count*	Maximum number of bytes to copy, including the trailing '0'

Returns

Length of the string on success (not including the trailing '0'), otherwise:

- -EFAULT is returned if an invalid memory area was accessed.

Note

This services already includes a check of the source address, calling rtdm_read_user_ok() for *src* explicitly is not required.

Environments:

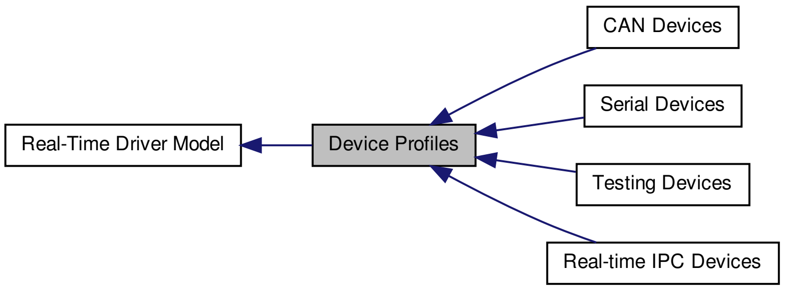
This service can be called from:

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

Rescheduling: never.

5.17 Device Profiles

Collaboration diagram for Device Profiles:



Data Structures

- struct rtdm_device_info

    Device information.

Modules

- CAN Devices
- Real-time IPC Devices
- Serial Devices
- Testing Devices

Typedefs

- typedef struct rtdm_device_info rtdm_device_info_t

    Device information.

RTDM_CLASS_xxx

Device classes

- #define **RTDM_CLASS_PARPORT** 1
- #define **RTDM_CLASS_SERIAL** 2
- #define **RTDM_CLASS_CAN** 3

- #define **RTDM_CLASS_NETWORK** 4
- #define **RTDM_CLASS_RTMAC** 5
- #define **RTDM_CLASS_TESTING** 6
- #define **RTDM_CLASS_RTIPC** 7
- #define **RTDM_CLASS_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.

5.17.1 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.

5.17.2 Define Documentation

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

Retrieve information about a device or socket.

Parameters

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

5.17.2.2 #define RTIOC_PURGE _IOW(RTIOC_TYPE_COMMON, 0x10, int)

Purge internal device or socket buffers.

Parameters

`in`	*arg*	Purge mask, see RTDM_PURGE_xxx_BUFFER

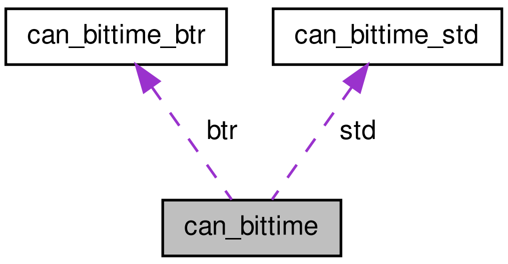
Chapter 6

Data Structure Documentation

6.1 can_bittime Struct Reference

Custom CAN bit-time definition.

Collaboration diagram for can_bittime:



Data Fields

- can_bittime_type_t type

  Type of bit-time definition.
- struct can_bittime_std std

  Standard bit-time.
- struct can_bittime_btr btr

  Hardware-spcific BTR bit-time.

6.1.1 Detailed Description

Custom CAN bit-time definition.

Examples:

rtcanconfig.c.

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

- include/rtdm/rtcan.h

6.2 can_bittime_btr Struct Reference

Hardware-specific BTR bit-times.

Data Fields

- uint8_t btr0

  Bus timing register 0.
- uint8_t btr1

  Bus timing register 1.

6.2.1 Detailed Description

Hardware-specific BTR bit-times.

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

- include/rtdm/rtcan.h

6.3 can_bittime_std Struct Reference

Standard bit-time parameters according to Bosch.

Data Fields

- uint32_t brp

  Baud rate prescaler.
- uint8_t prop_seg

  from 1 to 8
- uint8_t phase_seg1

from 1 to 8

- uint8_t phase_seg2

  from 1 to 8

- uint8_t sjw:7

  from 1 to 4

- uint8_t sam:1

  1 - enable triple sampling

6.3.1 Detailed Description

Standard bit-time parameters according to Bosch.

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

- include/rtdm/rtcan.h

6.4 can_filter Struct Reference

Filter for reception of CAN messages.

Data Fields

- uint32_t can_id

  CAN ID which must match with incoming IDs after passing the mask.

- uint32_t can_mask

  Mask which is applied to incoming IDs.

6.4.1 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, and rtcanrecv.c.

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:

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.

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

- include/rtdm/rtcan.h

6.5 can_frame Struct Reference

Raw CAN frame.

Public Member Functions

- uint8_t data[8] __attribute__ ((aligned(8)))

  Payload data bytes.

Data Fields

- can_id_t can_id

  CAN ID of the frame.
- uint8_t can_dlc

  Size of the payload in bytes.

6.5.1 Detailed Description

Raw CAN frame.

Central structure for receiving and sending CAN frames.

Examples:

rtcan_rtt.c, rtcanrecv.c, and rtcansend.c.

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.

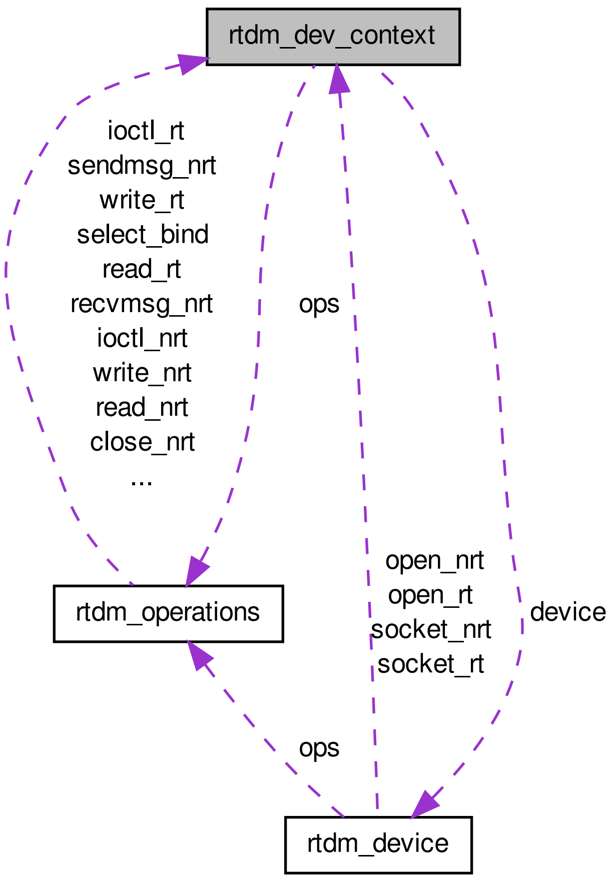
The documentation for this struct was generated from the following file:

- include/rtdm/rtcan.h

6.6 rtdm_dev_context Struct Reference

Device context.

Collaboration diagram for rtdm_dev_context:



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.
- struct rtdm_operations * ops

Set of active device operation handlers.

- struct rtdm_device * device

  Reference to owning device.

- struct rtdm_devctx_reserved reserved

  Data stored by RTDM inside a device context (internal use only)

- char dev_private [0]

  Begin of driver defined context data structure.

6.6.1 Detailed Description

Device context.

A device context structure is associated with every open device instance. R-TDM 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.

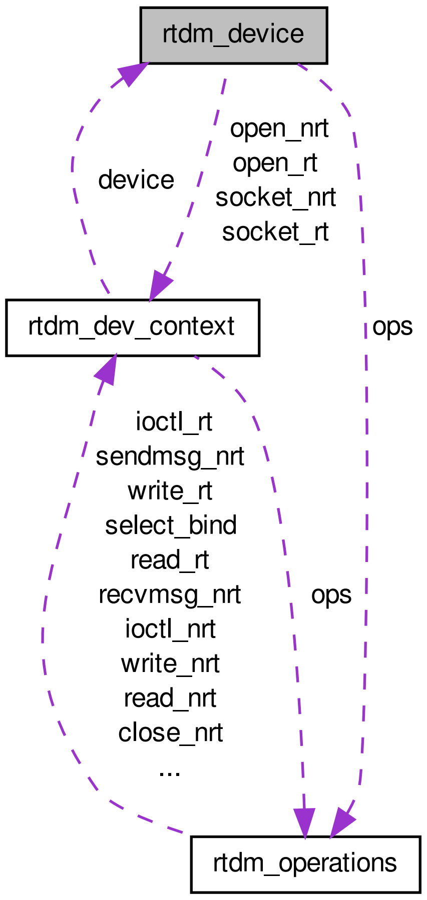
The documentation for this struct was generated from the following file:

- include/rtdm/rtdm_driver.h

6.7 rtdm_device Struct Reference

RTDM device.

Collaboration diagram for rtdm_device:



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 (but deprecated) 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 (but deprecated) 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.
- struct 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.
- struct proc_dir_entry ∗ proc_entry

  Set to device's /proc root entry after registration, do not modify.
- int device_id

  Driver definable device ID.
- void ∗ device_data

  Driver definable device data.
- struct rtdm_dev_reserved reserved

  Data stored by RTDM inside a registered device (internal use only)

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.

6.7.2 Field Documentation

6.7.2.1 rtdm_open_handler_t rtdm_device::open_rt

Named device instance creation for real-time contexts, optional (but deprecated) if open_nrt is non-NULL, ignored for protocol devices.

Deprecated Only use non-real-time open handler in new drivers.

Referenced by rtdm_dev_register().

6.7.2.2 rtdm_socket_handler_t rtdm_device::socket_rt

Protocol socket creation for real-time contexts, optional (but deprecated) if socket_nrt is non-NULL, ignored for named devices.

Deprecated Only use non-real-time socket creation handler in new drivers.

Referenced by rtdm_dev_register().

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

- include/rtdm/rtdm_driver.h

6.8 rtdm_device_info Struct Reference

Device information.

Data Fields

- int device_flags

  Device flags, see Device Flags for details.
- int device_class

  Device class ID, see RTDM_CLASS_xxx.
- int device_sub_class

Device sub-class, either RTDM_SUBCLASS_GENERIC or a RTDM_SUBCLASS_xxx definition of the related Device Profile.

- int profile_version

Supported device profile version.

6.8.1 Detailed Description

Device information.

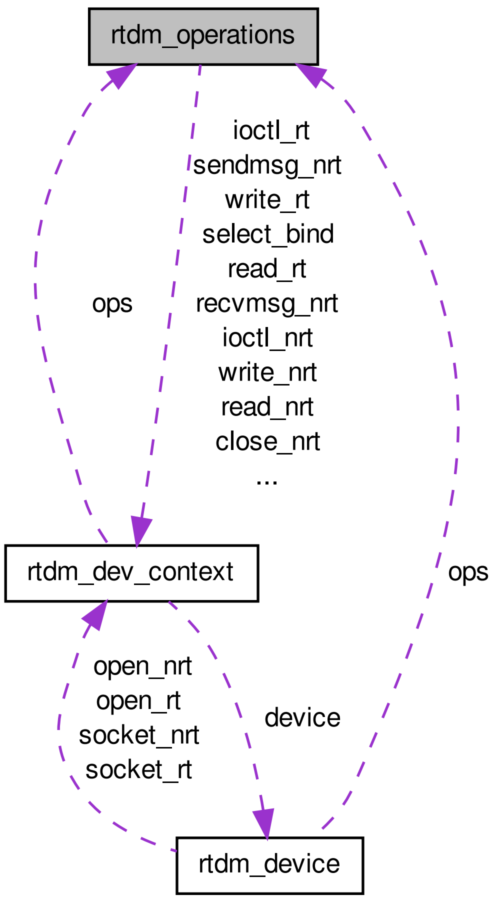
The documentation for this struct was generated from the following file:

- include/rtdm/rtdm.h

6.9 rtdm_operations Struct Reference

Device operations.

Collaboration diagram for rtdm_operations:



Data Fields

Common Operations

- rtdm_close_handler_t close_rt
  Close handler for real-time contexts (optional, deprecated)
- 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)
- rtdm_select_bind_handler_t select_bind
  Select binding handler for any 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)

6.9.1 Detailed Description

Device operations.

6.9.2 Field Documentation

6.9.2.1 rtdm_close_handler_t rtdm_operations::close_rt

Close handler for real-time contexts (optional, deprecated)

Deprecated Only use non-real-time close handler in new drivers.

