HellfireOS v2.0

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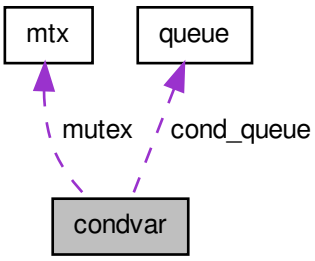
Data Structure Documentation

3.1 condvar Struct Reference

Condition variable data structure.

`#include <condvar.h>`

Collaboration diagram for condvar:



Data Fields

- struct queue * cond_queue
- mutex_t mutex

3.1.1 Detailed Description

Condition variable data structure.

3.1.2 Field Documentation

3.1.2.1 struct queue* condvar::cond_queue

queue for tasks waiting on the condition variable

3.1.2.2 mutex_t condvar::mutex

mutex used for the critical section associated with the condition variable

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

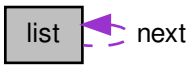
- sys/include/condvar.h

3.2 list Struct Reference

List data structure.

`#include <list.h>`

Collaboration diagram for list:



Data Fields

- void * elem
- struct list * next

3.2.1 Detailed Description

List data structure.

3.2.2 Field Documentation

3.2.2.1 void* list::elem

pointer to list node data

3.2.2.2 struct list* list::next

pointer to the next list node

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

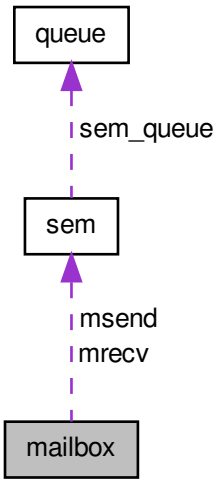
- sys/include/list.h

3.3 mailbox Struct Reference

Mailbox data structure.

`#include <mailbox.h>`

Collaboration diagram for mailbox:



Data Fields

- void * msg
- uint16_t n_waiting_tasks
- uint16_t count
- sem_t msend
- sem_t mrecv

3.3.1 Detailed Description

Mailbox data structure.

3.3.2 Field Documentation

3.3.2.1 uint16_t mailbox::count

number of elements on the mailbox

3.3.2.2 sem_t mailbox::mrecv

synchronization semaphore for mail receive

3.3.2.3 sem_t mailbox::msend

synchronization semaphore for mail send

3.3.2.4 void* mailbox::msg

pointer to a message buffer

3.3.2.5 uint16_t mailbox::n_waiting_tasks

number of waiting tasks in the mailbox

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

- sys/include/mailbox.h

3.4 mem_block Struct Reference

`#include <malloc.h>`

Collaboration diagram for mem_block:

Data Fields

- struct mem_block * next
- size_t size

3.4.1 Field Documentation

3.4.1.1 struct mem_block * mem_block::next

3.4.1.2 size_t mem_block::size

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

- sys/include/malloc.h

3.5 mem_chunk Struct Reference

`#include <malloc.h>`

Data Fields

- uint32_t size

3.5.1 Field Documentation

3.5.1.1 uint32_t mem_chunk::size

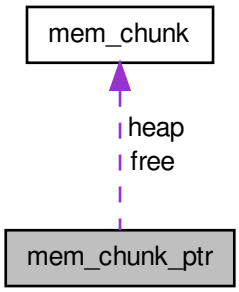
The documentation for this struct was generated from the following file:

- sys/include/malloc.h

3.6 mem_chunk_ptr Struct Reference

`#include <malloc.h>`

Collaboration diagram for mem_chunk_ptr:



Data Fields

- mem_chunk * free
- mem_chunk * heap

3.6.1 Field Documentation

3.6.1.1 mem_chunk* mem_chunk_ptr::free

3.6.1.2 mem_chunk* mem_chunk_ptr::heap

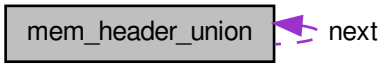
The documentation for this struct was generated from the following file:

- sys/include/malloc.h

3.7 mem_header_union Union Reference

`#include <malloc.h>`

Collaboration diagram for mem_header_union:



Data Fields

- struct {
  union mem_header_union * next
  uint32_t size
  } s
- align align_dummy

3.7.1 Field Documentation

3.7.1.1 align mem_header_union::align_dummy

3.7.1.2 union mem_header_union* mem_header_union::next

3.7.1.3 struct { ... } mem_header_union::s

3.7.1.4 uint32_t mem_header_union::size

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

- sys/include/malloc.h

3.8 mtx Struct Reference

Mutex data structure.

`#include <mutex.h>`

Data Fields

- int32_t lock
- uint8_t level [MAX_TASKS]
- uint8_t waiting [MAX_TASKS-1]

3.8.1 Detailed Description

Mutex data structure.

3.8.2 Field Documentation

3.8.2.1 uint8_t mtx::level[MAX_TASKS]

3.8.2.2 int32_t mtx::lock

mutex lock, atomically modified

3.8.2.3 uint8_t mtx::waiting[MAX_TASKS-1]

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

- sys/include/mutex.h

3.9 pcb_entry Struct Reference

`#include <kernel.h>`

Data Fields

- uint32_t coop_cswitch
- uint32_t preempt_cswitch
- uint32_t interrupts

3.9.1 Field Documentation

3.9.1.1 uint32_t pcb_entry::coop_cswitch

cooperative context switches

3.9.1.2 uint32_t pcb_entry::interrupts

number of non-masked interrupts

3.9.1.3 uint32_t pcb_entry::preempt_cswitch

preeptive context switches

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

- sys/include/kernel.h

3.10 queue Struct Reference

Queue data structure.

`#include <queue.h>`

Data Fields

- int32_t size
- int32_t elem
- int32_t head
- int32_t tail
- void ** data

3.10.1 Detailed Description

Queue data structure.

3.10.2 Field Documentation

3.10.2.1 void** queue::data

pointer to an array of pointers to node data

3.10.2.2 int32_t queue::elem

number of elements queued

3.10.2.3 int32_t queue::head

first element of the queue

3.10.2.4 int32_t queue::size

queue size (maximum number of elements)

3.10.2.5 int32_t queue::tail

last element of the queue

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

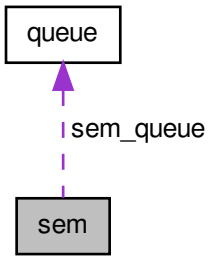
- sys/include/queue.h

3.11 sem Struct Reference

Semaphore data structure.

`#include <semaphore.h>`

Collaboration diagram for sem:



Data Fields

- struct queue * sem_queue
- int32_t count

3.11.1 Detailed Description

Semaphore data structure.

3.11.2 Field Documentation

3.11.2.1 int32_t sem::count

semaphore counter

3.11.2.2 struct queue* sem::sem_queue

queue for tasks waiting on the semaphore

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

- sys/include/semaphore.h

3.12 tcb_entry Struct Reference

Task control block (TCB) and processor control block (PCB) entry data structures.

`#include <kernel.h>`

Data Fields

- uint16_t id
- int8_t name [20]
- uint8_t state

- uint32_t delay
- uint32_t rtjobs
- uint32_t bgjobs
- uint32_t deadline_misses
- uint16_t period
- uint16_t capacity
- uint16_t deadline
- uint16_t capacity_rem
- uint16_t deadline_rem
- context task_context
- void(∗ ptask)(void)
- int32_t ∗ pstack
- uint32_t stack_size
- void ∗ other_data

3.12.1 Detailed Description

Task control block (TCB) and processor control block (PCB) entry data structures.

3.12.2 Field Documentation

3.12.2.1 uint32_t tcb_entry::bgjobs

total BE jobs executed. BE tasks share processor idle time and execute in the background.

3.12.2.2 uint16_t tcb_entry::capacity

task capacity

3.12.2.3 uint16_t tcb_entry::capacity_rem

remaining capacity on period

3.12.2.4 uint16_t tcb_entry::deadline

task deadline

3.12.2.5 uint32_t tcb_entry::deadline_misses

task realtime deadline misses

3.12.2.6 uint16_t tcb_entry::deadline_rem

remaining time slices on period

3.12.2.7 uint32_t tcb_entry::delay

delay to enter in the run/RT queue

3.12.2.8 uint16_t tcb_entry::id

task id

3.12.2.9 int8_t tcb_entry::name[20]

task description (or name)

3.12.2.10 void* tcb_entry::other_data

pointer to other data related to this task

3.12.2.11 uint16_t tcb_entry::period

task period

3.12.2.12 int32_t* tcb_entry::pstack

task stack area (bottom)

3.12.2.13 void(* tcb_entry::ptask)(void)

task entry point, pointer to function

3.12.2.14 uint32_t tcb_entry::rtjobs

total RT task jobs executed

3.12.2.15 uint32_t tcb_entry::stack_size

task stack size

3.12.2.16 uint8_t tcb_entry::state

0 - idle, 1 - ready, 2 - running, 3 - blocked, 4 - delayed, 5 - waiting

3.12.2.17 context tcb_entry::task_context

task context

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

- sys/include/kernel.h

Chapter 4

File Documentation

4.1 drivers/noc/include/noc.h File Reference

Functions

- void ni_init (void)

  NoC driver: initializes the network interface.
- void ni_isr (void *arg)

  NoC driver: network interface interrupt service routine.
- uint16_t hf_cpuid (void)

  Returns the current cpu id number.
- uint16_t hf_ncores (void)

  Returns the number of processors in the system.
- int32_t hf_comm_create (uint16_t id, uint16_t port, uint16_t packets)

  Creates a communication queue for a task, using a port number as an alias.
- int32_t hf_comm_destroy (uint16_t id)

  Destroys a communication queue, returning packets buffered on a task message queue to the shared pool of packets.
- int32_t hf_recv (uint16_t *source_cpu, uint16_t *source_port, int8_t *buf, uint16_t *size, uint16_t channel)

  Receives a message from a task (blocking receive).
- int32_t hf_send (uint16_t target_cpu, uint16_t target_port, int8_t *buf, uint16_t size, uint16_t channel)

  Sends a message to a task (blocking send).
- int32_t hf_recvack (uint16_t *source_cpu, uint16_t *source_port, int8_t *buf, uint16_t *size, uint16_t channel)

  Receives a message from a task (blocking receive) with acknowledgement.
- int32_t hf_sendack (uint16_t target_cpu, uint16_t target_port, int8_t *buf, uint16_t size, uint16_t channel, uint32_t timeout)

  Sends a message to a task (blocking send) with acknowledgement.

