AOSV PROJECT

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Chapter 1

AOSV Final Project Sources

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The sources are structured in this way:

1.1 <tt>Headers/</tt> cointains both header files and libraries for both user and kernel space

- Commonn.h: ioctls definition
- **def_struct.h** (p. **??**): struct used by the LKM
- export_porc_info.h/export_porc_info.c: code used by the LKM to manage /proc/ums
- **ums_user_library.h** (p. **??**)/ums_user_library.c: library to interct with LKM from user space
- **user_struct.h** (p. **??**): structs definiton used by **ums_user_library.h** (p. **??**) to exchnage infos with the LKM

1.2 <tt>Module/</tt> cointains the code of the LKM and its library

- **ums.c** (p. **??**)/ums.h: LKM code
- **module_library.c** (p. **??**)/module_library.h: support library for LKM

1.3 <tt>./</tt> cointains the test file

- **test.c** (p. **??**): test file

Chapter 2

Data Structure Index

2.1 Data Structures

Here are the data structures with brief descriptions:

Chapter 3

File Index

3.1 File List

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

Chapter 4

Data Structure Documentation

4.1 args Struct Reference

Data Fields

- int **fd**
- int **i**
- ums_pid_t **comp_list_id**
- int **padre**

4.1.1 Detailed Description

Definition at line 10 of file test.c.

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

- test.c

4.2 completion_list Struct Reference

Structure used by an UMS Scheduler to mantain Completion list infos, used in CREATE_COMP_LIST.

`#include <def_struct.h>`

Data Fields

- ums_pid_t **id**
- unsigned char **to_destroy**
- spinlock_t **list_lock**
- struct semaphore **sem_counter**
- struct list_head **next**
- struct list_head **workers**

4.2.1 Detailed Description

Structure used by an UMS Scheduler to mantain Completion list infos, used in CREATE_COMP_LIST.

Definition at line 67 of file def_struct.h.

4.2.2 Field Documentation

4.2.2.1 id

```
ums_pid_t id
```

id of current completion list

Definition at line 69 of file def_struct.h.

4.2.2.2 list_lock

```
spinlock_t list_lock
```

used for concurrency while add new worker

Definition at line 71 of file def_struct.h.

4.2.2.3 sem_counter

```
struct semaphore sem_counter
```

used by a scheduler thread to be sure that some worker can be executed

Definition at line 72 of file def_struct.h.

4.2.2.4 to_destroy

```
unsigned char to_destroy
```

bool used by DESTROY_COMP_LIST to denie new worker insertion

Definition at line 70 of file def_struct.h.

4.2.2.5 workers

```
struct list_head workers
```

reference to the worker threads list

Definition at line 74 of file def_struct.h.

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

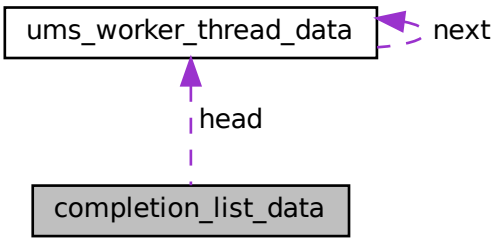
- Headers/ **def_struct.h**

4.3 completion_list_data Struct Reference

Struct used to share **completion_list_data** (p. **??**) info with the kernel.

```
#include <user_struct.h>
```

Collaboration diagram for completion_list_data:



Data Fields

- ums_pid_t **id**
- struct **ums_worker_thread_data** * **head**
- int **requested_size**

4.3.1 Detailed Description

Struct used to share **completion_list_data** (p. **??**) info with the kernel.

Definition at line 27 of file user_struct.h.

4.3.2 Field Documentation

4.3.2.1 head

```
struct  ums_worker_thread_data* head
```

pointer to an array of **ums_worker_thread_data** (p. **??**)

Definition at line 30 of file user_struct.h.

4.3.2.2 id

```
ums_pid_t id
```

identifier for the completion list

Definition at line 29 of file user_struct.h.

4.3.2.3 requested_size

```
int requested_size
```

size requested from the kernel to be allocated in user space for the DEQUEUE

Definition at line 31 of file user_struct.h.

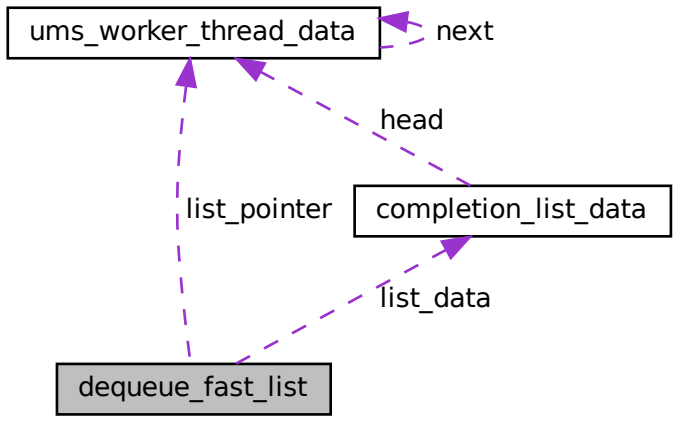
The documentation for this struct was generated from the following file:

- Headers/ **user_struct.h**

4.4 dequeue_fast_list Struct Reference

Struct used by a UMS Scheduler thread to mantain a pre-allocated completion_list_data* used in the dequeue function.