Referenced by rtdm_dev_register().

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

- include/rtdm/rtdm_driver.h

6.10 rtser_config Struct Reference

Serial device configuration.

Data Fields

- int config_mask

  mask specifying valid fields, see RTSER_SET_xxx
- int baud_rate

  baud rate, default RTSER_DEF_BAUD
- int parity

  number of parity bits, see RTSER_xxx_PARITY
- int data_bits

  number of data bits, see RTSER_xxx_BITS
- int stop_bits

  number of stop bits, see RTSER_xxx_STOPB
- int handshake

  handshake mechanisms, see RTSER_xxx_HAND
- int fifo_depth

  reception FIFO interrupt threshold, see RTSER_FIFO_xxx
- nanosecs_rel_t rx_timeout

  reception timeout, see RTSER_TIMEOUT_xxx for special values
- nanosecs_rel_t tx_timeout

  transmission timeout, see RTSER_TIMEOUT_xxx for special values
- nanosecs_rel_t event_timeout

  event timeout, see RTSER_TIMEOUT_xxx for special values
- int timestamp_history

  enable timestamp history, see RTSER_xxx_TIMESTAMP_HISTORY
- int event_mask

  event mask to be used with RTSER_RTIOC_WAIT_EVENT, see RTSER_E-VENT_xxx

6.10.1 Detailed Description

Serial device configuration.

Examples:

cross-link.c.

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

- include/rtdm/rtserial.h

6.11 rtser_event Struct Reference

Additional information about serial device events.

Data Fields

- int events

  signalled events, see RTSER_EVENT_xxx
- int rx_pending

  number of pending input characters
- nanosecs_abs_t last_timestamp

  last interrupt timestamp
- nanosecs_abs_t rxpend_timestamp

  reception timestamp of oldest character in input queue

6.11.1 Detailed Description

Additional information about serial device events.

Examples:

cross-link.c.

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

- include/rtdm/rtserial.h

6.12 rtser_status Struct Reference

Serial device status.

Data Fields

- int line_status

  line status register, see RTSER_LSR_xxx
- int modem_status

  modem status register, see RTSER_MSR_xxx

6.12.1 Detailed Description

Serial device status.

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

- include/rtdm/rtserial.h

6.13 sockaddr_can Struct Reference

Socket address structure for the CAN address family.

Data Fields

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

6.13.1 Detailed Description

Socket address structure for the CAN address family.

Examples:

rtcan_rtt.c, rtcanrecv.c, and rtcansend.c.

6.13.2 Field Documentation

6.13.2.1 int sockaddr_can::can_ifindex

Interface index of CAN controller.

See SIOCGIFINDEX.

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

- include/rtdm/rtcan.h

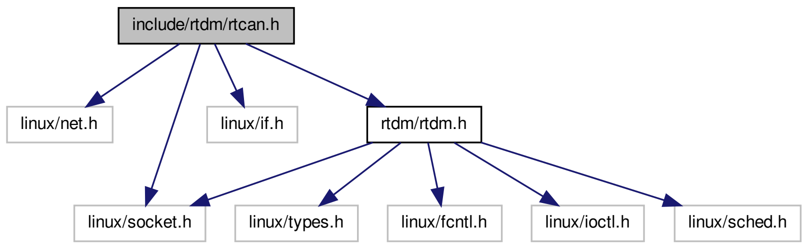
Chapter 7

File Documentation

7.1 include/rtdm/rtcan.h File Reference

Real-Time Driver Model for RT-Socket-CAN, CAN device profile header.

Include dependency graph for rtcan.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.

Defines

- #define AF_CAN 29

  CAN address family.
- #define PF_CAN AF_CAN

  CAN protocol family.
- #define SOL_CAN_RAW 103

  CAN socket levels.

CAN ID masks

Bit masks for masking CAN IDs

- #define CAN_EFF_MASK 0x1FFFFFFF

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

  Bit mask for standard CAN IDs.

CAN ID flags

Flags within a CAN ID indicating special CAN frame attributes

- #define CAN_EFF_FLAG 0x80000000

  Extended frame.
- #define CAN_RTR_FLAG 0x40000000

  Remote transmission frame.
- #define CAN_ERR_FLAG 0x20000000

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

  Invert CAN filter definition, only valid in struct can_filter.

Particular CAN protocols

Possible protocols for the PF_CAN protocol family

Currently only the RAW protocol is supported.

- #define CAN_RAW 1

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

CAN controller modes

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

Note

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

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

Timestamp switches

Arguments to pass to RTCAN_RTIOC_TAKE_TIMESTAMP

- #define RTCAN_TAKE_NO_TIMESTAMPS 0

  Switch off taking timestamps.
- #define RTCAN_TAKE_TIMESTAMPS 1

  Do take timestamps.

RAW socket options

Setting and getting CAN RAW socket options.

- #define CAN_RAW_FILTER 0x1

  CAN filter definition.
- #define CAN_RAW_ERR_FILTER 0x2

  CAN error mask.
- #define CAN_RAW_LOOPBACK 0x3

  CAN TX loopback.
- #define CAN_RAW_RECV_OWN_MSGS 0x4

  CAN receive own messages.

IOCTLs

CAN device IOCTLs

- #define SIOCGIFINDEX defined_by_kernel_header_file

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

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

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

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

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

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

Get current state of CAN controller.

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

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

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

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

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

  Specify a transmission timeout for a socket.

Error mask

Error class (mask) in `can_id` *field of struct can_frame to be used with CAN-_RAW_ERR_FILTER.*

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

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

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

- #define CAN_ERR_TX_TIMEOUT 0x00000001U

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

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

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

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

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

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

  Bus off.
- #define CAN_ERR_BUSERROR 0x00000080U

  Bus error (may flood!)

- #define CAN_ERR_RESTARTED 0x00000100U

  Controller restarted.
- #define CAN_ERR_MASK 0x1FFFFFFFU

  Omit EFF, RTR, ERR flags.

Arbitration lost error

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

- #define CAN_ERR_LOSTARB_UNSPEC 0x00

  unspecified

Controller problems

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

- #define CAN_ERR_CRTL_UNSPEC 0x00

  unspecified
- #define CAN_ERR_CRTL_RX_OVERFLOW 0x01

  RX buffer overflow.
- #define CAN_ERR_CRTL_TX_OVERFLOW 0x02

  TX buffer overflow.
- #define CAN_ERR_CRTL_RX_WARNING 0x04

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

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

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

  reached passive level for TX errors

Protocol error type

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

- #define CAN_ERR_PROT_UNSPEC 0x00

  unspecified
- #define CAN_ERR_PROT_BIT 0x01

  single bit error
- #define CAN_ERR_PROT_FORM 0x02

  frame format error
- #define CAN_ERR_PROT_STUFF 0x04

  bit stuffing error
- #define CAN_ERR_PROT_BIT0 0x08

  unable to send dominant bit
- #define CAN_ERR_PROT_BIT1 0x10

  unable to send recessive bit
- #define CAN_ERR_PROT_OVERLOAD 0x20

  bus overload
- #define CAN_ERR_PROT_ACTIVE 0x40

active error announcement
- #define CAN_ERR_PROT_TX 0x80
  error occured on transmission

Protocol error location

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

- #define CAN_ERR_PROT_LOC_UNSPEC 0x00
  unspecified
- #define CAN_ERR_PROT_LOC_SOF 0x03
  start of frame
- #define CAN_ERR_PROT_LOC_ID28_21 0x02
  ID bits 28 - 21 (SFF: 10 - 3)
- #define CAN_ERR_PROT_LOC_ID20_18 0x06
  ID bits 20 - 18 (SFF: 2 - 0)
- #define CAN_ERR_PROT_LOC_SRTR 0x04
  substitute RTR (SFF: RTR)
- #define CAN_ERR_PROT_LOC_IDE 0x05
  identifier extension
- #define CAN_ERR_PROT_LOC_ID17_13 0x07
  ID bits 17-13.
- #define CAN_ERR_PROT_LOC_ID12_05 0x0F
  ID bits 12-5.
- #define CAN_ERR_PROT_LOC_ID04_00 0x0E
  ID bits 4-0.
- #define CAN_ERR_PROT_LOC_RTR 0x0C
  RTR.
- #define CAN_ERR_PROT_LOC_RES1 0x0D
  reserved bit 1
- #define CAN_ERR_PROT_LOC_RES0 0x09
  reserved bit 0
- #define CAN_ERR_PROT_LOC_DLC 0x0B
  data length code
- #define CAN_ERR_PROT_LOC_DATA 0x0A
  data section
- #define CAN_ERR_PROT_LOC_CRC_SEQ 0x08
  CRC sequence.
- #define CAN_ERR_PROT_LOC_CRC_DEL 0x18
  CRC delimiter.
- #define CAN_ERR_PROT_LOC_ACK 0x19
  ACK slot.
- #define CAN_ERR_PROT_LOC_ACK_DEL 0x1B
  ACK delimiter.
- #define CAN_ERR_PROT_LOC_EOF 0x1A
  end of frame
- #define CAN_ERR_PROT_LOC_INTERM 0x12
  intermission

- #define CAN_ERR_TRX_UNSPEC 0x00

  0000 0000
- #define CAN_ERR_TRX_CANH_NO_WIRE 0x04

  0000 0100
- #define CAN_ERR_TRX_CANH_SHORT_TO_BAT 0x05

  0000 0101
- #define CAN_ERR_TRX_CANH_SHORT_TO_VCC 0x06

  0000 0110
- #define CAN_ERR_TRX_CANH_SHORT_TO_GND 0x07

  0000 0111
- #define CAN_ERR_TRX_CANL_NO_WIRE 0x40

  0100 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_BAT 0x50

  0101 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_VCC 0x60

  0110 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_GND 0x70

  0111 0000
- #define CAN_ERR_TRX_CANL_SHORT_TO_CANH 0x80

  1000 0000

Typedefs

- typedef uint32_t can_id_t

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

  Type of CAN error mask.
- typedef uint32_t can_baudrate_t

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

  See CAN_BITTIME_TYPE.
- typedef enum CAN_MODE can_mode_t

  See CAN_MODE.
- typedef int can_ctrlmode_t

  See CAN_CTRLMODE.
- typedef enum CAN_STATE can_state_t

  See CAN_STATE.
- typedef struct can_filter can_filter_t

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

  Raw CAN frame.

Enumerations

- enum CAN_BITTIME_TYPE { CAN_BITTIME_STD, CAN_BITTIME_BT-R }

  Supported CAN bit-time types.

CAN operation modes

Modes into which CAN controllers can be set

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

CAN controller states

States a CAN controller can be in.

- enum CAN_STATE { CAN_STATE_ACTIVE = 0, CAN_STATE_BU-S_WARNING, CAN_STATE_BUS_PASSIVE, CAN_STATE_BUS_O-FF, CAN_STATE_SCANNING_BAUDRATE, CAN_STATE_STOPP-ED, CAN_STATE_SLEEPING }

7.1.1 Detailed Description

Real-Time Driver Model for RT-Socket-CAN, CAN device profile header.

Note

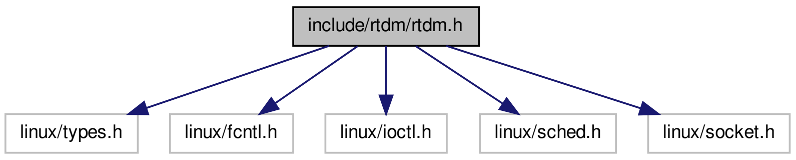
This RTDM CAN device profile header is based on:

include/linux/can.h, include/linux/socket.h, net/can/pf_can.h in linux-can.patch, a CAN socket framework for Linux

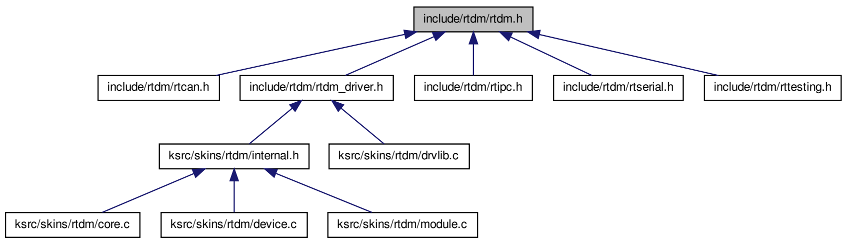
7.2 include/rtdm/rtdm.h File Reference

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

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.