Variables

- uint16_t pktdrv_ports [MAX_TASKS]

  Array of associations between tasks and reception ports.
- struct queue * pktdrv_tqueue [MAX_TASKS]

  Array of queues. Each task can have its own custom sized queue.
- struct queue * pktdrv_queue

  Queue of free (shared) packets. The number of packets is NOC_PACKET_SLOTS.

4.1.1 Detailed Description

Author

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Date

April 2016

4.1.2 LICENSE

This source code is licensed under the GNU General Public License, Version 2. See the file 'doc/license/gpl-2.0.txt' for more details.

4.1.3 DESCRIPTION

Network-on-Chip driver error codes and packet header offsets.

4.1.4 Function Documentation

4.1.4.1 int32_t hf_comm_create (uint16_t *id,* uint16_t *port,* uint16_t *packets*)

Creates a communication queue for a task, using a port number as an alias.

Parameters

id	is the task id which will own the communication queue
port	is the receiving port for the task
packets	is the communication queue size, in packets

Returns

ERR_OK when successful, ERR_INVALID_ID if no task matches the specified id, ERR_COMM_UNFEASIBLE if there is already a communication queue for the task, ERR_COMM_ERROR if there is already another task using the specified port and ERR_OUT_OF_MEMORY if the systems runs out of memory.

The queue created for the task will be used for the reception of data. Both ni_isr() and hf_recv() routines will manage the queue, putting and pulling packets from the queue on demand. The communication subsystem is configured by the association of a task id to a receiving port (alias) and the definition of how many packet slots a task has on its queue.

4.1.4.2 int32_t hf_comm_destroy (uint16_t *id*)

Destroys a communication queue, returning packets buffered on a task message queue to the shared pool of packets.

Parameters

id	is the task id which owns the communication queue

Returns

ERR_OK when successful, ERR_INVALID_ID if no task matches the specified id, ERR_COMM_ERROR if the queue could not be destroyed.

4.1.4.3 uint16_t hf_cpuid (void)

Returns the current cpu id number.

Returns

the current cpu id, defined by the CPU_ID macro.

4.1.4.4 uint16_t hf_ncores (void)

Returns the number of processors in the system.

Returns

the number of cores, defined by the dimensions of the NoC mesh.

4.1.4.5 int32_t hf_recv (uint16_t * *source_cpu*, uint16_t * *source_port*, int8_t * *buf*, uint16_t * *size*, uint16_t *channel*)

Receives a message from a task (blocking receive).

Parameters

source_cpu	is a pointer to a variable which will hold the source cpu
source_port	is a pointer to a variable which will hold the source port
buf	is a pointer to a buffer to hold the received message
size	a pointer to a variable which will hold the size (in bytes) of the received message
channel	is the selected message channel of this message (must be the same as in the sender)

Returns

ERR_OK when successful, ERR_COMM_UNFEASIBLE when no message queue (comm) was created and ERR_SEQ_ERROR when received packets arrive out of order, so the message is corrupted.

A message is build from packets received on the ni_isr() routine. Packets are decoded and combined in a complete message, returning the message, its size and source identification to the calling task. The buffer where the message will be stored must be large enough or we will have a problem that may not be noticed before its too late.

4.1.4.6 int32_t hf_recvack (uint16_t * *source_cpu*, uint16_t * *source_port*, int8_t * *buf*, uint16_t * *size*, uint16_t *channel*)

Receives a message from a task (blocking receive) with acknowledgement.

Parameters

source_cpu	is a pointer to a variable which will hold the source cpu
source_port	is a pointer to a variable which will hold the source port
buf	is a pointer to a buffer to hold the received message
size	a pointer to a variable which will hold the size (in bytes) of the received message
channel	is the selected message channel of this message (must be the same as in the sender)

Returns

ERR_OK when successful, ERR_COMM_UNFEASIBLE when no message queue (comm) was created and ERR_SEQ_ERROR when received packets arrive out of order, so the message is corrupted.

A message is build from packets received on the ni_isr() routine. Packets are decoded and combined in a complete message, returning the message, its size and source identification to the calling task. The buffer where the message

will be stored must be large enough or we will have a problem that may not be noticed before its too late. After the reception of the whole message is completed, an acknowledgement is sent to the sender task. This works as a flow control mechanism, avoiding buffer/queue overflows common to the raw protocol. Message channel 65535 will be used for the flow control mechanism.

4.1.4.7 int32_t hf_send (uint16_t *target_cpu,* uint16_t *target_port,* int8_t * *buf,* uint16_t *size,* uint16_t *channel*)

Sends a message to a task (blocking send).

Parameters

target_cpu	is the target processor
target_port	is the target task port
buf	is a pointer to a buffer that holds the message
size	is the size (in bytes) of the message
channel	is the selected message channel of this message (must be the same as in the receiver)

Returns

ERR_OK

A message is broken into packets containing a header and part of the message as the payload. The packets are injected, one by one, in the network through the network interface.

4.1.4.8 int32_t hf_sendack (uint16_t *target_cpu,* uint16_t *target_port,* int8_t * *buf,* uint16_t *size,* uint16_t *channel,* uint32_t *timeout*)

Sends a message to a task (blocking send) with acknowledgement.

Parameters

target_cpu	is the target processor
target_port	is the target task port
buf	is a pointer to a buffer that holds the message
size	is the size (in bytes) of the message
channel	is the selected message channel of this message (must be the same as in the receiver)
timeout	is the time (in ms) that the sender will wait for a reception acknowledgement

Returns

ERR_OK

A message is broken into packets containing a header and part of the message as the payload. The packets are injected, one by one, in the network through the network interface. After that, the sender will wait for an acknowledgement from the receiver. This works as a flow control mechanism, avoiding buffer/queue overflows common to the raw protocol. Message channel 65535 will be used for the flow control mechanism.

4.1.4.9 void ni_init (void)

NoC driver: initializes the network interface.

A queue for the packet driver is initialized with NOC_PACKET_SLOTS capacity (in packets). The queue is populated with empty packets (pointers to dinamically allocated memory areas) which will be used (shared) among all tasks for the reception of data. The hardware is reset and the NoC interrupt handler is registered. This routine is called during the system boot-up and is dependent on the architecture implementation.

4.1.4.10 void ni_isr (void * *arg*)

NoC driver: network interface interrupt service routine.

This routine is called by the second level of interrupt handling. An interrupt from the network interface means a full packet has arrived. The packet header is decoded and the target port is identified. A reference to an empty packet is removed from the pool of buffers (packets), the contents of the empty packet are filled with flits from the hardware queue and the reference is put on the target task (associated to a port) queue of packets. There is one queue per task of configurable size.

4.1.5 Variable Documentation

4.1.5.1 uint16_t pktdrv_ports[MAX_TASKS]

Array of associations between tasks and reception ports.

4.1.5.2 struct queue* pktdrv_queue

Queue of free (shared) packets. The number of packets is NOC_PACKET_SLOTS.

4.1.5.3 struct queue* pktdrv_tqueue[MAX_TASKS]

Array of queues. Each task can have its own custom sized queue.

4.2 drivers/noc/noc.c File Reference

Functions

- void ni_init (void)

  NoC driver: initializes the network interface.
- void ni_isr (void *arg)

  NoC driver: network interface interrupt service routine.
- uint16_t hf_cpuid (void)

  Returns the current cpu id number.
- uint16_t hf_ncores (void)

  Returns the number of processors in the system.
- int32_t hf_comm_create (uint16_t id, uint16_t port, uint16_t packets)

  Creates a communication queue for a task, using a port number as an alias.
- int32_t hf_comm_destroy (uint16_t id)

  Destroys a communication queue, returning packets buffered on a task message queue to the shared pool of packets.
- int32_t hf_recv (uint16_t *source_cpu, uint16_t *source_port, int8_t *buf, uint16_t *size, uint16_t channel)

  Receives a message from a task (blocking receive).
- int32_t hf_send (uint16_t target_cpu, uint16_t target_port, int8_t *buf, uint16_t size, uint16_t channel)

  Sends a message to a task (blocking send).
- int32_t hf_recvack (uint16_t *source_cpu, uint16_t *source_port, int8_t *buf, uint16_t *size, uint16_t channel)

  Receives a message from a task (blocking receive) with acknowledgement.
- int32_t hf_sendack (uint16_t target_cpu, uint16_t target_port, int8_t *buf, uint16_t size, uint16_t channel, uint32_t timeout)

  Sends a message to a task (blocking send) with acknowledgement.