Defines

API Versioning

- #define RTDM_API_VER 8
  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_RTIPC** 7
- #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 struct rtdm_device_info rtdm_device_info_t

  Device information.

7.2.1 Detailed Description

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

Note

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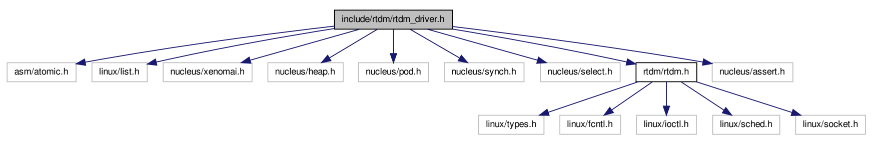
Copyright (C) 2005 Joerg Langenberg <`joerg.langenberg@gmx.net`>

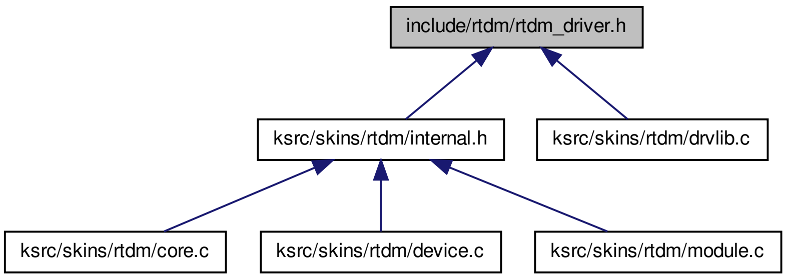
7.3 include/rtdm/rtdm_driver.h File Reference

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

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.

Defines

- #define rtdm_irq_get_arg(irq_handle, type) ((type *)irq_handle->cookie)

  Retrieve IRQ handler argument.

Device Flags

Static flags describing a RTDM device

- #define RTDM_EXCLUSIVE 0x0001

  If set, only a single instance of the device can be requested by an application.
- #define RTDM_NAMED_DEVICE 0x0010

  If set, the device is addressed via a clear-text name.
- #define RTDM_PROTOCOL_DEVICE 0x0020

  If set, the device is addressed via a combination of protocol ID and socket type.
- #define RTDM_DEVICE_TYPE_MASK 0x00F0

  Mask selecting the device type.

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 /* first user-definable flag */

  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 5

  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.

Global Lock across Scheduler Invocation

- #define RTDM_EXECUTE_ATOMICALLY(code_block)

  Execute code block atomically.

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** XNSCHED_LOW_PRIO
- #define **RTDM_TASK_HIGHEST_PRIORITY** XNSCHED_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 int(* rtdm_irq_handler_t)(rtdm_irq_t *irq_handle)
  Interrupt handler.
- typedef void(* rtdm_nrtsig_handler_t)(rtdm_nrtsig_t nrt_sig, void *arg)
  Non-real-time signal handler.
- typedef void(* rtdm_timer_handler_t)(rtdm_timer_t *timer)
  Timer handler.
- typedef void(* rtdm_task_proc_t)(void *arg)
  Real-time task procedure.

Operation Handler Prototypes

- typedef int(* rtdm_open_handler_t)(struct rtdm_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 __user *arg)
  IOCTL handler.
- typedef int(* rtdm_select_bind_handler_t)(struct rtdm_dev_context *context, rtdm_selector_t *selector, enum rtdm_selecttype type, unsigned fd_index)
  Select binding 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(∗ rtdm_write_handler_t)(struct rtdm_dev_context ∗context, rtdm_user_info_t ∗user_info, const void ∗buf, size_t nbyte)
  Write handler.
- typedef ssize_t(∗ rtdm_recvmsg_handler_t)(struct rtdm_dev_context ∗context, rtdm_user_info_t ∗user_info, struct msghdr ∗msg, int flags)
  Receive message handler.
- 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.

Enumerations

RTDM_SELECTTYPE_xxx

Event types select can bind to

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

RTDM_TIMERMODE_xxx

Timer operation modes

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

Functions

- static void ∗ rtdm_context_to_private (struct rtdm_dev_context ∗context)
  Locate the driver private area associated to a device context structure.
- static struct rtdm_dev_context ∗ rtdm_private_to_context (void ∗dev_private)
  Locate a device context structure from its driver private area.
- 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.
- struct rtdm_dev_context ∗ rtdm_context_get (int fd)
  Retrieve and lock a device context.

- int rtdm_select_bind (int fd, rtdm_selector_t ∗selector, enum rtdm_-selecttype type, unsigned fd_index)

  Bind a selector to specified event types of a given file descriptor.
- int rtdm_irq_request (rtdm_irq_t ∗irq_handle, unsigned int irq_no, rtdm-_irq_handler_t handler, unsigned long flags, const char ∗device_name, void ∗arg)

  Register an interrupt handler.
- void rtdm_timer_destroy (rtdm_timer_t ∗timer)

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

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

  Stop a timer.
- int rtdm_task_init (rtdm_task_t ∗task, const char ∗name, rtdm_task_proc-_t task_proc, void ∗arg, int priority, nanosecs_rel_t period)

  Intialise and start a real-time task.
- 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 time-out)

  Initialise a timeout sequence.
- void rtdm_event_init (rtdm_event_t ∗event, unsigned long pending)

  Initialise an event.
- int rtdm_event_select_bind (rtdm_event_t ∗event, rtdm_selector_-t ∗selector, enum rtdm_selecttype type, unsigned fd_index)

  Bind a selector to an event.
- int rtdm_event_wait (rtdm_event_t ∗event)

  Wait on event occurrence.
- int rtdm_event_timedwait (rtdm_event_t ∗event, nanosecs_rel_t timeout, rtdm_toseq_t ∗timeout_seq)

  Wait on event occurrence with timeout.
- void rtdm_event_signal (rtdm_event_t ∗event)

  Signal an event occurrence.
- void rtdm_event_clear (rtdm_event_t ∗event)

  Clear event state.
- void rtdm_sem_init (rtdm_sem_t ∗sem, unsigned long value)

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

  Bind a selector to a semaphore.
- int rtdm_sem_down (rtdm_sem_t ∗sem)

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

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

  Increment a semaphore.
- void rtdm_mutex_init (rtdm_mutex_t ∗mutex)

  Initialise a mutex.
- int rtdm_mutex_lock (rtdm_mutex_t ∗mutex)

  Request a mutex.
- int rtdm_mutex_timedlock (rtdm_mutex_t ∗mutex, nanosecs_rel_t timeout, rtdm_toseq_t ∗timeout_seq)

  Request a mutex with timeout.

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.

7.3.1 Detailed Description

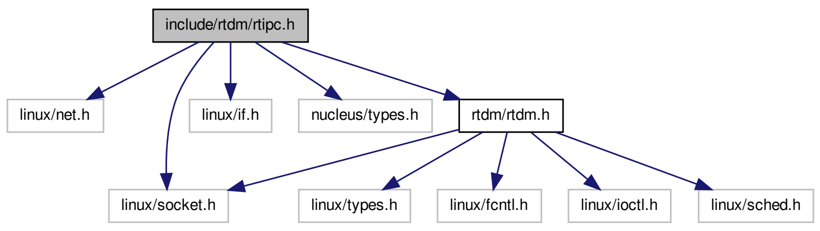
Real-Time Driver Model for Xenomai, driver API header.

Note

7.4 include/rtdm/rtipc.h File Reference

This file is part of the Xenomai project.

Include dependency graph for rtipc.h:



7.4.1 Detailed Description

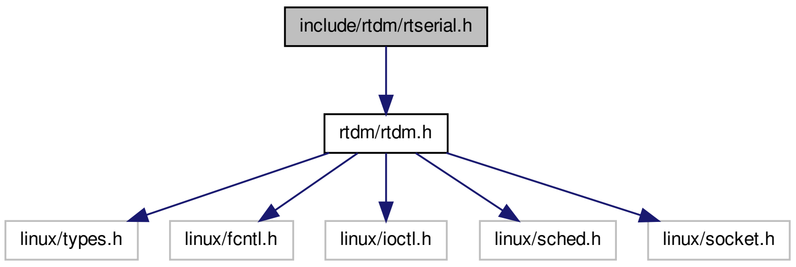
This file is part of the Xenomai project.

Note

7.5 include/rtdm/rtserial.h File Reference

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

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.

Defines

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

  Set or clear break on UART output line.

RTSER_DEF_BAUD

Default baud rate

- #define **RTSER_DEF_BAUD** 9600

RTSER_xxx_PARITY

Number of parity bits

- #define **RTSER_NO_PARITY** 0x00
- #define **RTSER_ODD_PARITY** 0x01
- #define **RTSER_EVEN_PARITY** 0x03
- #define **RTSER_DEF_PARITY** RTSER_NO_PARITY

RTSER_xxx_BITS

Number of data bits

- #define **RTSER_5_BITS** 0x00
- #define **RTSER_6_BITS** 0x01
- #define **RTSER_7_BITS** 0x02
- #define **RTSER_8_BITS** 0x03
- #define **RTSER_DEF_BITS** RTSER_8_BITS

RTSER_xxx_STOPB

Number of stop bits

- #define RTSER_1_STOPB 0x00

  valid only in combination with 5 data bits
- #define RTSER_1_5_STOPB 0x01

  valid only in combination with 5 data bits
- #define RTSER_2_STOPB 0x01

  valid only in combination with 5 data bits
- #define RTSER_DEF_STOPB RTSER_1_STOPB

  valid only in combination with 5 data bits

RTSER_xxx_HAND

Handshake mechanisms

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

RTSER_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_EMTPY** 0x20
- #define **RTSER_LSR_TRANSM_EMPTY** 0x40
- #define **RTSER_LSR_FIFO_ERR** 0x80
- #define **RTSER_SOFT_OVERRUN_ERR** 0x0100

RTSER_MSR_xxx

Modem status bits

- #define **RTSER_MSR_DCTS** 0x01
- #define **RTSER_MSR_DDSR** 0x02
- #define **RTSER_MSR_TERI** 0x04
- #define **RTSER_MSR_DDCD** 0x08
- #define **RTSER_MSR_CTS** 0x10
- #define **RTSER_MSR_DSR** 0x20
- #define **RTSER_MSR_RI** 0x40
- #define **RTSER_MSR_DCD** 0x80

RTSER_MCR_xxx

Modem control bits

- #define **RTSER_MCR_DTR** 0x01
- #define **RTSER_MCR_RTS** 0x02
- #define **RTSER_MCR_OUT1** 0x04
- #define **RTSER_MCR_OUT2** 0x08
- #define **RTSER_MCR_LOOP** 0x10

Sub-Classes of RTDM_CLASS_SERIAL

- #define **RTDM_SUBCLASS_16550A** 0

IOCTLs

Serial device IOCTLs

- #define RTSER_RTIOC_GET_CONFIG _IOR(RTIOC_TYPE_SERIAL, 0x00, struct rtser_config)
  Get serial device configuration.
- #define RTSER_RTIOC_SET_CONFIG _IOW(RTIOC_TYPE_SERIAL, 0x01, struct rtser_config)
  Set serial device configuration.
- #define RTSER_RTIOC_GET_STATUS _IOR(RTIOC_TYPE_SERIAL, 0x02, struct rtser_status)
  Get serial device status.
- #define RTSER_RTIOC_GET_CONTROL _IOR(RTIOC_TYPE_SERIAL, 0x03, int)
  Get serial device's modem contol register.
- #define RTSER_RTIOC_SET_CONTROL _IOW(RTIOC_TYPE_SERIAL, 0x04, int)
  Set serial device's modem contol register.
- #define RTSER_RTIOC_WAIT_EVENT _IOR(RTIOC_TYPE_SERIAL, 0x05, struct rtser_event)
  Wait on serial device events according to previously set mask.

RTSER_BREAK_xxx

Break control

- #define RTSER_BREAK_CLR 0x00

Serial device configuration.

- #define RTSER_BREAK_SET 0x01

  Serial device configuration.

- #define RTIOC_TYPE_SERIAL RTDM_CLASS_SERIAL

  Serial device configuration.

- typedef struct rtser_config rtser_config_t

  Serial device configuration.

- typedef struct rtser_status rtser_status_t

  Serial device status.

- typedef struct rtser_event rtser_event_t

  Additional information about serial device events.

7.5.1 Detailed Description

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

Note

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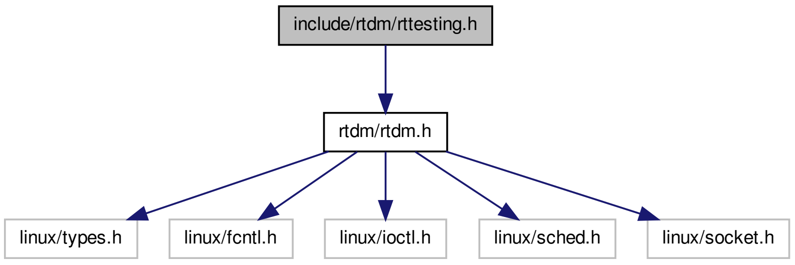
7.6 include/rtdm/rttesting.h File Reference

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

Include dependency graph for rttesting.h:



Defines

Sub-Classes of RTDM_CLASS_TESTING

- #define RTDM_SUBCLASS_TIMERBENCH 0

  subclass name: "timerbench"
- #define RTDM_SUBCLASS_IRQBENCH 1

  subclass name: "irqbench"
- #define RTDM_SUBCLASS_SWITCHTEST 2

  subclass name: "switchtest"
- #define RTDM_SUBCLASS_RTDMTEST 3

  subclase name: "rtdm"

IOCTLs

Testing device IOCTLs

- #define **RTTST_RTIOC_INTERM_BENCH_RES** _IOWR(RTIOC_TYPE_TESTING, 0x00, struct rttst_interm_bench_res)
- #define **RTTST_RTIOC_TMBENCH_START** _IOW(RTIOC_TYPE_TESTING, 0x10, struct rttst_tmbench_config)
- #define **RTTST_RTIOC_TMBENCH_STOP** _IOWR(RTIOC_TYPE_TESTING, 0x11, struct rttst_overall_bench_res)
- #define **RTTST_RTIOC_IRQBENCH_START** _IOW(RTIOC_TYPE_TESTING, 0x20, struct rttst_irqbench_config)
- #define **RTTST_RTIOC_IRQBENCH_STOP** _IO(RTIOC_TYPE_TESTING, 0x21)
- #define **RTTST_RTIOC_IRQBENCH_GET_STATS** _IOR(RTIOC_TYPE_TESTING, 0x22, struct rttst_irqbench_stats)
- #define **RTTST_RTIOC_IRQBENCH_WAIT_IRQ** _IO(RTIOC_TYPE_TESTING, 0x23)
- #define **RTTST_RTIOC_IRQBENCH_REPLY_IRQ** _IO(RTIOC_TYPE_TESTING, 0x24)

- #define **RTTST_RTIOC_SWTEST_SET_TASKS_COUNT** _IOW(RTIOC_TYPE_TESTING, 0x30, unsigned long)
- #define **RTTST_RTIOC_SWTEST_SET_CPU** _IOW(RTIOC_TYPE_TESTING, 0x31, unsigned long)
- #define **RTTST_RTIOC_SWTEST_REGISTER_UTASK** _IOW(RTIOC_TYPE_TESTING, 0x32, struct rttst_swtest_task)
- #define **RTTST_RTIOC_SWTEST_CREATE_KTASK** _IOWR(RTIOC_TYPE_TESTING, 0x33, struct rttst_swtest_task)
- #define **RTTST_RTIOC_SWTEST_PEND** _IOR(RTIOC_TYPE_TESTING, 0x34, struct rttst_swtest_task)
- #define **RTTST_RTIOC_SWTEST_SWITCH_TO** _IOR(RTIOC_TYPE_TESTING, 0x35, struct rttst_swtest_dir)
- #define **RTTST_RTIOC_SWTEST_GET_SWITCHES_COUNT** _IOR(RTIOC_TYPE_TESTING, 0x36, unsigned long)
- #define **RTTST_RTIOC_SWTEST_GET_LAST_ERROR** _IOR(RTIOC_TYPE_TESTING, 0x37, struct rttst_swtest_error)
- #define **RTTST_RTIOC_SWTEST_SET_PAUSE** _IOW(RTIOC_TYPE_TESTING, 0x38, unsigned long)
- #define **RTTST_RTIOC_RTDM_DEFER_CLOSE** _IOW(RTIOC_TYPE_TESTING, 0x40, unsigned long)

7.6.1 Detailed Description

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

Note

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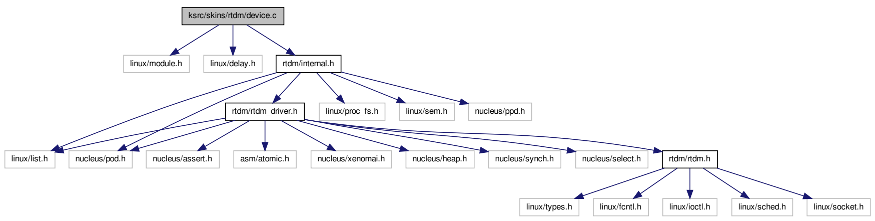
7.7 ksrc/skins/rtdm/device.c File Reference

Real-Time Driver Model for Xenomai, device management.

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.

7.7.1 Detailed Description

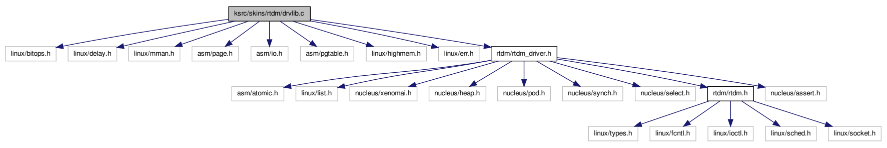
Real-Time Driver Model for Xenomai, device management.

Note

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

Real-Time Driver Model for Xenomai, driver library.

Include dependency graph for drvlib.c:



Functions

- nanosecs_abs_t rtdm_clock_read (void)

  Get system time.
- nanosecs_abs_t rtdm_clock_read_monotonic (void)

  Get monotonic 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.
- int rtdm_task_sleep (nanosecs_rel_t delay)

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

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

  Sleep until a specified absolute time.
- void rtdm_task_join_nrt (rtdm_task_t ∗task, unsigned int poll_delay)

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

  Busy-wait a specified amount of time.
- int rtdm_timer_init (rtdm_timer_t ∗timer, rtdm_timer_handler_t handler, const char ∗name)

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

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

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

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

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

  Stop a timer from inside a timer handler.
- int rtdm_irq_request (rtdm_irq_t ∗irq_handle, unsigned int irq_no, rtdm_irq_handler_t handler, unsigned long flags, const char ∗device_name, void ∗arg)

  Register an interrupt handler.
- int rtdm_irq_free (rtdm_irq_t ∗irq_handle)

  Release an interrupt handler.
- int rtdm_irq_enable (rtdm_irq_t ∗irq_handle)

  Enable interrupt line.
- int rtdm_irq_disable (rtdm_irq_t ∗irq_handle)

  Disable interrupt line.
- int rtdm_nrtsig_init (rtdm_nrtsig_t ∗nrt_sig, rtdm_nrtsig_handler_t handler, void ∗arg)

  Register a non-real-time signal handler.
- void rtdm_nrtsig_destroy (rtdm_nrtsig_t ∗nrt_sig)

  Release a non-realtime signal handler.
- void rtdm_nrtsig_pend (rtdm_nrtsig_t ∗nrt_sig)

  Trigger non-real-time signal.
- 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, phys_addr_t src_addr, size_t len, int prot, void ∗∗pptr, struct vm_operations_struct ∗vm_ops, void ∗vm_private_data)

  Map an I/O memory range into the address space of the user.
- int rtdm_munmap (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.
- int rtdm_rt_capable (rtdm_user_info_t *user_info)

  Test if the caller is capable of running in real-time context.

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 rtdm_event_destroy (rtdm_event_t *event)

  Destroy an event.
- void rtdm_event_pulse (rtdm_event_t *event)

  Signal an event occurrence to currently listening waiters.
- void rtdm_event_signal (rtdm_event_t *event)

  Signal an event occurrence.
- int rtdm_event_wait (rtdm_event_t *event)

Wait on event occurrence.
- int rtdm_event_timedwait (rtdm_event_t *event, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
  Wait on event occurrence with timeout.
- void rtdm_event_clear (rtdm_event_t *event)
  Clear event state.
- int rtdm_event_select_bind (rtdm_event_t *event, rtdm_selector_t *selector, enum rtdm_selecttype type, unsigned fd_index)
  Bind a selector to an event.

Semaphore Services

- void rtdm_sem_init (rtdm_sem_t *sem, unsigned long value)
  Initialise a semaphore.
- void rtdm_sem_destroy (rtdm_sem_t *sem)
  Destroy a semaphore.
- int rtdm_sem_down (rtdm_sem_t *sem)
  Decrement a semaphore.
- int rtdm_sem_timeddown (rtdm_sem_t *sem, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
  Decrement a semaphore with timeout.
- void rtdm_sem_up (rtdm_sem_t *sem)
  Increment a semaphore.
- int rtdm_sem_select_bind (rtdm_sem_t *sem, rtdm_selector_t *selector, enum rtdm_selecttype type, unsigned fd_index)
  Bind a selector to a semaphore.

Mutex Services

- void rtdm_mutex_init (rtdm_mutex_t *mutex)
  Initialise a mutex.
- void rtdm_mutex_destroy (rtdm_mutex_t *mutex)
  Destroy a mutex.
- void rtdm_mutex_unlock (rtdm_mutex_t *mutex)
  Release a mutex.
- int rtdm_mutex_lock (rtdm_mutex_t *mutex)
  Request a mutex.
- int rtdm_mutex_timedlock (rtdm_mutex_t *mutex, nanosecs_rel_t timeout, rtdm_toseq_t *timeout_seq)
  Request a mutex with timeout.

7.8.1 Detailed Description

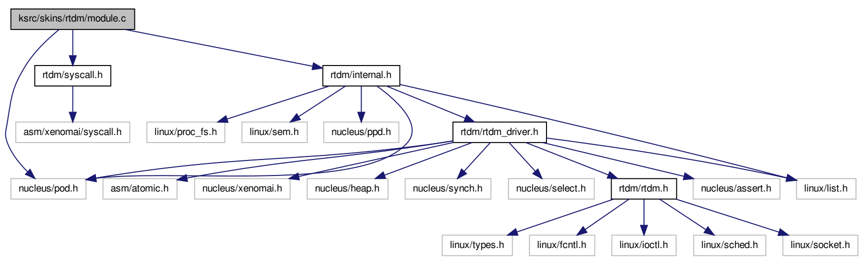
Real-Time Driver Model for Xenomai, driver library.

Note

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

Real-Time Driver Model for Xenomai.

Include dependency graph for module.c:



7.9.1 Detailed Description

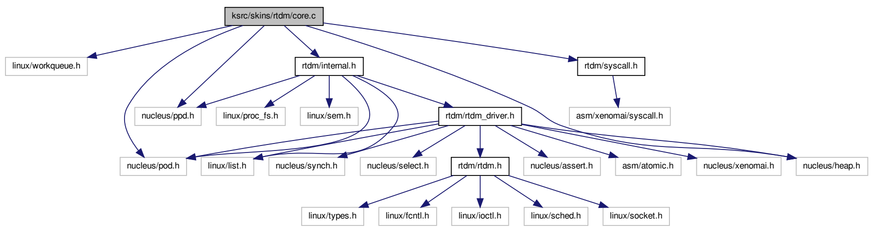
Real-Time Driver Model for Xenomai.

Note

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

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

Include dependency graph for core.c:



Functions

- struct rtdm_dev_context ∗ rtdm_context_get (int fd)

  Retrieve and lock a device context.
- int rtdm_select_bind (int fd, rtdm_selector_t ∗selector, enum rtdm_-selecttype type, unsigned fd_index)

  Bind a selector to specified event types of a given file descriptor.
- 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.
- void rtdm_context_put (struct rtdm_dev_context ∗context)

  Release a device context obtained via rtdm_context_get()
- int rtdm_open (const char ∗path, int oflag,...)

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

  Create a socket.
- int rtdm_close (int fd)

  Close a device or socket.

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

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

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

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

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

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

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

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

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

  Transmit message to socket.
- int rtdm_bind (int fd, const struct sockaddr ∗my_addr, socklen_t ad-drlen)

  Bind to local address.
- int rtdm_connect (int fd, const struct sockaddr ∗serv_addr, socklen_t ad-drlen)

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

  Listen for incomming 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_recvmsg (int fd, struct msghdr *msg, int flags)

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

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

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

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

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

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

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

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

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

  Accept 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.