4.2.1 Detailed Description

Author

Sergio Johann Filho

Date

April 2016

4.2.2 LICENSE

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4.2.3 DESCRIPTION

NoC (Network-on-Chip) interconnect driver. This driver assumes a 16-bit channel width and a basic communication protocol between the cores and the network interface, provided by _ni_read(), _ni_write() and _ni_status() helper functions (defined on the architecture HAL). A 2D mesh NoC and a buffered (1 packet) network interface are assumed.

Packet format is as follows:

```
 2 bytes   2 bytes   2 bytes   2 bytes   2 bytes   2 bytes   2 bytes   2 bytes       ....
-------------------------------------------------------------------------------------------------
|tgt_cpu  |payload  |src_cpu  |src_port |tgt_port |msg_size |seq      |channel  |  ... data ...  |
-------------------------------------------------------------------------------------------------
```

The platform should include the following macros:

NOC_INTERCONNECT intra-chip interconnection type CPU_ID a unique sequential number for each core NOC_WIDTH number of columns of the 2D mesh NOC_HEIGHT number of rows of the 2D mesh NOC_PACKET_SIZE packet size (in 16 bit flits) NOC_PACKET_SLOTS number of slots in the shared packet queue per core

4.2.4 Function Documentation

4.2.4.1 int32_t hf_comm_create (uint16_t *id*, uint16_t *port*, uint16_t *packets*)

Creates a communication queue for a task, using a port number as an alias.

Parameters

id	is the task id which will own the communication queue
port	is the receiving port for the task
packets	is the communication queue size, in packets

Returns

ERR_OK when successful, ERR_INVALID_ID if no task matches the specified id, ERR_COMM_UNFEASIBLE if there is already a communication queue for the task, ERR_COMM_ERROR if there is already another task using the specified port and ERR_OUT_OF_MEMORY if the systems runs out of memory.

The queue created for the task will be used for the reception of data. Both ni_isr() and hf_recv() routines will manage the queue, putting and pulling packets from the queue on demand. The communication subsystem is configured by the association of a task id to a receiving port (alias) and the definition of how many packet slots a task has on its queue.

4.2.4.2 int32_t hf_comm_destroy (uint16_t *id*)

Destroys a communication queue, returning packets buffered on a task message queue to the shared pool of packets.

Parameters

id	is the task id which owns the communication queue

Returns

ERR_OK when successful, ERR_INVALID_ID if no task matches the specified id, ERR_COMM_ERROR if the queue could not be destroyed.

4.2.4.3 uint16_t hf_cpuid (void)

Returns the current cpu id number.

Returns

the current cpu id, defined by the CPU_ID macro.

4.2.4.4 uint16_t hf_ncores (void)

Returns the number of processors in the system.

Returns

the number of cores, defined by the dimensions of the NoC mesh.

4.2.4.5 int32_t hf_recv (uint16_t * *source_cpu*, uint16_t * *source_port*, int8_t * *buf*, uint16_t * *size*, uint16_t *channel*)

Receives a message from a task (blocking receive).

Parameters

source_cpu	is a pointer to a variable which will hold the source cpu
source_port	is a pointer to a variable which will hold the source port
buf	is a pointer to a buffer to hold the received message
size	a pointer to a variable which will hold the size (in bytes) of the received message
channel	is the selected message channel of this message (must be the same as in the sender)

Returns

ERR_OK when successful, ERR_COMM_UNFEASIBLE when no message queue (comm) was created and ERR_SEQ_ERROR when received packets arrive out of order, so the message is corrupted.

A message is build from packets received on the ni_isr() routine. Packets are decoded and combined in a complete message, returning the message, its size and source identification to the calling task. The buffer where the message will be stored must be large enough or we will have a problem that may not be noticed before its too late.

4.2.4.6 int32_t hf_recvack (uint16_t * *source_cpu*, uint16_t * *source_port*, int8_t * *buf*, uint16_t * *size*, uint16_t *channel*)

Receives a message from a task (blocking receive) with acknowledgement.

Parameters

source_cpu	is a pointer to a variable which will hold the source cpu
source_port	is a pointer to a variable which will hold the source port
buf	is a pointer to a buffer to hold the received message
size	a pointer to a variable which will hold the size (in bytes) of the received message
channel	is the selected message channel of this message (must be the same as in the sender)

Returns

ERR_OK when successful, ERR_COMM_UNFEASIBLE when no message queue (comm) was created and ERR_SEQ_ERROR when received packets arrive out of order, so the message is corrupted.

A message is build from packets received on the ni_isr() routine. Packets are decoded and combined in a complete message, returning the message, its size and source identification to the calling task. The buffer where the message will be stored must be large enough or we will have a problem that may not be noticed before its too late. After the reception of the whole message is completed, an acknowledgement is sent to the sender task. This works as a flow control mechanism, avoiding buffer/queue overflows common to the raw protocol. Message channel 65535 will be used for the flow control mechanism.

4.2.4.7 int32_t hf_send (uint16_t *target_cpu*, uint16_t *target_port*, int8_t * *buf*, uint16_t *size*, uint16_t *channel*)

Sends a message to a task (blocking send).

Parameters

target_cpu	is the target processor
target_port	is the target task port
buf	is a pointer to a buffer that holds the message
size	is the size (in bytes) of the message
channel	is the selected message channel of this message (must be the same as in the receiver)

Returns

ERR_OK

A message is broken into packets containing a header and part of the message as the payload. The packets are injected, one by one, in the network through the network interface.

4.2.4.8 int32_t hf_sendack (uint16_t *target_cpu*, uint16_t *target_port*, int8_t * *buf*, uint16_t *size*, uint16_t *channel*, uint32_t *timeout*)

Sends a message to a task (blocking send) with acknowledgement.

Parameters

target_cpu	is the target processor
target_port	is the target task port
buf	is a pointer to a buffer that holds the message
size	is the size (in bytes) of the message
channel	is the selected message channel of this message (must be the same as in the receiver)
timeout	is the time (in ms) that the sender will wait for a reception acknowledgement

Returns

ERR_OK

A message is broken into packets containing a header and part of the message as the payload. The packets are injected, one by one, in the network through the network interface. After that, the sender will wait for an acknowledgement from the receiver. This works as a flow control mechanism, avoiding buffer/queue overflows common to the raw protocol. Message channel 65535 will be used for the flow control mechanism.

4.2.4.9 void ni_init (void)

NoC driver: initializes the network interface.

A queue for the packet driver is initialized with NOC_PACKET_SLOTS capacity (in packets). The queue is populated with empty packets (pointers to dinamically allocated memory areas) which will be used (shared) among all tasks for the reception of data. The hardware is reset and the NoC interrupt handler is registered. This routine is called during the system boot-up and is dependent on the architecture implementation.

4.2.4.10 void ni_isr (void * *arg*)

NoC driver: network interface interrupt service routine.

This routine is called by the second level of interrupt handling. An interrupt from the network interface means a full packet has arrived. The packet header is decoded and the target port is identified. A reference to an empty packet is removed from the pool of buffers (packets), the contents of the empty packet are filled with flits from the hardware queue and the reference is put on the target task (associated to a port) queue of packets. There is one queue per task of configurable size.

4.3 sys/include/condvar.h File Reference

Data Structures

- struct condvar

  Condition variable data structure.

Typedefs

- typedef struct condvar cond_t

Functions

- int32_t hf_condinit (cond_t *c)

  Initializes a condition variable.
- int32_t hf_conddestroy (cond_t *c)

  Destroys a condition variable.
- void hf_condwait (cond_t *c, mutex_t *m)

  Wait on a condition variable.
- void hf_condsignal (cond_t *c)

  Signal a condition variable.
- void hf_condbroadcast (cond_t *c)

  Signal (broadcast) a condition variable.

4.3.1 Typedef Documentation

4.3.1.1 typedef struct condvar cond_t

4.3.2 Function Documentation

4.3.2.1 void hf_condbroadcast (cond_t * c)

Signal (broadcast) a condition variable.

Parameters

c	is a pointer to a condition variable.

Implements the condition signal broadcast operation for all waiting tasks. The call unblocks and removes all tasks from the waiting queue. If no tasks are waiting for the condition, the signal is lost.

4.3.2.2 int32_t hf_conddestroy (cond_t * c)

Destroys a condition variable.

Parameters

c	is a pointer to a condition variable.

Returns

ERR_OK on success and ERR_ERROR if the condition variable could not be removed from memory.

4.3.2.3 int32_t hf_condinit (cond_t * c)

Initializes a condition variable.

Parameters

c	is a pointer to a condition variable.

Returns

ERR_OK on success and ERR_ERROR if the condition variable could not be allocated in memory.

4.3.2.4 void hf_condsignal (cond_t * c)

Signal a condition variable.

Parameters

c	is a pointer to a condition variable.

Implements the condition signal operation for one waiting task. The call removes a task from the waiting queue and unblocks it. If no tasks are waiting for the condition, the signal is lost.

4.3.2.5 void hf_condwait (cond_t * c, mutex_t * m)

Wait on a condition variable.

Parameters

c	is a pointer to a condition variable.
m	is a pointer to a mutex.

Implements the atomic condition wait operation. The call should always be invoked with the mutex locked. The current task is put in a queue on the condition variable, its state is set to blocked and unlocks the mutex atomically, then yields the processor. When woke up (by a signalling task), the task locks the mutex and returns.

4.4 sys/include/ecodes.h File Reference

4.5 sys/include/hellfire.h File Reference

4.5.1 Detailed Description

Author

Sergio Johann Filho

Date

February 2016

4.5.2 LICENSE

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4.5.3 DESCRIPTION

Default system wide include file and error code definitions.

4.6 sys/include/kernel.h File Reference

Data Structures

- struct tcb_entry

  Task control block (TCB) and processor control block (PCB) entry data structures.
- struct pcb_entry

Variables

- struct tcb_entry krnl_tcb [MAX_TASKS]

  The task control block and processor control block.
- struct pcb_entry krnl_pcb
- struct tcb_entry * krnl_task
- uint16_t krnl_tasks

- uint16_t krnl_current_task
- uint16_t krnl_schedule
- struct queue * krnl_run_queue
- struct queue * krnl_delay_queue
- struct queue * krnl_rt_queue
- struct queue * krnl_event_queue
- uint8_t krnl_heap [HEAP_SIZE]
- uint32_t krnl_free

4.6.1 Detailed Description

Author

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Date

February 2016

4.6.2 LICENSE

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4.6.3 DESCRIPTION

Kernel data structures.

4.6.4 Variable Documentation

4.6.4.1 uint16_t krnl_current_task

the current running task id

4.6.4.2 struct queue* krnl_delay_queue

pointer to a queue of delayed tasks

4.6.4.3 struct queue* krnl_event_queue

pointer to a queue of tasks waiting for an event

4.6.4.4 uint32_t krnl_free

amount of free heap memory, in bytes

4.6.4.5 uint8_t krnl_heap[HEAP_SIZE]

contiguous heap memory area to be used as a memory pool. the memory allocator (malloc() and free()) controls this data structure

4.6.4.6 struct pcb_entry krnl_pcb

4.6.4.7 struct queue* krnl_rt_queue

pointer to a queue of real time tasks

4.6.4.8 struct queue* krnl_run_queue

pointer to a queue of best effort tasks

4.6.4.9 uint16_t krnl_schedule

scheduler enable / disable flag

4.6.4.10 struct tcb_entry* krnl_task

pointer to a task control block entry

4.6.4.11 uint16_t krnl_tasks

number of tasks in the system

4.6.4.12 struct tcb_entry krnl_tcb[MAX_TASKS]

The task control block and processor control block.

4.7 sys/include/kprintf.h File Reference

Functions

- int32_t kprintf (const int8_t *fmt,...)
  Kernel short version of printf().
- int32_t dprintf (const int8_t *fmt,...)
  Kernel debug version of printf().

4.7.1 Function Documentation

4.7.1.1 int32_t dprintf (const int8_t * *fmt*, ...)

Kernel debug version of printf().

Parameters

fmt	is a pointer to formatted data to be printed on the debug output.

Returns

0.

4.7.1.2 int32_t kprintf (const int8_t * *fmt*, ...)

Kernel short version of printf().

Parameters

fmt	is a pointer to formatted data to be printed.

Returns

0.

4.8 sys/include/list.h File Reference

Data Structures

- struct list

  List data structure.

Functions

- struct list * hf_list_init (void)

  Initializes a list.
- int32_t hf_list_append (struct list *lst, void *item)

  Appends a new node to the end of the list.
- int32_t hf_list_insert (struct list *lst, void *item, int32_t pos)

  Inserts a new node to an arbitrary position in a list.
- int32_t hf_list_remove (struct list *lst, int32_t pos)

  Removes an arbitrary node from a list.
- void * hf_list_get (struct list *lst, int32_t pos)

  Returns the address of the data belonging to a list node.
- int32_t hf_list_set (struct list *lst, void *item, int32_t pos)

  Changes the address of the data belonging to a list node.
- int32_t hf_list_count (struct list *lst)

  Returns the number of nodes in a list.

4.8.1 Function Documentation

4.8.1.1 int32_t hf_list_append (struct list * *lst*, void * *item*)

Appends a new node to the end of the list.

Parameters

lst	is a pointer to a list structure.
item	is a pointer to data belonging to the list node.

Returns

0 when successful and -1 otherwise.

4.8.1.2 int32_t hf_list_count (struct list * lst)

Returns the number of nodes in a list.

Parameters

lst	is a pointer to a list structure.

Returns

The number of elements in the list.

4.8.1.3 void* hf_list_get (struct list * lst, int32_t pos)

Returns the address of the data belonging to a list node.

Parameters

lst	is a pointer to a list structure.
pos	is the n-th element position in the list.

Returns

0 when the element is not found and the address to data otherwise.

4.8.1.4 struct list* hf_list_init (void) [read]

Initializes a list.

Returns

a pointer to a list structure.

4.8.1.5 int32_t hf_list_insert (struct list * lst, void * item, int32_t pos)

Inserts a new node to an arbitrary position in a list.

Parameters

lst	is a pointer to a list structure.
item	is a pointer to data belonging to the list node.
pos	is the n-th element position in the list.

Returns

0 when successful and -1 otherwise.

4.8.1.6 int32_t hf_list_remove (struct list * lst, int32_t pos)

Removes an arbitrary node from a list.

Parameters

lst	is a pointer to a list structure.
pos	is the n-th element position in the list.

Returns

0 when successful and -1 otherwise.

4.8.1.7 int32_t hf_list_set (struct list * *lst*, void * *item*, int32_t *pos*)

Changes the address of the data belonging to a list node.

Parameters

lst	is a pointer to a list structure.
item	is an address to data belonging to the list node.
pos	is the n-th element position in the list.

Returns

-1 when the element is not found and 0 if the element was updated.

4.9 sys/include/mailbox.h File Reference

Data Structures

- struct mailbox

  Mailbox data structure.

Typedefs

- typedef struct mailbox mail_t

Functions

- void hf_mboxinit (mail_t *mbox, uint16_t n_waiting_tasks)
- void hf_mboxsend (mail_t *mbox, void *msg)
- void * hf_mboxrecv (mail_t *mbox)
- void * hf_mboxaccept (mail_t *mbox)

4.9.1 Typedef Documentation

4.9.1.1 typedef struct mailbox mail_t

mailbox type definition

4.9.2 Function Documentation

4.9.2.1 void* hf_mboxaccept (mail_t * *mbox*)

4.9.2.2 void hf_mboxinit (mail_t * *mbox*, uint16_t *n_waiting_tasks*)

4.9.2.3 void* hf_mboxrecv (mail_t * *mbox*)

4.9.2.4 void hf_mboxsend (mail_t * *mbox*, void * *msg*)

4.10 sys/include/main.h File Reference

Functions

- void app_main (void)

4.10.1 Function Documentation

4.10.1.1 void app_main (void)

4.11 sys/include/malloc.h File Reference

Data Structures

- struct mem_chunk
- struct mem_chunk_ptr
- union mem_header_union
- struct mem_block
- struct mem_block

Typedefs

- typedef uint32_t align
- typedef union mem_header_union mem_header_t

Functions

- void hf_free (void *ptr)
- void * hf_malloc (uint32_t size)
- void heapinit (void *heap, uint32_t len)
- void * hf_calloc (uint32_t qty, uint32_t type_size)
- void * hf_realloc (void *ptr, uint32_t size)

Variables

- mem_chunk_ptr krnl_heap_ptr
- struct mem_block * ff

4.11.1 Detailed Description

Author

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4.11.2 LICENSE

4.11.3 DESCRIPTION

Data structures of several memory allocators.

4.11.4 Typedef Documentation

4.11.4.1 typedef uint32_t align

4.11.4.2 typedef union mem_header_union mem_header_t

4.11.5 Function Documentation

4.11.5.1 void heapinit (void * *heap,* uint32_t *len*)

4.11.5.2 void* hf_calloc (uint32_t *qty,* uint32_t *type_size*)

4.11.5.3 void hf_free (void * *ptr*)

4.11.5.4 void * hf_malloc (uint32_t *size*)

4.11.5.5 void* hf_realloc (void * *ptr,* uint32_t *size*)

4.11.6 Variable Documentation

4.11.6.1 struct mem_block* ff

4.11.6.2 mem_chunk_ptr krnl_heap_ptr

4.12 sys/include/mutex.h File Reference

Data Structures

- struct mtx

  Mutex data structure.
- struct mtx

  Mutex data structure.

Typedefs

- typedef struct mtx mutex_t

Functions

- void hf_mtxinit (mutex_t *m)

  Initializes a mutex, defining its initial value.
- void hf_mtxlock (mutex_t *m)

  Locks a mutex.
- void hf_mtxunlock (mutex_t *m)

  Unlocks a mutex.

4.12.1 Typedef Documentation

4.12.1.1 typedef struct mtx mutex_t

4.12.2 Function Documentation

4.12.2.1 void hf_mtxinit (mutex_t * m)

Initializes a mutex, defining its initial value.

Parameters

s	is a pointer to a mutex.

4.12.2.2 void hf_mtxlock (mutex_t * m)

Locks a mutex.

Parameters

s	is a pointer to a mutex.

If the mutex is not locked, the calling task continues execution. Otherwise, the task spins.

4.12.2.3 void hf_mtxunlock (mutex_t * m)

Unlocks a mutex.

Parameters

s	is a pointer to a mutex.

4.13 sys/include/panic.h File Reference

Functions

- void panic (int32_t cause)

  Causes the kernel to panic.

4.13.1 Function Documentation

4.13.1.1 void panic (int32_t *cause*)

Causes the kernel to panic.

Interrupts are disabled, the panic cause is presented to the user and the system is locked forever.

4.14 sys/include/processor.h File Reference

Functions

- void hf_schedlock (int32_t lock)

Enables or disables the task scheduler.