7.10.1 Detailed Description

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

Note

Chapter 8

Example Documentation

8.1 cross-link.c

```
/*
 * cross-link.c
 *
 * Userspace test program (Xenomai native skin) for RTDM-based UART drivers
 * Copyright 2005 by Joerg Langenberg <joergel75@gmx.net>
 *
 * Updates by Jan Kiszka <jan.kiszka@web.de>
 *
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 */
#include <stdio.h>
#include <signal.h>
#include <unistd.h>
#include <sys/mman.h>

#include <native/task.h>
#include <native/timer.h>

#include <rtdm/rtserial.h>

#define MAIN_PREFIX   "main : "
#define WTASK_PREFIX  "write_task: "
#define RTASK_PREFIX  "read_task: "

#define WRITE_FILE    "rtser0"
#define READ_FILE     "rtser1"
```

```
int read_fd  = -1;
int write_fd = -1;

#define STATE_FILE_OPENED         1
#define STATE_TASK_CREATED        2

unsigned int read_state = 0;
unsigned int write_state = 0;

/*                           --s-ms-us-ns */
RTIME write_task_period_ns =    100000000llu;
RT_TASK write_task;
RT_TASK read_task;

static const struct rtser_config read_config = {
        .config_mask       = 0xFFFF,
        .baud_rate         = 115200,
        .parity            = RTSER_DEF_PARITY,
        .data_bits         = RTSER_DEF_BITS,
        .stop_bits         = RTSER_DEF_STOPB,
        .handshake         = RTSER_DEF_HAND,
        .fifo_depth        = RTSER_DEF_FIFO_DEPTH,
        .rx_timeout        = RTSER_DEF_TIMEOUT,
        .tx_timeout        = RTSER_DEF_TIMEOUT,
        .event_timeout     = 1000000000, /* 1 s */
        .timestamp_history = RTSER_RX_TIMESTAMP_HISTORY,
        .event_mask        = RTSER_EVENT_RXPEND,
};

static const struct rtser_config write_config = {
        .config_mask       = RTSER_SET_BAUD | RTSER_SET_TIMESTAMP_HISTORY,
        .baud_rate         = 115200,
        .timestamp_history = RTSER_DEF_TIMESTAMP_HISTORY,
        /* the rest implicitely remains default */
};

static int close_file( int fd, char *name)
{
        int err, i=0;

        do {
                i++;
                err = rt_dev_close(fd);
                switch (err) {
                case -EAGAIN:
                        printf(MAIN_PREFIX "%s -> EAGAIN (%d times)\n",
                               name, i);
                        rt_task_sleep(50000); /* wait 50us */
                        break;
                case 0:
                        printf(MAIN_PREFIX "%s -> closed\n", name);
                        break;
                default:
                        printf(MAIN_PREFIX "%s -> %s\n", name,
                               strerror(-err));
                        break;
                }
        } while (err == -EAGAIN && i < 10);

        return err;
}
```

```
void cleanup_all(void)
{
        if (read_state & STATE_FILE_OPENED) {
                close_file(read_fd, READ_FILE" (read)");
                read_state &= ~STATE_FILE_OPENED;
        }

        if (write_state & STATE_FILE_OPENED) {
                close_file(write_fd, WRITE_FILE " (write)");
                write_state &= ~STATE_FILE_OPENED;
        }

        if (write_state & STATE_TASK_CREATED) {
                printf(MAIN_PREFIX "delete write_task\n");
                rt_task_delete(&write_task);
                write_state &= ~STATE_TASK_CREATED;
        }

        if (read_state & STATE_TASK_CREATED) {
                printf(MAIN_PREFIX "delete read_task\n");
                rt_task_delete(&read_task);
                read_state &= ~STATE_TASK_CREATED;
        }
}

void catch_signal(int sig)
{
        cleanup_all();
        printf(MAIN_PREFIX "exit\n");
        return;
}

void write_task_proc(void *arg)
{
        int err;
        RTIME write_time;
        ssize_t sz = sizeof(RTIME);
        ssize_t written = 0;

        err = rt_task_set_periodic(NULL, TM_NOW,
                                   rt_timer_ns2ticks(write_task_period_ns));
        if (err) {
                printf(WTASK_PREFIX "error on set periodic, %s\n",
                       strerror(-err));
                goto exit_write_task;
        }

        while (1) {
                err = rt_task_wait_period(NULL);
                if (err) {
                        printf(WTASK_PREFIX
                               "error on rt_task_wait_period, %s\n",
                               strerror(-err));
                        break;
                }

                write_time = rt_timer_read();

                written = rt_dev_write(write_fd, &write_time, sz);
                if (written < 0 ) {
                        printf(WTASK_PREFIX "error on rt_dev_write, %s\n",
                              strerror(-err));
                        break;
                } else if (written != sz) {
                        printf(WTASK_PREFIX "only %d / %d byte transmitted\n",
                               written, sz);
                        break;
                }
        }

 exit_write_task:
        if ((write_state & STATE_FILE_OPENED) &&
            close_file(write_fd, WRITE_FILE " (write)") == 0)
                write_state &= ~STATE_FILE_OPENED;

        printf(WTASK_PREFIX "exit\n");
}

void read_task_proc(void *arg)
{
        int err;
        int nr = 0;
        RTIME read_time  = 0;
        RTIME write_time = 0;
        RTIME irq_time   = 0;
        ssize_t sz = sizeof(RTIME);
        ssize_t read = 0;
        struct rtser_event rx_event;

        printf(" Nr |   write->irq    |    irq->read    |   write->read   |\n")
      ;
        printf("-----------------------------------------------------------\n")
      ;

        /*
         * We are in secondary mode now due to printf, the next
         * blocking Xenomai or driver call will switch us back
         * (here: RTSER_RTIOC_WAIT_EVENT).
         */

        while (1) {
                /* waiting for event */
                err = rt_dev_ioctl(read_fd, RTSER_RTIOC_WAIT_EVENT, &rx_event);
                if (err) {
                        printf(RTASK_PREFIX
                               "error on RTSER_RTIOC_WAIT_EVENT, %s\n",
                               strerror(-err));
                        if (err == -ETIMEDOUT)
                                continue;
                        break;
                }

                irq_time = rx_event.rxpend_timestamp;
                read = rt_dev_read(read_fd, &write_time, sz);
                if (read == sz) {
                        read_time = rt_timer_read();
                        printf("%3d |%16llu |%16llu |%16llu\n", nr,
                               irq_time  - write_time,
                               read_time - irq_time,
                               read_time - write_time);
                        nr++;
                } else if (read < 0 ) {
                        printf(RTASK_PREFIX "error on rt_dev_read, code %s\n",
                                strerror(-err));
                        break;
                } else {
                        printf(RTASK_PREFIX "only %d / %d byte received \n",
                                read, sz);
                        break;
                }
        }

        if ((read_state & STATE_FILE_OPENED) &&
            close_file(read_fd, READ_FILE " (read)") == 0)
                read_state &= ~STATE_FILE_OPENED;

        printf(RTASK_PREFIX "exit\n");
}

int main(int argc, char* argv[])
{
        int err = 0;

        signal(SIGTERM, catch_signal);
        signal(SIGINT, catch_signal);

        /* no memory-swapping for this programm */
        mlockall(MCL_CURRENT | MCL_FUTURE);

        /* open rtser0 */
        write_fd = rt_dev_open( WRITE_FILE, 0);
        if (write_fd < 0) {
                printf(MAIN_PREFIX "can't open %s (write), %s\n", WRITE_FILE,
                       strerror(-write_fd));
                goto error;
        }
        write_state |= STATE_FILE_OPENED;
        printf(MAIN_PREFIX "write-file opened\n");

        /* writing write-config */
        err = rt_dev_ioctl(write_fd, RTSER_RTIOC_SET_CONFIG, &write_config);
        if (err) {
                printf(MAIN_PREFIX "error while RTSER_RTIOC_SET_CONFIG, %s\n",
                       strerror(-err));
                goto error;
        }
        printf(MAIN_PREFIX "write-config written\n");

        /* open rtser1 */
        read_fd = rt_dev_open( READ_FILE, 0 );
        if (read_fd < 0) {
                printf(MAIN_PREFIX "can't open %s (read), %s\n", READ_FILE,
                       strerror(-read_fd));
                goto error;
        }
        read_state |= STATE_FILE_OPENED;
        printf(MAIN_PREFIX "read-file opened\n");

        /* writing read-config */
        err = rt_dev_ioctl(read_fd, RTSER_RTIOC_SET_CONFIG, &read_config);
        if (err) {
                printf(MAIN_PREFIX "error while rt_dev_ioctl, %s\n",
                       strerror(-err));
                goto error;
        }
        printf(MAIN_PREFIX "read-config written\n");

        /* create write_task */
        err = rt_task_create(&write_task, "write_task", 0, 50, 0);
        if (err) {
                printf(MAIN_PREFIX "failed to create write_task, %s\n",
                       strerror(-err));
                goto error;
        }
        write_state |= STATE_TASK_CREATED;
        printf(MAIN_PREFIX "write-task created\n");

        /* create read_task */
        err = rt_task_create(&read_task, "read_task", 0, 51, 0);
        if (err) {
                printf(MAIN_PREFIX "failed to create read_task, %s\n",
                       strerror(-err));
                goto error;
        }
        read_state |= STATE_TASK_CREATED;
        printf(MAIN_PREFIX "read-task created\n");

        /* start write_task */
        printf(MAIN_PREFIX "starting write-task\n");
        err = rt_task_start(&write_task, &write_task_proc, NULL);
        if (err) {
                printf(MAIN_PREFIX "failed to start write_task, %s\n",
                       strerror(-err));
                goto error;
        }

        /* start read_task */
        printf(MAIN_PREFIX "starting read-task\n");
        err = rt_task_start(&read_task,&read_task_proc,NULL);
        if (err) {
                printf(MAIN_PREFIX "failed to start read_task, %s\n",
                       strerror(-err));
                goto error;
        }

        pause();
        return 0;

 error:
        cleanup_all();
        return err;
}
```

8.2 rtcan_rtt.c

```
/*
 * Round-Trip-Time Test - sends and receives messages and measures the
 *                        time in between.
 *
 * Copyright (C) 2006 Wolfgang Grandegger <wg@grandegger.com>
 *
 * Based on RTnet's examples/xenomai/posix/rtt-sender.c.
 *
 * Copyright (C) 2002 Ulrich Marx <marx@kammer.uni-hannover.de>
 *               2002 Marc Kleine-Budde <kleine-budde@gmx.de>
 *               2006 Jan Kiszka <jan.kiszka@web.de>
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 *
 *
 * The program sends out CAN messages periodically and copies the current
 * time-stamp to the payload. At reception, that time-stamp is compared
 * with the current time to determine the round-trip time. The jitter
 * values are printer out regularly. Concurrent tests can be carried out
 * by starting the program with different message identifiers. It is also
 * possible to use this program on a remote system as simple repeater to
 * loopback messages.
 */

#include <errno.h>
#include <mqueue.h>
#include <signal.h>
#include <pthread.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
#include <limits.h>
#include <getopt.h>
#include <netinet/in.h>
#include <net/if.h>
#include <sys/ioctl.h>
#include <sys/mman.h>

#ifdef __XENO__
#include <rtdm/rtcan.h>
#else
#include <linux/can.h>
#include <linux/can/raw.h>
#endif

#define NSEC_PER_SEC 1000000000

static unsigned int cycle = 10000; /* 10 ms */
static canid_t can_id = 0x1;

static pthread_t txthread, rxthread;
static int txsock, rxsock;
static mqd_t mq;
static int txcount, rxcount;
static int overruns;
static int repeater;

struct rtt_stat {
    long long rtt;
    long long rtt_min;
    long long rtt_max;
    long long rtt_sum;
    long long rtt_sum_last;
    int counts_per_sec;
};

static void print_usage(char *prg)
{
    fprintf(stderr,
            "Usage: %s  [Options] <tx-can-interface> <rx-can-interface>\n"
            "Options:\n"
            " -h, --help     This help\n"
            " -r, --repeater Repeater, send back received messages\n"
            " -i, --id=ID    CAN Identifier (default = 0x1)\n"
            " -c, --cycle    Cycle time in us (default = 10000us)\n",
            prg);
}

void *transmitter(void *arg)
{
    struct sched_param  param = { .sched_priority = 80 };
    struct timespec next_period;
    struct timespec time;
    struct can_frame frame;
    long long *rtt_time = (long long *)&frame.data;

    /* Pre-fill CAN frame */
    frame.can_id = can_id;
    frame.can_dlc = sizeof(*rtt_time);

#ifdef __XENO__
    pthread_set_name_np(pthread_self(), "rtcan_rtt_transmitter");
#endif
    pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);

    clock_gettime(CLOCK_MONOTONIC, &next_period);

    while(1) {
        next_period.tv_nsec += cycle * 1000;
        while (next_period.tv_nsec >= NSEC_PER_SEC) {
                next_period.tv_nsec -= NSEC_PER_SEC;
                next_period.tv_sec++;
        }

        clock_nanosleep(CLOCK_MONOTONIC, TIMER_ABSTIME, &next_period, NULL);

        if (rxcount != txcount) {
            overruns++;
            continue;
        }

        clock_gettime(CLOCK_MONOTONIC, &time);
        *rtt_time = (long long)time.tv_sec * NSEC_PER_SEC + time.tv_nsec;

        /* Transmit the message containing the local time */
        if (send(txsock, (void *)&frame, sizeof(struct can_frame), 0) < 0) {
            if (errno == EBADF)
                printf("terminating transmitter thread\n");
            else
                perror("send failed");
            return NULL;
        }
        txcount++;
    }
}


void *receiver(void *arg)
{
    struct sched_param param = { .sched_priority = 82 };
    struct timespec time;
    struct can_frame frame;
    long long *rtt_time = (long long *)frame.data;
    struct rtt_stat rtt_stat = {0, 1000000000000000000LL, -1000000000000000000
      LL,
                                0, 0, 0};

#ifdef __XENO__
    pthread_set_name_np(pthread_self(), "rtcan_rtt_receiver");
#endif
    pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);

    rtt_stat.counts_per_sec = 1000000 / cycle;

    while (1) {
        if (recv(rxsock, (void *)&frame, sizeof(struct can_frame), 0) < 0) {
            if (errno == EBADF)
                printf("terminating receiver thread\n");
            else
                perror("recv failed");
            return NULL;
        }
        if (repeater) {
            /* Transmit the message back as is */
            if (send(txsock, (void *)&frame, sizeof(struct can_frame), 0) < 0)
      {
                if (errno == EBADF)
                    printf("terminating transmitter thread\n");
                else
                    perror("send failed");
                return NULL;
            }
            txcount++;
        } else {
            clock_gettime(CLOCK_MONOTONIC, &time);
            if (rxcount > 0) {
                rtt_stat.rtt = ((long long)time.tv_sec * 1000000000LL +
                                time.tv_nsec - *rtt_time);
                rtt_stat.rtt_sum += rtt_stat.rtt;
                if (rtt_stat.rtt <  rtt_stat.rtt_min)
                    rtt_stat.rtt_min = rtt_stat.rtt;
                if (rtt_stat.rtt > rtt_stat.rtt_max)
                    rtt_stat.rtt_max = rtt_stat.rtt;
            }
        }
        rxcount++;

        if ((rxcount % rtt_stat.counts_per_sec) == 0) {
            mq_send(mq, (char *)&rtt_stat, sizeof(rtt_stat), 0);
            rtt_stat.rtt_sum_last = rtt_stat.rtt_sum;
        }
    }
```

```
}

void catch_signal(int sig)
{
    mq_close(mq);
}


int main(int argc, char *argv[])
{
    struct sched_param param = { .sched_priority = 1 };
    pthread_attr_t thattr;
    struct mq_attr mqattr;
    struct sockaddr_can rxaddr, txaddr;
    struct can_filter rxfilter[1];
    struct rtt_stat rtt_stat;
    char mqname[32];
    char *txdev, *rxdev;
    struct ifreq ifr;
    int ret, opt;

    struct option long_options[] = {
        { "id", required_argument, 0, 'i'},
        { "cycle", required_argument, 0, 'c'},
        { "repeater", no_argument, 0, 'r'},
        { "help", no_argument, 0, 'h'},
        { 0, 0, 0, 0},
    };

    while ((opt = getopt_long(argc, argv, "hri:c:",
                              long_options, NULL)) != -1) {
        switch (opt) {
        case 'c':
            cycle = atoi(optarg);
            break;

        case 'i':
            can_id = strtoul(optarg, NULL, 0);
            break;

        case 'r':
            repeater = 1;
            break;

        default:
            fprintf(stderr, "Unknown option %c\n", opt);
        case 'h':
            print_usage(argv[0]);
            exit(-1);
        }
    }

    printf("%d %d\n", optind, argc);
    if (optind + 2 != argc) {
        print_usage(argv[0]);
        exit(0);
    }

    txdev = argv[optind];
    rxdev = argv[optind + 1];

    /* Create and configure RX socket */
    if ((rxsock = socket(PF_CAN, SOCK_RAW, CAN_RAW)) < 0) {
        perror("RX socket failed");
        return -1;
    }

    strncpy(ifr.ifr_name, rxdev, IFNAMSIZ);
    printf("RX rxsock=%d, ifr_name=%s\n", rxsock, ifr.ifr_name);

    if (ioctl(rxsock, SIOCGIFINDEX, &ifr) < 0) {
        perror("RX ioctl SIOCGIFINDEX failed");
        goto failure1;
    }

    /* We only want to receive our own messages */
    rxfilter[0].can_id = can_id;
    rxfilter[0].can_mask = 0x3ff;
    if (setsockopt(rxsock, SOL_CAN_RAW, CAN_RAW_FILTER,
                   &rxfilter, sizeof(struct can_filter)) < 0) {
        perror("RX setsockopt CAN_RAW_FILTER failed");
        goto failure1;
    }
    memset(&rxaddr, 0, sizeof(rxaddr));
    rxaddr.can_ifindex = ifr.ifr_ifindex;
    rxaddr.can_family = AF_CAN;
    if (bind(rxsock, (struct sockaddr *)&rxaddr, sizeof(rxaddr)) < 0) {
        perror("RX bind failed\n");
        goto failure1;
    }

    /* Create and configure TX socket */

    if (strcmp(rxdev, txdev) == 0) {
        txsock = rxsock;
    } else {
        if ((txsock = socket(PF_CAN, SOCK_RAW, 0)) < 0) {
            perror("TX socket failed");
            goto failure1;
        }

        strncpy(ifr.ifr_name, txdev, IFNAMSIZ);
        printf("TX txsock=%d, ifr_name=%s\n", txsock, ifr.ifr_name);

        if (ioctl(txsock, SIOCGIFINDEX, &ifr) < 0) {
            perror("TX ioctl SIOCGIFINDEX failed");
            goto failure2;
        }

        /* Suppress definiton of a default receive filter list */
        if (setsockopt(txsock, SOL_CAN_RAW, CAN_RAW_FILTER, NULL, 0) < 0) {
            perror("TX setsockopt CAN_RAW_FILTER failed");
            goto failure2;
        }

        memset(&txaddr, 0, sizeof(txaddr));
        txaddr.can_ifindex = ifr.ifr_ifindex;
        txaddr.can_family = AF_CAN;

        if (bind(txsock, (struct sockaddr *)&txaddr, sizeof(txaddr)) < 0) {
                perror("TX bind failed\n");
                goto failure2;
        }
    }
    signal(SIGTERM, catch_signal);
    signal(SIGINT, catch_signal);
    signal(SIGHUP, catch_signal);
    mlockall(MCL_CURRENT|MCL_FUTURE);

    printf("Round-Trip-Time test %s -> %s with CAN ID 0x%x\n",
           argv[optind], argv[optind + 1], can_id);
    printf("Cycle time: %d us\n", cycle);
    printf("All RTT timing figures are in us.\n");

    /* Create statistics message queue */
    snprintf(mqname, sizeof(mqname), "/rtcan_rtt-%d", getpid());
    mqattr.mq_flags   = 0;
    mqattr.mq_maxmsg  = 100;
    mqattr.mq_msgsize = sizeof(struct rtt_stat);
    mq = mq_open(mqname, O_RDWR | O_CREAT | O_EXCL, 0600, &mqattr);
    if (mq == (mqd_t)-1) {
        perror("opening mqueue failed");
        goto failure2;
    }

    /* Create receiver RT-thread */
    pthread_attr_init(&thattr);
    pthread_attr_setdetachstate(&thattr, PTHREAD_CREATE_JOINABLE);
    pthread_attr_setstacksize(&thattr, PTHREAD_STACK_MIN);
    ret = pthread_create(&rxthread, &thattr, &receiver, NULL);
    if (ret) {
        fprintf(stderr, "%s: pthread_create(receiver) failed\n",
                strerror(-ret));
        goto failure3;
    }

    if (!repeater) {
        /* Create transitter RT-thread */
        ret = pthread_create(&txthread, &thattr, &transmitter, NULL);
        if (ret) {
            fprintf(stderr, "%s: pthread_create(transmitter) failed\n",
                    strerror(-ret));
            goto failure4;
        }
    }

    pthread_setschedparam(pthread_self(), SCHED_FIFO, &param);

    if (repeater)
        printf("Messages\n");
    else
        printf("Messages RTTlast RTT_avg RTT_min RTT_max Overruns\n");

    while (1) {
        long long rtt_avg;

        ret = mq_receive(mq, (char *)&rtt_stat, sizeof(rtt_stat), NULL);
        if (ret != sizeof(rtt_stat)) {
            if (ret < 0) {
                if (errno == EBADF)
                    printf("terminating mq_receive\n");
                else
                    perror("mq_receive failed");
            } else
                fprintf(stderr,
                        "mq_receive returned invalid length %d\n", ret);
            break;
        }

        if (repeater) {
            printf("%8d\n", rxcount);
        } else {
            rtt_avg = ((rtt_stat.rtt_sum - rtt_stat.rtt_sum_last) /
                       rtt_stat.counts_per_sec);
            printf("%8d %7ld %7ld %7ld %7ld %8d\n", rxcount,
                   (long)(rtt_stat.rtt / 1000), (long)(rtt_avg / 1000),
                   (long)(rtt_stat.rtt_min / 1000),
                   (long)(rtt_stat.rtt_max / 1000),
                   overruns);
        }
    }

    /* This call also leaves primary mode, required for socket cleanup. */
    printf("shutting down\n");

    /* Important: First close the sockets! */
    while ((close(rxsock) < 0) && (errno == EAGAIN)) {
        printf("RX socket busy - waiting...\n");
        sleep(1);
    }
    while ((close(txsock) < 0) && (errno == EAGAIN)) {
        printf("TX socket busy - waiting...\n");
        sleep(1);
    }

    pthread_join(txthread, NULL);
    pthread_kill(rxthread, SIGHUP);
    pthread_join(rxthread, NULL);

    return 0;

 failure4:
    pthread_kill(rxthread, SIGHUP);
    pthread_join(rxthread, NULL);
 failure3:
    mq_close(mq);
 failure2:
    close(txsock);
 failure1:
    close(rxsock);

    return 1;
}
```