- int32_t hf_freecpu (void)

  Returns the percentage of free processor time. Only realtime tasks are accounted as processor load.

- int32_t hf_cpuload (uint16_t id)

  Returns the percentage of processor time used by a given task. Both realtime and best effort tasks are accounted. Best effort tasks lose processor time when realtime tasks are part of the task set, as they only run in the background (idle time).

- uint32_t hf_freemem (void)

  Returns the amount of free memory.

4.14.1 Function Documentation

4.14.1.1 int32_t hf_cpuload (uint16_t *id*)

Returns the percentage of processor time used by a given task. Both realtime and best effort tasks are accounted. Best effort tasks lose processor time when realtime tasks are part of the task set, as they only run in the background (idle time).

Parameters

id	is the task id number

Returns

a number representing the percentage of processor usage or ERR_INVALID_ID if the referenced task does not exist.

4.14.1.2 int32_t hf_freecpu (void)

Returns the percentage of free processor time. Only realtime tasks are accounted as processor load.

Returns

a number representing the percentage of free processor.

4.14.1.3 uint32_t hf_freemem (void)

Returns the amount of free memory.

Returns

free heap memory, in bytes.

4.14.1.4 void hf_schedlock (int32_t *lock*)

Enables or disables the task scheduler.

Parameters

lock	defines the scheduler activation (a value of 1 disables task scheduling).

4.15 sys/include/queue.h File Reference

Data Structures

- struct queue

  Queue data structure.

Functions

- struct queue * hf_queue_create (int32_t size)

  Creates a queue of specified size.
- int32_t hf_queue_destroy (struct queue *q)

  Destroys a queue.
- int32_t hf_queue_count (struct queue *q)

  Counts the number of nodes in a queue.
- int32_t hf_queue_addtail (struct queue *q, void *ptr)

  Adds a node to the tail of the queue.
- void * hf_queue_remhead (struct queue *q)

  Removes a node from the head of the queue.
- void * hf_queue_remtail (struct queue *q)

  Removes a node from the tail of the queue.
- void * hf_queue_get (struct queue *q, int32_t elem)

  Returns a node from the queue.
- int32_t hf_queue_set (struct queue *q, int32_t elem, void *ptr)

  Updates a node on the queue.
- int32_t hf_queue_swap (struct queue *q, int32_t elem1, int32_t elem2)

  Swap the position of two nodes in the queue.

4.15.1 Function Documentation

4.15.1.1 int32_t hf_queue_addtail (struct queue * *q*, void * *ptr*)

Adds a node to the tail of the queue.

Parameters

q	is a pointer to a queue structure.
ptr	a pointer to data belonging to the queue node.

Returns

0 when successful and -1 otherwise.

4.15.1.2 int32_t hf_queue_count (struct queue * *q*)

Counts the number of nodes in a queue.

Parameters

q	is a pointer to a queue structure.

Returns

the number of nodes.

4.15.1.3 struct queue* hf_queue_create (int32_t *size*) [read]

Creates a queue of specified size.

Parameters

size	is the maximum number of elements.

Returns

pointer to the queue on success and NULL otherwise.

4.15.1.4 int32_t hf_queue_destroy (struct queue * *q*)

Destroys a queue.

Parameters

q	is a pointer to a queue structure.

Returns

0 when successful and -1 otherwise.

4.15.1.5 void* hf_queue_get (struct queue * *q*, int32_t *elem*)

Returns a node from the queue.

Parameters

q	is a pointer to a queue structure.
elem	is the n-th element from the queue.

Returns

pointer to node data success and 0 otherwise.

4.15.1.6 void* hf_queue_remhead (struct queue * *q*)

Removes a node from the head of the queue.

Parameters

q	is a pointer to a queue structure.

Returns

pointer to node data on success and 0 otherwise.

4.15.1.7 void* hf_queue_remtail (struct queue * q)

Removes a node from the tail of the queue.

Parameters

q	is a pointer to a queue structure.

Returns

pointer to node data on success and 0 otherwise.

4.15.1.8 int32_t hf_queue_set (struct queue * q, int32_t elem, void * ptr)

Updates a node on the queue.

Parameters

q	is a pointer to a queue structure.
elem	is the n-th element from the queue.
ptr	a pointer to data belonging to the queue node.

Returns

0 success and -1 otherwise.

4.15.1.9 int32_t hf_queue_swap (struct queue * q, int32_t elem1, int32_t elem2)

Swap the position of two nodes in the queue.

Parameters

q	is a pointer to a queue structure.
elem1	is the first n-th element from the queue.
elem2	is the second n-th element from the queue.

Returns

0 when successful and -1 otherwise.

4.16 sys/include/scheduler.h File Reference

Functions

- void dispatch_isr (void *arg)

  The task dispatcher.
- int32_t sched_be (void)

  Best effort (BE) scheduler.
- int32_t sched_rt (void)

  Real time (RT) scheduler.

4.16.1 Function Documentation

4.16.1.1 void dispatch_isr (void * *arg*)

The task dispatcher.

The job of the dispatcher is simple: save the current task context on the TCB, update its state to ready and check its stack for overflow. If there are tasks to be scheduled, process the delay queue and invoke the real-time scheduler. If no RT tasks are ready to be scheduled, invoke the best effort scheduler. Update the scheduled task state to running and restore the context of the task.

Delayed tasks are in the delay queue, and are processed in the following way:

- The number of elements (tasks) in queue is counted;
- The a task from the head of the queue is removed and its delay is decremented;
  - If the decremented delay of a task reaches 0, it is put on RT or BE run queue;
  - It is put it back on the tail of the delay queue otherwise;
- Repeat until the whole queue is processed;

4.16.1.2 int32_t sched_be (void)

Best effort (BE) scheduler.

Returns

Best effort task id.

The algorithm is Lottery Scheduling.

- Take a task from the run queue, copy its entry and put it back at the tail of the run queue.
- If the task is in the blocked state (it may be simply blocked or waiting in a semaphore) or its not the ticket, it is put back at the tail of the run queue and the next task is picked up.
- So, if all tasks are blocked, at least the idle task can execute (it is never blocked, at least it is what we hope!).
- Tasks in the blocked state are never removed from the run queue (they are ignored), although they may be in another queue waiting for a resource.

4.16.1.3 int32_t sched_rt (void)

Real time (RT) scheduler.

Returns

Real time task id.

The scheduling algorithm is Rate Monotonic.

- Sort the queue of RT tasks by period;
- Update real time information (remaining deadline and capacity) of the whole task set.
- If the task at the head of the queue fits the requirements to be scheduled (not blocked, has jobs to execute and no task with higher priority according to RM was selected) then register the task to be scheduled.

4.17 sys/include/semaphore.h File Reference

Data Structures

- struct sem

  Semaphore data structure.

Typedefs

- typedef struct sem sem_t

Functions

- int32_t hf_seminit (sem_t *s, int32_t value)

  Initializes a semaphore and defines its initial value.
- int32_t hf_semdestroy (sem_t *s)

  Destroys a semaphore.
- void hf_semwait (sem_t *s)

  Wait on a semaphore.
- void hf_sempost (sem_t *s)

  Signal a semaphore.

4.17.1 Typedef Documentation

4.17.1.1 typedef struct sem sem_t

4.17.2 Function Documentation

4.17.2.1 int32_t hf_semdestroy (sem_t * *s*)

Destroys a semaphore.

Parameters

s	is a pointer to a semaphore.

Returns

ERR_OK on success and ERR_ERROR if the semaphore could not be removed from memory.

4.17.2.2 int32_t hf_seminit (sem_t * *s*, int32_t *value*)

Initializes a semaphore and defines its initial value.

Parameters

s	is a pointer to a semaphore.
value	is the semaphore initial value.

Returns

ERR_OK on success and ERR_ERROR if the semaphore could not be allocated in memory or its initial value is less than zero.

4.17.2.3 void hf_sempost (sem_t * s)

Signal a semaphore.

Parameters

s	is a pointer to a semaphore.

Implements the atomic V() operation. The semaphore count is incremented and the task from the head of the semaphore queue is unblocked if the count is less than or equal to zero.

4.17.2.4 void hf_semwait (sem_t * s)

Wait on a semaphore.

Parameters

s	is a pointer to a semaphore.

Implements the atomic P() operation. The semaphore count is decremented and calling task is blocked and queued on the semaphore if the count reaches a negative value. If not, the task continues its execution.

4.18 sys/include/task.h File Reference

Functions

- int32_t hf_id (int8_t *name)

  Get a task id by its name.
- int8_t * hf_name (uint16_t id)

  Get a task name by its id.
- uint16_t hf_selfid (void)

  Get the current task id.
- int8_t * hf_selfname (void)

  Get the current task name.
- int32_t hf_state (uint16_t id)

  Get the current state of a task.
- int32_t hf_jobs (uint16_t id)

  Get the number of executed jobs of a task.
- int32_t hf_dlm (uint16_t id)

  Get the number of deadline misses of a task.
- int32_t hf_spawn (void(*task)(), uint16_t period, uint16_t capacity, uint16_t deadline, int8_t *name, uint32_t stack_size)

  Spawn a new task.
- void hf_yield (void)

  Yields the current task.
- int32_t hf_block (uint16_t id)

  Blocks a task.

- int32_t hf_resume (uint16_t id)

  Resumes a blocked task.
- int32_t hf_kill (uint16_t id)

  Kills a task.
- int32_t hf_delay (uint16_t id, uint32_t delay)

  Delays a task for an amount of time.

4.18.1 Function Documentation

4.18.1.1 int32_t hf_block (uint16_t *id*)

Blocks a task.

Parameters

id	is a task id number.

Returns

ERR_OK on success, ERR_INVALID_ID if the referenced task does not exist or ERR_ERROR if the task is already in the blocked state.

The task is marked as TASK_BLOCKED so the scheduler doesn't select it as a candidate for scheduling. The blocking state is acomplished without removing the task from the run queue, reducing the cost of the operation in cases where the task state is switched frequently (such as in semaphore primitives).

4.18.1.2 int32_t hf_delay (uint16_t *id*, uint32_t *delay*)

Delays a task for an amount of time.

Parameters

id	is a task id number.
delay	is the amount of time (in quantum / tick units).

Returns

ERR_OK on success or ERR_INVALID_ID if the referenced task does not exist.

A task is removed from its run queue and its state is marked as TASK_DELAYED. The task is put on the delay queue and remains there until the dispatcher places it back to its run queue. Time is managed by the task dispatcher, which counts down delays, controls the delay queue by cycling the tasks and removing them when the task delay has passed.

4.18.1.3 int32_t hf_dlm (uint16_t *id*)

Get the number of deadline misses of a task.

Parameters

id	is a task id number.

Returns

deadlines missed by the task if found and ERR_INVALID_ID otherwise.

4.18.1.4 int32_t hf_id (int8_t * *name*)

Get a task id by its name.

Parameters

name	is a pointer to an array holding the task name.

Returns

task id if the task is found and ERR_INVALID_NAME otherwise.

4.18.1.5 int32_t hf_jobs (uint16_t *id*)

Get the number of executed jobs of a task.

Parameters

id	is a task id number.

Returns

jobs executed by the task if found and ERR_INVALID_ID otherwise.

4.18.1.6 int32_t hf_kill (uint16_t *id*)

Kills a task.

Parameters

id	is a task id number.

Returns

ERR_OK on success or ERR_INVALID_ID if the referenced task does not exist.

All memory allocated during the task initialization is freed, the TCB entry is cleared and the task is removed from its run queue.

4.18.1.7 int8_t* hf_name (uint16_t *id*)

Get a task name by its id.

Parameters

id	is a task id number.

Returns

task name if the task is found and NULL otherwise.

4.18.1.8 int32_t hf_resume (uint16_t *id*)

Resumes a blocked task.

Parameters

id	is a task id number.

Returns

ERR_OK on success, ERR_INVALID_ID if the referenced task does not exist or ERR_ERROR if the task is not in the blocked state.

The task must be in the TASK_BLOCKED state in order to be resumed. The task is marked as TASK_BLOCKED so the scheduler doesn't select it as a candidate for scheduling. The blocking state is acomplished without removing the task from the run queue, reducing the cost of the operation in cases where the task state is switched frequently (such as in semaphore primitives).

4.18.1.9 uint16_t hf_selfid (void)

Get the current task id.

Returns

current task id.

4.18.1.10 int8_t* hf_selfname (void)

Get the current task name.

Returns

current task name.

4.18.1.11 int32_t hf_spawn (void(*)() *task*, uint16_t *period*, uint16_t *capacity*, uint16_t *deadline*, int8_t * *name*, uint32_t *stack_size*)

Spawn a new task.

Parameters

task	is a pointer to a task function / body.
period	is the task RT period (in quantum / tick units).
capacity	is the amount of work to be executed in a period (in quantum / tick units).
deadline	is the task deadline to complete the work in the period (in quantum / tick units).
name	is a string used to identify a task.
stack_size	is the stack memory to be allocated for the task.

Returns

task id if the task is created, ERR_EXCEED_MAX_NUM if the maximum number of tasks in the system is exceeded, ERR_INVALID_PARAMETER if impossible RT parameters are specified or ERR_OUT_OF_MEMORY if the system fails to allocate memory for the task resources.

If a task has defined realtime parameters, it is put on the RT queue, if not (period 0, capacity 0 and deadline 0), it is put on the BE queue. WARNING: Task stack size should be always configured correctly, considering data declared on the auto region (local variables) and around 1024 of spare memory for the OS. For example, if you declare a buffer of 5000 bytes, stack size should be at least 6000.

4.18.1.12 int32_t hf_state (uint16_t *id*)

Get the current state of a task.

Parameters

id	is a task id number.

Returns

task state the task if found (TASK_IDLE, TASK_READY, TASK_RUNNING, TASK_BLOCKED, TASK_DELAYED or TASK_WAITING) and ERR_INVALID_ID otherwise.

4.18.1.13 void hf_yield (void)

Yields the current task.

The current task gives up execution and the best effort scheduler is invoked.

4.19 sys/kernel/main.c File Reference

Functions

- int main (void)

  HellfireOS kernel entry point and system initialization.

4.19.1 Detailed Description

Author

Sergio Johann Filho

Date

January 2016

4.19.2 LICENSE

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4.19.3 DESCRIPTION

The HellfireOS realtime operating system kernel.

4.19.4 Function Documentation

4.19.4.1 int main (void)

HellfireOS kernel entry point and system initialization.

Returns

should not return.

We assume that the following machine state has been already set before this routine.

- Kernel BSS section is filled with 0.
- Kernel stack is configured.
- All interrupts are disabled.
- Minimum page table is set. (MMU systems only)

4.20 sys/kernel/panic.c File Reference

Functions

- void panic (int32_t cause)

  Causes the kernel to panic.

4.20.1 Detailed Description

Author

Sergio Johann Filho

Date

March 2016

4.20.2 LICENSE

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4.20.3 DESCRIPTION

Kernel panic.

4.20.4 Function Documentation

4.20.4.1 void panic (int32_t *cause*)

Causes the kernel to panic.

Interrupts are disabled, the panic cause is presented to the user and the system is locked forever.

4.21 sys/kernel/processor.c File Reference

Functions

- void hf_schedlock (int32_t lock)

Enables or disables the task scheduler.

- int32_t hf_freecpu (void)

  Returns the percentage of free processor time. Only realtime tasks are accounted as processor load.

- int32_t hf_cpuload (uint16_t id)

  Returns the percentage of processor time used by a given task. Both realtime and best effort tasks are accounted. Best effort tasks lose processor time when realtime tasks are part of the task set, as they only run in the background (idle time).

- uint32_t hf_freemem (void)

  Returns the amount of free memory.

4.21.1 Detailed Description

Author

Sergio Johann Filho

Date

March 2016

4.21.2 LICENSE

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4.21.3 DESCRIPTION

Processor and scheduler management primitives and auxiliary functions.

4.21.4 Function Documentation

4.21.4.1 int32_t hf_cpuload (uint16_t *id*)

Returns the percentage of processor time used by a given task. Both realtime and best effort tasks are accounted. Best effort tasks lose processor time when realtime tasks are part of the task set, as they only run in the background (idle time).

Parameters

id	is the task id number

Returns

a number representing the percentage of processor usage or ERR_INVALID_ID if the referenced task does not exist.

4.21.4.2 int32_t hf_freecpu (void)

Returns the percentage of free processor time. Only realtime tasks are accounted as processor load.

Returns

a number representing the percentage of free processor.

4.21.4.3 uint32_t hf_freemem (void)

Returns the amount of free memory.

Returns

free heap memory, in bytes.

4.21.4.4 void hf_schedlock (int32_t *lock*)

Enables or disables the task scheduler.

Parameters

lock	defines the scheduler activation (a value of 1 disables task scheduling).

4.22 sys/kernel/scheduler.c File Reference

Functions

- void dispatch_isr (void *arg)
  The task dispatcher.
- int32_t sched_be (void)
  Best effort (BE) scheduler.
- int32_t sched_rt (void)
  Real time (RT) scheduler.

4.22.1 Detailed Description

Author

Sergio Johann Filho

Date

February 2016

4.22.2 LICENSE

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4.22.3 DESCRIPTION

Kernel two-level scheduler and task queue management.

4.22.4 Function Documentation

4.22.4.1 void dispatch_isr (void * *arg*)

The task dispatcher.

The job of the dispatcher is simple: save the current task context on the TCB, update its state to ready and check its stack for overflow. If there are tasks to be scheduled, process the delay queue and invoke the real-time scheduler. If no RT tasks are ready to be scheduled, invoke the best effort scheduler. Update the scheduled task state to running and restore the context of the task.

Delayed tasks are in the delay queue, and are processed in the following way:

- The number of elements (tasks) in queue is counted;
- The a task from the head of the queue is removed and its delay is decremented;
  - If the decremented delay of a task reaches 0, it is put on RT or BE run queue;
  - It is put it back on the tail of the delay queue otherwise;
- Repeat until the whole queue is processed;

4.22.4.2 int32_t sched_be (void)

Best effort (BE) scheduler.

Returns

Best effort task id.

The algorithm is Lottery Scheduling.

- Take a task from the run queue, copy its entry and put it back at the tail of the run queue.
- If the task is in the blocked state (it may be simply blocked or waiting in a semaphore) or its not the ticket, it is put back at the tail of the run queue and the next task is picked up.
- So, if all tasks are blocked, at least the idle task can execute (it is never blocked, at least it is what we hope!).
- Tasks in the blocked state are never removed from the run queue (they are ignored), although they may be in another queue waiting for a resource.

4.22.4.3 int32_t sched_rt (void)

Real time (RT) scheduler.

Returns

Real time task id.

The scheduling algorithm is Rate Monotonic.