8.3 rtcanconfig.c

```
/*
 * Program to configuring the CAN controller
 *
 * Copyright (C) 2006 Wolfgang Grandegger <wg@grandegger.com>
 *
 * Copyright (C) 2005, 2006 Sebastian Smolorz
 *                          <Sebastian.Smolorz@stud.uni-hannover.de>
 *
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 * along with this program; if not, write to the Free Software
 * Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
 */

#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
#include <string.h>
#include <time.h>
#include <errno.h>
#include <getopt.h>
#include <sys/mman.h>

#include <rtdm/rtcan.h>

static void print_usage(char *prg)
{
    fprintf(stderr,
            "Usage: %s <can-interface> [Options] [up|down|start|stop|sleep]\n"
            "Options:\n"
            " -v, --verbose            be verbose\n"
            " -h, --help               this help\n"
            " -c, --ctrlmode=CTRLMODE  listenonly, loopback or none\n"
            " -b, --baudrate=BPS       baudrate in bits/sec\n"
            " -B, --bittime=BTR0:BTR1  BTR or standard bit-time\n"
            " -B, --bittime=BRP:PROP_SEG:PHASE_SEG1:PHASE_SEG2:SJW:SAM\n",
            prg);
}

can_baudrate_t string_to_baudrate(char *str)
{
    can_baudrate_t baudrate;
    if (sscanf(str, "%i", &baudrate) != 1)
        return -1;
    return baudrate;
}

int string_to_mode(char *str)
{
    if ( !strcmp(str, "up") || !strcmp(str, "start") )
        return CAN_MODE_START;
    else if ( !strcmp(str, "down") || !strcmp(str, "stop") )
        return CAN_MODE_STOP;
    else if ( !strcmp(str, "sleep") )
        return CAN_MODE_SLEEP;
    return -EINVAL;
}

int string_to_ctrlmode(char *str)
```

```
{
    if ( !strcmp(str, "listenonly") )
        return CAN_CTRLMODE_LISTENONLY;
    else if ( !strcmp(str, "loopback") )
        return CAN_CTRLMODE_LOOPBACK;
    else if ( !strcmp(str, "none") )
        return 0;

    return -1;
}

int main(int argc, char *argv[])
{
    char    ifname[16];
    int     can_fd = -1;
    int     new_baudrate = -1;
    int     new_mode = -1;
    int     new_ctrlmode = 0, set_ctrlmode = 0;
    int     verbose = 0;
    int     bittime_count = 0, bittime_data[6];
    struct  ifreq ifr;
    can_baudrate_t *baudrate;
    can_ctrlmode_t *ctrlmode;
    can_mode_t *mode;
    struct can_bittime *bittime;
    int opt, ret;
    char* ptr;

    struct option long_options[] = {
        { "help", no_argument, 0, 'h' },
        { "verbose", no_argument, 0, 'v'},
        { "baudrate", required_argument, 0, 'b'},
        { "bittime", required_argument, 0, 'B'},
        { "ctrlmode", required_argument, 0, 'c'},
        { 0, 0, 0, 0},
    };

    while ((opt = getopt_long(argc, argv, "hvb:B:c:",
                              long_options, NULL)) != -1) {
        switch (opt) {
        case 'h':
            print_usage(argv[0]);
            exit(0);

        case 'v':
            verbose = 1;
            break;

        case 'b':
            new_baudrate = string_to_baudrate(optarg);
            if (new_baudrate == -1) {
                print_usage(argv[0]);
                exit(0);
            }
            break;

        case 'B':
            ptr = optarg;
            while (1) {
                bittime_data[bittime_count++] = strtoul(ptr, NULL, 0);
                if (!(ptr = strchr(ptr, ':')))
                    break;
                ptr++;
            }
            if (bittime_count != 2 && bittime_count != 6) {
                print_usage(argv[0]);
                exit(0);
            }
            break;

        case 'c':
            ret = string_to_ctrlmode(optarg);
            if (ret == -1) {
                print_usage(argv[0]);
                exit(0);
            }
            new_ctrlmode |= ret;
            set_ctrlmode = 1;
            break;

            break;

        default:
            fprintf(stderr, "Unknown option %c\n", opt);
            break;
        }
    }

    /* Get CAN interface name */
    if (optind != argc - 1 && optind != argc - 2) {
        print_usage(argv[0]);
        return 0;
    }

    strncpy(ifname, argv[optind], IFNAMSIZ);
    strncpy(ifr.ifr_name, ifname, IFNAMSIZ);

    if (optind == argc - 2) {   /* Get mode setting */
        new_mode = string_to_mode(argv[optind + 1]);
        if (verbose)
            printf("mode: %s (%#x)\n", argv[optind + 1], new_mode);
        if (new_mode < 0) {
            print_usage(argv[0]);
            return 0;
        }
    }

    can_fd = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
    if (can_fd < 0) {
        fprintf(stderr, "Cannot open RTDM CAN socket. Maybe driver not loaded?
  \n");
        return can_fd;
    }

    ret = rt_dev_ioctl(can_fd, SIOCGIFINDEX, &ifr);
    if (ret) {
        fprintf(stderr,"Can't get interface index for %s, code = %d\n", ifname,
       ret);
        return ret;
    }


    if (new_baudrate != -1) {
        if (verbose)
```

```
            printf("baudrate: %d\n", new_baudrate);
        baudrate = (can_baudrate_t *)&ifr.ifr_ifru;
        *baudrate = new_baudrate;
        ret = rt_dev_ioctl(can_fd, SIOCSCANBAUDRATE, &ifr);
        if (ret) {
            goto abort;
        }
    }

    if (bittime_count) {
        bittime = (struct can_bittime *)&ifr.ifr_ifru;
        if (bittime_count == 2) {
            bittime->type = CAN_BITTIME_BTR;
            bittime->btr.btr0 = bittime_data[0];
            bittime->btr.btr1 = bittime_data[1];
            if (verbose)
                printf("bit-time: btr0=0x%02x btr1=0x%02x\n",
                       bittime->btr.btr0, bittime->btr.btr1);
        } else {
            bittime->type = CAN_BITTIME_STD;
            bittime->std.brp = bittime_data[0];
            bittime->std.prop_seg = bittime_data[1];
            bittime->std.phase_seg1 = bittime_data[2];
            bittime->std.phase_seg2 = bittime_data[3];
            bittime->std.sjw = bittime_data[4];
            bittime->std.sam = bittime_data[5];
            if (verbose)
                printf("bit-time: brp=%d prop_seg=%d phase_seg1=%d "
                       "phase_seg2=%d sjw=%d sam=%d\n",
                       bittime->std.brp,
                       bittime->std.prop_seg,
                       bittime->std.phase_seg1,
                       bittime->std.phase_seg2,
                       bittime->std.sjw,
                       bittime->std.sam);
        }

        ret = rt_dev_ioctl(can_fd, SIOCSCANCUSTOMBITTIME, &ifr);
        if (ret) {
            goto abort;
        }

    }

    if (set_ctrlmode != 0) {
        ctrlmode = (can_ctrlmode_t *)&ifr.ifr_ifru;
        *ctrlmode = new_ctrlmode;
        if (verbose)
            printf("ctrlmode: %#x\n", new_ctrlmode);
        ret = rt_dev_ioctl(can_fd, SIOCSCANCTRLMODE, &ifr);
        if (ret) {
            goto abort;
        }
    }

    if (new_mode != -1) {
        mode = (can_mode_t *)&ifr.ifr_ifru;
        *mode = new_mode;
        ret = rt_dev_ioctl(can_fd, SIOCSCANMODE, &ifr);
        if (ret) {
            goto abort;
        }
    }

    rt_dev_close(can_fd);
    return 0;

 abort:
    rt_dev_close(can_fd);
    return ret;
}
```

8.4 rtcanrecv.c

```
#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
#include <time.h>
#include <errno.h>
#include <getopt.h>
#include <sys/mman.h>

#include <native/task.h>
#include <native/pipe.h>

#include <rtdm/rtcan.h>

static void print_usage(char *prg)
{
    fprintf(stderr,
            "Usage: %s [<can-interface>] [Options]\n"
            "Options:\n"
            " -f  --filter=id:mask[:id:mask]... apply filter\n"
            " -e  --error=mask      receive error messages\n"
            " -t, --timeout=MS      timeout in ms\n"
            " -T, --timestamp       with absolute timestamp\n"
            " -R, --timestamp-rel   with relative timestamp\n"
            " -v, --verbose         be verbose\n"
            " -p, --print=MODULO    print every MODULO message\n"
            " -h, --help            this help\n",
            prg);
}


extern int optind, opterr, optopt;

static int s = -1, verbose = 0, print = 1;
static nanosecs_rel_t timeout = 0, with_timestamp = 0, timestamp_rel = 0;

RT_TASK rt_task_desc;

#define BUF_SIZ 255
#define MAX_FILTER 16

struct sockaddr_can recv_addr;
struct can_filter recv_filter[MAX_FILTER];
static int filter_count = 0;

int add_filter(u_int32_t id, u_int32_t mask)
{
    if (filter_count >= MAX_FILTER)
        return -1;
    recv_filter[filter_count].can_id = id;
    recv_filter[filter_count].can_mask = mask;
    printf("Filter #%d: id=0x%08x mask=0x%08x\n", filter_count, id, mask);
    filter_count++;
    return 0;
}

void cleanup(void)
{
    int ret;

    if (verbose)
        printf("Cleaning up...\n");

    if (s >= 0) {
        ret = rt_dev_close(s);
        s = -1;
        if (ret) {
            fprintf(stderr, "rt_dev_close: %s\n", strerror(-ret));
        }
        rt_task_delete(&rt_task_desc);
    }
    }

void cleanup_and_exit(int sig)
{
    if (verbose)
        printf("Signal %d received\n", sig);
    cleanup();
    exit(0);
}

void rt_task(void)
{
    int i, ret, count = 0;
    struct can_frame frame;
    struct sockaddr_can addr;
    socklen_t addrlen = sizeof(addr);
    struct msghdr msg;
    struct iovec iov;
    nanosecs_abs_t timestamp, timestamp_prev = 0;

    if (with_timestamp) {
        msg.msg_iov = &iov;
        msg.msg_iovlen = 1;
        msg.msg_name = (void *)&addr;
        msg.msg_namelen = sizeof(struct sockaddr_can);
        msg.msg_control = (void *)&timestamp;
        msg.msg_controllen = sizeof(nanosecs_abs_t);
    }

    while (1) {
        if (with_timestamp) {
            iov.iov_base = (void *)&frame;
            iov.iov_len = sizeof(can_frame_t);
            ret = rt_dev_recvmsg(s, &msg, 0);
        } else
            ret = rt_dev_recvfrom(s, (void *)&frame, sizeof(can_frame_t), 0,
                                  (struct sockaddr *)&addr, &addrlen);
        if (ret < 0) {
            switch (ret) {
            case -ETIMEDOUT:
                if (verbose)
                    printf("rt_dev_recv: timed out");
                continue;
            case -EBADF:
                if (verbose)
                    printf("rt_dev_recv: aborted because socket was closed");
                break;
            default:
                fprintf(stderr, "rt_dev_recv: %s\n", strerror(-ret));
            }
            break;
        }

        if (print && (count % print) == 0) {
            printf("#%d: (%d) ", count, addr.can_ifindex);
            if (with_timestamp && msg.msg_controllen) {
                if (timestamp_rel) {
                printf("%lldns ", (long long)(timestamp - timestamp_prev));
                    timestamp_prev = timestamp;
                } else
                    printf("%lldns ", (long long)timestamp);
            }
            if (frame.can_id & CAN_ERR_FLAG)
                printf("!0x%08x!", frame.can_id & CAN_ERR_MASK);
            else if (frame.can_id & CAN_EFF_FLAG)
                printf("<0x%08x>", frame.can_id & CAN_EFF_MASK);
            else
                printf("<0x%03x>", frame.can_id & CAN_SFF_MASK);

            printf(" [%d]", frame.can_dlc);
            if (!(frame.can_id & CAN_RTR_FLAG))
                for (i = 0; i < frame.can_dlc; i++) {
                    printf(" %02x", frame.data[i]);
                }
            if (frame.can_id & CAN_ERR_FLAG) {
                printf(" ERROR ");
                if (frame.can_id & CAN_ERR_BUSOFF)
                    printf("bus-off");
                if (frame.can_id & CAN_ERR_CRTL)
                    printf("controller problem");
            } else if (frame.can_id & CAN_RTR_FLAG)
                printf(" remote request");
            printf("\n");
        }
        count++;
    }
}

int main(int argc, char **argv)
{
    int opt, ret;
    u_int32_t id, mask;
    u_int32_t err_mask = 0;
    struct ifreq ifr;
    char *ptr;
    char name[32];

    struct option long_options[] = {
        { "help", no_argument, 0, 'h' },
        { "verbose", no_argument, 0, 'v'},
        { "filter", required_argument, 0, 'f'},
        { "error", required_argument, 0, 'e'},
        { "timeout", required_argument, 0, 't'},
        { "timestamp", no_argument, 0, 'T'},
        { "timestamp-rel", no_argument, 0, 'R'},
        { 0, 0, 0, 0},
    };

    mlockall(MCL_CURRENT | MCL_FUTURE);

    signal(SIGTERM, cleanup_and_exit);
    signal(SIGINT, cleanup_and_exit);

    while ((opt = getopt_long(argc, argv, "hve:f:t:p:RT",
                              long_options, NULL)) != -1) {
        switch (opt) {
        case 'h':
            print_usage(argv[0]);
            exit(0);

        case 'p':
            print = strtoul(optarg, NULL, 0);
            break;

        case 'v':
            verbose = 1;
            break;

        case 'e':
            err_mask = strtoul(optarg, NULL, 0);
            break;

        case 'f':
            ptr = optarg;
            while (1) {
                id = strtoul(ptr, NULL, 0);
                ptr = strchr(ptr, ':');
                if (!ptr) {
                    fprintf(stderr, "filter must be applied in the form
       id:mask[:id:mask]...\n");
                    exit(1);
                }
                ptr++;
                mask = strtoul(ptr, NULL, 0);
                ptr = strchr(ptr, ':');
                add_filter(id, mask);
                if (!ptr)
                    break;
                ptr++;
            }
            break;

        case 't':
            timeout = (nanosecs_rel_t)strtoul(optarg, NULL, 0) * 1000000;
            break;

        case 'R':
            timestamp_rel = 1;
        case 'T':
            with_timestamp = 1;
            break;
        default:
            fprintf(stderr, "Unknown option %c\n", opt);
            break;
        }
    }

    ret = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
    if (ret < 0) {
        fprintf(stderr, "rt_dev_socket: %s\n", strerror(-ret));
        return -1;
    }
    s = ret;

    if (argv[optind] == NULL) {
        if (verbose)
            printf("interface all\n");

        ifr.ifr_ifindex = 0;
    } else {
        if (verbose)
            printf("interface %s\n", argv[optind]);

        strncpy(ifr.ifr_name, argv[optind], IFNAMSIZ);
        if (verbose)
            printf("s=%d, ifr_name=%s\n", s, ifr.ifr_name);

        ret = rt_dev_ioctl(s, SIOCGIFINDEX, &ifr);
        if (ret < 0) {
            fprintf(stderr, "rt_dev_ioctl GET_IFINDEX: %s\n", strerror(-ret));
            goto failure;
        }
    }

    if (err_mask) {
        ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_ERR_FILTER,
                                &err_mask, sizeof(err_mask));
        if (ret < 0) {
            fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
            goto failure;
        }
        if (verbose)
            printf("Using err_mask=%#x\n", err_mask);
    }

    if (filter_count) {
        ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_FILTER,
                                &recv_filter, filter_count *
                                sizeof(struct can_filter));
        if (ret < 0) {
            fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
            goto failure;
        }
    }

    recv_addr.can_family = AF_CAN;
    recv_addr.can_ifindex = ifr.ifr_ifindex;
    ret = rt_dev_bind(s, (struct sockaddr *)&recv_addr,
                      sizeof(struct sockaddr_can));
    if (ret < 0) {
        fprintf(stderr, "rt_dev_bind: %s\n", strerror(-ret));
        goto failure;
    }
    if (timeout) {
        if (verbose)
            printf("Timeout: %lld ns\n", (long long)timeout);
        ret = rt_dev_ioctl(s, RTCAN_RTIOC_RCV_TIMEOUT, &timeout);
        if (ret) {
            fprintf(stderr, "rt_dev_ioctl RCV_TIMEOUT: %s\n", strerror(-ret));
            goto failure;
        }
    }

    if (with_timestamp) {
        ret = rt_dev_ioctl(s, RTCAN_RTIOC_TAKE_TIMESTAMP, RTCAN_TAKE_TIMESTAMPS
      );
        if (ret) {
            fprintf(stderr, "rt_dev_ioctl TAKE_TIMESTAMP: %s\n", strerror(-ret)
      );
            goto failure;
        }
    }

    snprintf(name, sizeof(name), "rtcanrecv-%d", getpid());
    ret = rt_task_shadow(&rt_task_desc, name, 0, 0);
    if (ret) {
        fprintf(stderr, "rt_task_shadow: %s\n", strerror(-ret));
        goto failure;
    }

    rt_task();
    /* never returns */

 failure:
    cleanup();
    return -1;
}
```