- Sort the queue of RT tasks by period;
- Update real time information (remaining deadline and capacity) of the whole task set.
- If the task at the head of the queue fits the requirements to be scheduled (not blocked, has jobs to execute and no task with higher priority according to RM was selected) then register the task to be scheduled.

4.23 sys/kernel/task.c File Reference

Functions

- int32_t hf_id (int8_t *name)

  Get a task id by its name.
- int8_t * hf_name (uint16_t id)

  Get a task name by its id.
- uint16_t hf_selfid (void)

  Get the current task id.
- int8_t * hf_selfname (void)

  Get the current task name.
- int32_t hf_state (uint16_t id)

  Get the current state of a task.
- int32_t hf_jobs (uint16_t id)

  Get the number of executed jobs of a task.
- int32_t hf_dlm (uint16_t id)

  Get the number of deadline misses of a task.
- int32_t hf_spawn (void(*task)(), uint16_t period, uint16_t capacity, uint16_t deadline, int8_t *name, uint32_t stack_size)

  Spawn a new task.
- void hf_yield (void)

  Yields the current task.
- int32_t hf_block (uint16_t id)

  Blocks a task.
- int32_t hf_resume (uint16_t id)

  Resumes a blocked task.
- int32_t hf_kill (uint16_t id)

  Kills a task.
- int32_t hf_delay (uint16_t id, uint32_t delay)

  Delays a task for an amount of time.

4.23.1 Detailed Description

Author

Sergio Johann Filho

Date

March 2016

4.23.2 LICENSE

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4.23.3 DESCRIPTION

Task management primitives and auxiliary functions.

4.23.4 Function Documentation

4.23.4.1 int32_t hf_block (uint16_t *id*)

Blocks a task.

Parameters

id	is a task id number.

Returns

ERR_OK on success, ERR_INVALID_ID if the referenced task does not exist or ERR_ERROR if the task is already in the blocked state.

The task is marked as TASK_BLOCKED so the scheduler doesn't select it as a candidate for scheduling. The blocking state is acomplished without removing the task from the run queue, reducing the cost of the operation in cases where the task state is switched frequently (such as in semaphore primitives).

4.23.4.2 int32_t hf_delay (uint16_t *id,* uint32_t *delay*)

Delays a task for an amount of time.

Parameters

id	is a task id number.
delay	is the amount of time (in quantum / tick units).

Returns

ERR_OK on success or ERR_INVALID_ID if the referenced task does not exist.

A task is removed from its run queue and its state is marked as TASK_DELAYED. The task is put on the delay queue and remains there until the dispatcher places it back to its run queue. Time is managed by the task dispatcher, which counts down delays, controls the delay queue by cycling the tasks and removing them when the task delay has passed.

4.23.4.3 int32_t hf_dlm (uint16_t *id*)

Get the number of deadline misses of a task.

Parameters

id	is a task id number.

Returns

deadlines missed by the task if found and ERR_INVALID_ID otherwise.

4.23.4.4 int32_t hf_id (int8_t * *name*)

Get a task id by its name.

Parameters

name	is a pointer to an array holding the task name.

Returns

task id if the task is found and ERR_INVALID_NAME otherwise.

4.23.4.5 int32_t hf_jobs (uint16_t *id*)

Get the number of executed jobs of a task.

Parameters

id	is a task id number.

Returns

jobs executed by the task if found and ERR_INVALID_ID otherwise.

4.23.4.6 int32_t hf_kill (uint16_t *id*)

Kills a task.

Parameters

id	is a task id number.

Returns

ERR_OK on success or ERR_INVALID_ID if the referenced task does not exist.

All memory allocated during the task initialization is freed, the TCB entry is cleared and the task is removed from its run queue.

4.23.4.7 int8_t* hf_name (uint16_t *id*)

Get a task name by its id.

Parameters

id	is a task id number.

Returns

task name if the task is found and NULL otherwise.

4.23.4.8 int32_t hf_resume (uint16_t *id*)

Resumes a blocked task.

Parameters

id	is a task id number.

Returns

ERR_OK on success, ERR_INVALID_ID if the referenced task does not exist or ERR_ERROR if the task is not in the blocked state.

The task must be in the TASK_BLOCKED state in order to be resumed. The task is marked as TASK_BLOCKED so the scheduler doesn't select it as a candidate for scheduling. The blocking state is acomplished without removing the task from the run queue, reducing the cost of the operation in cases where the task state is switched frequently (such as in semaphore primitives).

4.23.4.9 uint16_t hf_selfid (void)

Get the current task id.

Returns

current task id.

4.23.4.10 int8_t* hf_selfname (void)

Get the current task name.

Returns

current task name.

4.23.4.11 int32_t hf_spawn (void(*)() *task,* uint16_t *period,* uint16_t *capacity,* uint16_t *deadline,* int8_t * *name,* uint32_t *stack_size*)

Spawn a new task.

Parameters

task	is a pointer to a task function / body.
period	is the task RT period (in quantum / tick units).
capacity	is the amount of work to be executed in a period (in quantum / tick units).
deadline	is the task deadline to complete the work in the period (in quantum / tick units).
name	is a string used to identify a task.
stack_size	is the stack memory to be allocated for the task.

Returns

task id if the task is created, ERR_EXCEED_MAX_NUM if the maximum number of tasks in the system is exceeded, ERR_INVALID_PARAMETER if impossible RT parameters are specified or ERR_OUT_OF_MEMORY if the system fails to allocate memory for the task resources.

If a task has defined realtime parameters, it is put on the RT queue, if not (period 0, capacity 0 and deadline 0), it is put on the BE queue. WARNING: Task stack size should be always configured correctly, considering data declared on the auto region (local variables) and around 1024 of spare memory for the OS. For example, if you declare a buffer of 5000 bytes, stack size should be at least 6000.

4.23.4.12 int32_t hf_state (uint16_t *id*)

Get the current state of a task.

Parameters

id	is a task id number.

Returns

task state the task if found (TASK_IDLE, TASK_READY, TASK_RUNNING, TASK_BLOCKED, TASK_DELAYED or TASK_WAITING) and ERR_INVALID_ID otherwise.

4.23.4.13 void hf_yield (void)

Yields the current task.

The current task gives up execution and the best effort scheduler is invoked.

4.24 sys/lib/kprintf.c File Reference

Functions

- int32_t kprintf (const int8_t *fmt,...)

  Kernel short version of printf().
- int32_t dprintf (const int8_t *fmt,...)

  Kernel debug version of printf().

4.24.1 Detailed Description

Author

Sergio Johann Filho

Date

February 2016

4.24.2 LICENSE

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4.24.3 DESCRIPTION

Kernel printing / conversion auxiliary functions.

4.24.4 Function Documentation

4.24.4.1 int32_t dprintf (const int8_t * *fmt*, ...)

Kernel debug version of printf().

Parameters

fmt	is a pointer to formatted data to be printed on the debug output.

Returns

0.

4.24.4.2 int32_t kprintf (const int8_t * *fmt*, ...)

Kernel short version of printf().

Parameters

fmt	is a pointer to formatted data to be printed.

Returns

0.

4.25 sys/lib/list.c File Reference

Functions

- struct list * hf_list_init (void)

  Initializes a list.
- int32_t hf_list_append (struct list *lst, void *item)

  Appends a new node to the end of the list.
- int32_t hf_list_insert (struct list *lst, void *item, int32_t pos)

  Inserts a new node to an arbitrary position in a list.
- int32_t hf_list_remove (struct list *lst, int32_t pos)

  Removes an arbitrary node from a list.
- void * hf_list_get (struct list *lst, int32_t pos)

  Returns the address of the data belonging to a list node.
- int32_t hf_list_set (struct list *lst, void *item, int32_t pos)

  Changes the address of the data belonging to a list node.
- int32_t hf_list_count (struct list *lst)

  Returns the number of nodes in a list.

4.25.1 Detailed Description

Author

Sergio Johann Filho

Date

January 2016

4.25.2 LICENSE

4.25.3 DESCRIPTION

List manipulation primitives and auxiliary functions. List structures are allocated dynamically at runtime, which makes them very flexible. Memory is allocated / deallocated on demand, so additional memory management penalties are incurred.

4.25.4 Function Documentation

4.25.4.1 int32_t hf_list_append (struct list * *lst*, void * *item*)

Appends a new node to the end of the list.

Parameters

lst	is a pointer to a list structure.
item	is a pointer to data belonging to the list node.

Returns

0 when successful and -1 otherwise.

4.25.4.2 int32_t hf_list_count (struct list * *lst*)

Returns the number of nodes in a list.

Parameters

lst	is a pointer to a list structure.

Returns

The number of elements in the list.

4.25.4.3 void* hf_list_get (struct list * *lst*, int32_t *pos*)

Returns the address of the data belonging to a list node.

Parameters

lst	is a pointer to a list structure.
pos	is the n-th element position in the list.

Returns

0 when the element is not found and the address to data otherwise.

4.25.4.4 struct list* hf_list_init (void) [read]

Initializes a list.

Returns

a pointer to a list structure.

4.25.4.5 int32_t hf_list_insert (struct list * lst, void * item, int32_t pos)

Inserts a new node to an arbitrary position in a list.

Parameters

lst	is a pointer to a list structure.
item	is a pointer to data belonging to the list node.
pos	is the n-th element position in the list.

Returns

0 when successful and -1 otherwise.

4.25.4.6 int32_t hf_list_remove (struct list * lst, int32_t pos)

Removes an arbitrary node from a list.

Parameters

lst	is a pointer to a list structure.
pos	is the n-th element position in the list.

Returns

0 when successful and -1 otherwise.

4.25.4.7 int32_t hf_list_set (struct list * lst, void * item, int32_t pos)

Changes the address of the data belonging to a list node.

Parameters

lst	is a pointer to a list structure.
item	is an address to data belonging to the list node.
pos	is the n-th element position in the list.

Returns

-1 when the element is not found and 0 if the element was updated.

4.26 sys/lib/malloc.c File Reference

Functions

- void hf_free (void *ptr)
- void * hf_malloc (uint32_t size)
- void heapinit (void *heap, uint32_t len)
- void * hf_calloc (uint32_t qty, uint32_t type_size)
- void * hf_realloc (void *ptr, uint32_t size)

4.26.1 Function Documentation

4.26.1.1 void heapinit (void * *heap,* uint32_t *len*)

4.26.1.2 void* hf_calloc (uint32_t *qty,* uint32_t *type_size*)

4.26.1.3 void hf_free (void * *ptr*)

4.26.1.4 void* hf_malloc (uint32_t *size*)

4.26.1.5 void* hf_realloc (void * *ptr,* uint32_t *size*)

4.27 sys/lib/queue.c File Reference

Functions

- struct queue * hf_queue_create (int32_t size)
  Creates a queue of specified size.
- int32_t hf_queue_destroy (struct queue *q)
  Destroys a queue.
- int32_t hf_queue_count (struct queue *q)
  Counts the number of nodes in a queue.
- int32_t hf_queue_addtail (struct queue *q, void *ptr)
  Adds a node to the tail of the queue.
- void * hf_queue_remhead (struct queue *q)
  Removes a node from the head of the queue.
- void * hf_queue_remtail (struct queue *q)
  Removes a node from the tail of the queue.
- void * hf_queue_get (struct queue *q, int32_t elem)
  Returns a node from the queue.
- int32_t hf_queue_set (struct queue *q, int32_t elem, void *ptr)
  Updates a node on the queue.
- int32_t hf_queue_swap (struct queue *q, int32_t elem1, int32_t elem2)
  Swap the position of two nodes in the queue.

4.27.1 Detailed Description

Author

Sergio Johann Filho

Date

February 2016

4.27.2 LICENSE

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4.27.3 DESCRIPTION

Queue manipulation primitives and auxiliary functions. Queue structures are allocated only on the creation of queues, so little additional overhead regarding memory management is incurred at runtime.

4.27.4 Function Documentation

4.27.4.1 int32_t hf_queue_addtail (struct queue * q, void * ptr)

Adds a node to the tail of the queue.

Parameters

q	is a pointer to a queue structure.
ptr	a pointer to data belonging to the queue node.

Returns

0 when successful and -1 otherwise.

4.27.4.2 int32_t hf_queue_count (struct queue * q)

Counts the number of nodes in a queue.

Parameters

q	is a pointer to a queue structure.

Returns

the number of nodes.

4.27.4.3 struct queue* hf_queue_create (int32_t size) [read]

Creates a queue of specified size.

Parameters

size	is the maximum number of elements.

Returns

pointer to the queue on success and NULL otherwise.

4.27.4.4 int32_t hf_queue_destroy (struct queue * q)

Destroys a queue.

Parameters

q	is a pointer to a queue structure.

Returns

0 when successful and -1 otherwise.

4.27.4.5 void* hf_queue_get (struct queue * q, int32_t elem)

Returns a node from the queue.

Parameters

q	is a pointer to a queue structure.
elem	is the n-th element from the queue.

Returns

pointer to node data success and 0 otherwise.

4.27.4.6 void* hf_queue_remhead (struct queue * q)

Removes a node from the head of the queue.

Parameters

q	is a pointer to a queue structure.

Returns

pointer to node data on success and 0 otherwise.

4.27.4.7 void* hf_queue_remtail (struct queue * q)

Removes a node from the tail of the queue.

Parameters

q	is a pointer to a queue structure.

Returns

pointer to node data on success and 0 otherwise.

4.27.4.8 int32_t hf_queue_set (struct queue * q, int32_t elem, void * ptr)

Updates a node on the queue.

Parameters

q	is a pointer to a queue structure.
elem	is the n-th element from the queue.
ptr	a pointer to data belonging to the queue node.

Returns

0 success and -1 otherwise.

4.27.4.9 int32_t hf_queue_swap (struct queue * *q*, int32_t *elem1*, int32_t *elem2*)

Swap the position of two nodes in the queue.

Parameters

q	is a pointer to a queue structure.
elem1	is the first n-th element from the queue.
elem2	is the second n-th element from the queue.

Returns

0 when successful and -1 otherwise.

4.28 sys/sync/condvar.c File Reference

Functions

- int32_t hf_condinit (cond_t *c)

  Initializes a condition variable.
- int32_t hf_conddestroy (cond_t *c)

  Destroys a condition variable.
- void hf_condwait (cond_t *c, mutex_t *m)

  Wait on a condition variable.
- void hf_condsignal (cond_t *c)

  Signal a condition variable.
- void hf_condbroadcast (cond_t *c)

  Signal (broadcast) a condition variable.

4.28.1 Detailed Description

Author

Sergio Johann Filho

Date

May 2016

4.28.2 LICENSE

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4.28.3 DESCRIPTION

Condition variable synchronization primitives.

4.28.4 Function Documentation

4.28.4.1 void hf_condbroadcast (cond_t * c)

Signal (broadcast) a condition variable.

Parameters

c	is a pointer to a condition variable.

Implements the condition signal broadcast operation for all waiting tasks. The call unblocks and removes all tasks from the waiting queue. If no tasks are waiting for the condition, the signal is lost.

4.28.4.2 int32_t hf_conddestroy (cond_t * c)

Destroys a condition variable.

Parameters

c	is a pointer to a condition variable.

Returns

ERR_OK on success and ERR_ERROR if the condition variable could not be removed from memory.

4.28.4.3 int32_t hf_condinit (cond_t * c)

Initializes a condition variable.

Parameters

c	is a pointer to a condition variable.

Returns

ERR_OK on success and ERR_ERROR if the condition variable could not be allocated in memory.

4.28.4.4 void hf_condsignal (cond_t * c)

Signal a condition variable.

Parameters

c	is a pointer to a condition variable.

Implements the condition signal operation for one waiting task. The call removes a task from the waiting queue and unblocks it. If no tasks are waiting for the condition, the signal is lost.

4.28.4.5 void hf_condwait (cond_t * c, mutex_t * m)

Wait on a condition variable.

Parameters

c	is a pointer to a condition variable.
m	is a pointer to a mutex.

Implements the atomic condition wait operation. The call should always be invoked with the mutex locked. The current task is put in a queue on the condition variable, its state is set to blocked and unlocks the mutex atomically, then yields the processor. When woke up (by a signalling task), the task locks the mutex and returns.

4.29 sys/sync/mutex.c File Reference

Functions

- void hf_mtxinit (mutex_t *m)

  Initializes a mutex, defining its initial value.
- void hf_mtxlock (mutex_t *m)

  Locks a mutex.
- void hf_mtxunlock (mutex_t *m)

  Unlocks a mutex.

4.29.1 Detailed Description

Author

Sergio Johann Filho

Date

February 2016

4.29.2 LICENSE

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4.29.3 DESCRIPTION

Mutex synchronization primitives.

4.29.4 Function Documentation

4.29.4.1 void hf_mtxinit (mutex_t * *m*)

Initializes a mutex, defining its initial value.

Parameters

s	is a pointer to a mutex.

4.29.4.2 void hf_mtxlock (mutex_t * *m*)

Locks a mutex.

Parameters

s	is a pointer to a mutex.

If the mutex is not locked, the calling task continues execution. Otherwise, the task spins.

4.29.4.3 void hf_mtxunlock (mutex_t * *m*)

Unlocks a mutex.

Parameters

s	is a pointer to a mutex.

4.30 sys/sync/semaphore.c File Reference

Functions

- int32_t hf_seminit (sem_t *s, int32_t value)

  Initializes a semaphore and defines its initial value.
- int32_t hf_semdestroy (sem_t *s)

  Destroys a semaphore.
- void hf_semwait (sem_t *s)

  Wait on a semaphore.
- void hf_sempost (sem_t *s)

  Signal a semaphore.

4.30.1 Detailed Description

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4.30.3 DESCRIPTION

Semaphore synchronization primitives.

4.30.4 Function Documentation

4.30.4.1 int32_t hf_semdestroy (sem_t * *s*)

Destroys a semaphore.

Parameters

s	is a pointer to a semaphore.

Returns

ERR_OK on success and ERR_ERROR if the semaphore could not be removed from memory.

4.30.4.2 int32_t hf_seminit (sem_t * *s*, int32_t *value*)

Initializes a semaphore and defines its initial value.

Parameters

s	is a pointer to a semaphore.
value	is the semaphore initial value.

Returns

ERR_OK on success and ERR_ERROR if the semaphore could not be allocated in memory or its initial value is less than zero.

4.30.4.3 void hf_sempost (sem_t * *s*)

Signal a semaphore.

Parameters

s	is a pointer to a semaphore.

Implements the atomic V() operation. The semaphore count is incremented and the task from the head of the semaphore queue is unblocked if the count is less than or equal to zero.

4.30.4.4 void hf_semwait (sem_t * *s*)

Wait on a semaphore.

Parameters

s	is a pointer to a semaphore.

Implements the atomic P() operation. The semaphore count is decremented and calling task is blocked and queued on the semaphore if the count reaches a negative value. If not, the task continues its execution.

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