8.5 rtcansend.c

```
#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
#include <time.h>
#include <errno.h>
#include <getopt.h>
#include <sys/mman.h>

#include <native/task.h>
#include <native/timer.h>
#include <native/pipe.h>

#include <rtdm/rtcan.h>

extern int optind, opterr, optopt;

static void print_usage(char *prg)
{
    fprintf(stderr,
            "Usage: %s <can-interface> [Options] <can-msg>\n"
            "<can-msg> can consist of up to 8 bytes given as a space separated
       list\n"
            "Options:\n"
            " -i, --identifier=ID   CAN Identifier (default = 1)\n"
            " -r  --rtr             send remote request\n"
            " -e  --extended        send extended frame\n"
            " -l  --loop=COUNT      send message COUNT times\n"
            " -c, --count           message count in data[0-3]\n"
            " -d, --delay=MS        delay in ms (default = 1ms)\n"
            " -s, --send            use send instead of sendto\n"
            " -t, --timeout=MS      timeout in ms\n"
            " -L, --loopback=0|1    switch local loopback off or on\n"
            " -v, --verbose         be verbose\n"
            " -p, --print=MODULO    print every MODULO message\n"
            " -h, --help            this help\n",
            prg);
}


RT_TASK rt_task_desc;

static int s=-1, dlc=0, rtr=0, extended=0, verbose=0, loops=1;
static SRTIME delay=1000000;
static int count=0, print=1, use_send=0, loopback=-1;
static nanosecs_rel_t timeout = 0;
static struct can_frame frame;
static struct sockaddr_can to_addr;


void cleanup(void)
{
    int ret;

    if (verbose)
        printf("Cleaning up...\n");

    usleep(100000);

    if (s >= 0) {
        ret = rt_dev_close(s);
        s = -1;
        if (ret) {
            fprintf(stderr, "rt_dev_close: %s\n", strerror(-ret));
        }
        rt_task_delete(&rt_task_desc);
    }
}

void cleanup_and_exit(int sig)
{
    if (verbose)
        printf("Signal %d received\n", sig);
    cleanup();
    exit(0);
}

void rt_task(void)
{
    int i, j, ret;

    for (i = 0; i < loops; i++) {
        rt_task_sleep(rt_timer_ns2ticks(delay));
        if (count)
            memcpy(&frame.data[0], &i, sizeof(i));
        /* Note: sendto avoids the definiton of a receive filter list */
        if (use_send)
            ret = rt_dev_send(s, (void *)&frame, sizeof(can_frame_t), 0);
        else
            ret = rt_dev_sendto(s, (void *)&frame, sizeof(can_frame_t), 0,
                                (struct sockaddr *)&to_addr, sizeof(to_addr));
        if (ret < 0) {
            switch (ret) {
            case -ETIMEDOUT:
                if (verbose)
                    printf("rt_dev_send(to): timed out");
                break;
            case -EBADF:
                if (verbose)
                    printf("rt_dev_send(to): aborted because socket was closed"
      );
                break;
            default:
                fprintf(stderr, "rt_dev_send: %s\n", strerror(-ret));
                break;
            }
            i = loops;          /* abort */
            break;
        }
        if (verbose && (i % print) == 0) {
            if (frame.can_id & CAN_EFF_FLAG)
                printf("<0x%08x>", frame.can_id & CAN_EFF_MASK);
            else
                printf("<0x%03x>", frame.can_id & CAN_SFF_MASK);
            printf(" [%d]", frame.can_dlc);
            for (j = 0; j < frame.can_dlc; j++) {
                printf(" %02x", frame.data[j]);
            }
            printf("\n");
        }
    }
}

int main(int argc, char **argv)
{
    int i, opt, ret;
    struct ifreq ifr;
    char name[32];

    struct option long_options[] = {
        { "help", no_argument, 0, 'h' },
        { "identifier", required_argument, 0, 'i'},
        { "rtr", no_argument, 0, 'r'},
        { "extended", no_argument, 0, 'e'},
        { "verbose", no_argument, 0, 'v'},
        { "count", no_argument, 0, 'c'},
        { "print", required_argument, 0, 'p'},
        { "loop", required_argument, 0, 'l'},
        { "delay", required_argument, 0, 'd'},
        { "send", no_argument, 0, 's'},
        { "timeout", required_argument, 0, 't'},
        { "loopback", required_argument, 0, 'L'},
        { 0, 0, 0, 0},
    };
```

```
mlockall(MCL_CURRENT | MCL_FUTURE);

signal(SIGTERM, cleanup_and_exit);
signal(SIGINT, cleanup_and_exit);

frame.can_id = 1;

while ((opt = getopt_long(argc, argv, "hvi:l:red:t:cp:sL:",
                          long_options, NULL)) != -1) {
    switch (opt) {
    case 'h':
        print_usage(argv[0]);
        exit(0);

    case 'p':
        print = strtoul(optarg, NULL, 0);

    case 'v':
        verbose = 1;
        break;

    case 'c':
        count = 1;
        break;

    case 'l':
        loops = strtoul(optarg, NULL, 0);
        break;

    case 'i':
        frame.can_id = strtoul(optarg, NULL, 0);
        break;

    case 'r':
        rtr = 1;
        break;

    case 'e':
        extended = 1;
        break;

    case 'd':
        delay = strtoul(optarg, NULL, 0) * 1000000LL;
        break;

    case 's':
        use_send = 1;
        break;

    case 't':
        timeout = strtoul(optarg, NULL, 0) * 1000000LL;
        break;

    case 'L':
        loopback = strtoul(optarg, NULL, 0);
        break;

    default:
        fprintf(stderr, "Unknown option %c\n", opt);
        break;
    }
}
```

```
    if (optind == argc) {
        print_usage(argv[0]);
        exit(0);
    }

    if (argv[optind] == NULL) {
        fprintf(stderr, "No Interface supplied\n");
        exit(-1);
    }

    if (verbose)
        printf("interface %s\n", argv[optind]);

    ret = rt_dev_socket(PF_CAN, SOCK_RAW, CAN_RAW);
    if (ret < 0) {
        fprintf(stderr, "rt_dev_socket: %s\n", strerror(-ret));
        return -1;
    }
    s = ret;

    if (loopback >= 0) {
        ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_LOOPBACK,
                                &loopback, sizeof(loopback));
        if (ret < 0) {
            fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
            goto failure;
        }
        if (verbose)
            printf("Using loopback=%d\n", loopback);
    }

    strncpy(ifr.ifr_name, argv[optind], IFNAMSIZ);
    if (verbose)
        printf("s=%d, ifr_name=%s\n", s, ifr.ifr_name);

    ret = rt_dev_ioctl(s, SIOCGIFINDEX, &ifr);
    if (ret < 0) {
        fprintf(stderr, "rt_dev_ioctl: %s\n", strerror(-ret));
        goto failure;
    }

    memset(&to_addr, 0, sizeof(to_addr));
    to_addr.can_ifindex = ifr.ifr_ifindex;
    to_addr.can_family = AF_CAN;
    if (use_send) {
        /* Suppress definiton of a default receive filter list */
        ret = rt_dev_setsockopt(s, SOL_CAN_RAW, CAN_RAW_FILTER, NULL, 0);
        if (ret < 0) {
            fprintf(stderr, "rt_dev_setsockopt: %s\n", strerror(-ret));
            goto failure;
        }

        ret = rt_dev_bind(s, (struct sockaddr *)&to_addr, sizeof(to_addr));
        if (ret < 0) {
            fprintf(stderr, "rt_dev_bind: %s\n", strerror(-ret));
            goto failure;
        }
    }

    if (count)
        frame.can_dlc = sizeof(int);
    else {
        for (i = optind + 1; i < argc; i++) {
            frame.data[dlc] = strtoul(argv[i], NULL, 0);
            dlc++;
            if( dlc == 8 )
                break;
        }
        frame.can_dlc = dlc;
    }

    if (rtr)
        frame.can_id |= CAN_RTR_FLAG;

    if (extended)
        frame.can_id |= CAN_EFF_FLAG;

    if (timeout) {
        if (verbose)
            printf("Timeout: %lld ns\n", (long long)timeout);
        ret = rt_dev_ioctl(s, RTCAN_RTIOC_SND_TIMEOUT, &timeout);
        if (ret) {
            fprintf(stderr, "rt_dev_ioctl SND_TIMEOUT: %s\n", strerror(-ret));
            goto failure;
        }
    }

    snprintf(name, sizeof(name), "rtcansend-%d", getpid());
    ret = rt_task_shadow(&rt_task_desc, name, 1, 0);
    if (ret) {
        fprintf(stderr, "rt_task_shadow: %s\n", strerror(-ret));
        goto failure;
    }

    rt_task();

    cleanup();
    return 0;

 failure:
    cleanup();
    return -1;
}
```