Collaboration diagram for dequeue_fast_list:



Data Fields

- struct **completion_list_data** * **list_data**
- int **cur_size**
- int **origin_size**
- struct **ums_worker_thread_data** ** **list_pointer**

4.4.1 Detailed Description

Struct used by a UMS Scheduler thread to mantain a pre-allocated completion_list_data* used in the dequeue function.

Definition at line 13 of file ums_user_library.c.

4.4.2 Field Documentation

4.4.2.1 cur_size

```
int cur_size
```

cur size of list_data

Definition at line 17 of file ums_user_library.c.

4.4.2.2 list_data

```
struct completion_list_data* list_data
```

pointer to the **completion_list_data** (p. **??**) that will be passed to the LKM

Definition at line 16 of file ums_user_library.c.

4.4.2.3 list_pointer

```
struct ums_worker_thread_data** list_pointer
```

array that contains all the pointer used in list_data, this array is used only to free the element, since the kernel will overwrite ums_worker_thread_data->next in case of "NULL"

Definition at line 19 of file ums_user_library.c.

4.4.2.4 origin_size

```
int origin_size
```

origin size of list_data

Definition at line 18 of file ums_user_library.c.

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

- Headers/ums_user_library.c

4.5 sched_thread_data Struct Reference

Struct used to share **sched_thread_data** (p. **??**) info with the kernel.

```
#include <user_struct.h>
```

Data Fields

- unsigned long **completion_list**
- int(* **entry_point**)(void *)
- void * **args**

4.5.1 Detailed Description

Struct used to share **sched_thread_data** (p. **??**) info with the kernel.

Definition at line 16 of file user_struct.h.

4.5.2 Field Documentation

4.5.2.1 args

```
void*  args
```

pointer to the entry_point params(usually you need to pass at least the file descriptor)

Definition at line 19 of file user_struct.h.

4.5.2.2 completion_list

```
unsigned long  completion_list
```

ID of the **completion_list** (p. **??**)

Definition at line 17 of file user_struct.h.

4.5.2.3 entry_point

```
int(* entry_point(void *)
```

pointer to the scheduling function

Definition at line 18 of file user_struct.h.

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

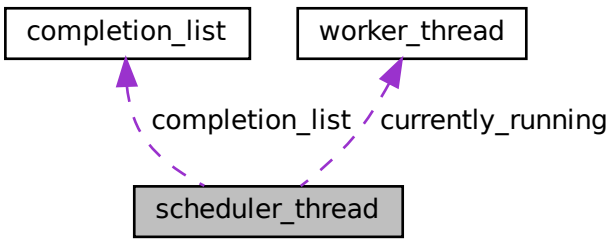
- Headers/ **user_struct.h**

4.6 scheduler_thread Struct Reference

Structure used by an UMS Scheduler to mantain scheduler thread infos, used in ENTER_SCHEDULING_MODE.

`#include <def_struct.h>`

Collaboration diagram for scheduler_thread:



Data Fields

- pid_t **pid**
- int(* **entry_point**)(void *)
- void * **args**
- int **yield_priority**
- int **nesting**
- struct **worker_thread** * **currently_running**
- struct list_head **worker_lifo**
- struct list_head **next**
- struct **completion_list** * **completion_list**
- spinlock_t **sched_lock**
- int **destroy**
- int **started**
- int **ended**
- int **numb_switch**
- struct proc_dir_entry * **ent**
- struct proc_dir_entry * **ent_write**
- struct proc_dir_entry * **father**
- time64_t **last_switch_time**
- time64_t **mean_switch_time**

4.6.1 Detailed Description

Structure used by an UMS Scheduler to mantain scheduler thread infos, used in ENTER_SCHEDULING_MODE.

Definition at line 95 of file def_struct.h.

4.6.2 Field Documentation

4.6.2.1 args

```
void*  args
```

scheduling function

Definition at line 99 of file def_struct.h.

4.6.2.2 currently_running

```
struct  worker_thread* currently_running
```

pointer to the currently running worker

Definition at line 102 of file def_struct.h.

4.6.2.3 destroy

```
int destroy
```

flag used for determing when the thread has to exit after a ums_release(fd)

Definition at line 108 of file def_struct.h.

4.6.2.4 ended

```
int ended
```

counter of the worker thread that has completed

Definition at line 110 of file def_struct.h.

4.6.2.5 ent

```
struct proc_dir_entry* ent
```

pointer to proc_entry for "/proc/ums/scheduler_id/schedulers/pid"

Definition at line 112 of file def_struct.h.

4.6.2.6 ent_write

```
struct proc_dir_entry* ent_write
```

pointer to proc_entry for "/proc/ums/scheduler_id/schedulers/pid/workers"

Definition at line 113 of file def_struct.h.

4.6.2.7 entry_point

```
int(* entry_point(void *)
```

scheduling function

Definition at line 98 of file def_struct.h.

4.6.2.8 father

```
struct proc_dir_entry* father
```

pointer to proc_entry for "/proc/ums/scheduler_id/schdulers"

Definition at line 114 of file def_struct.h.

4.6.2.9 last_switch_time

```
time64_t last_switch_time
```

time elapsed to complete the last context switch

Definition at line 115 of file def_struct.h.

4.6.2.10 mean_switch_time

```
time64_t mean_switch_time
```

time elapsed to complete the last context switch

Definition at line 116 of file def_struct.h.

4.6.2.11 nesting

```
int nesting
```

used with completion_list->sem_counter to take priority on the **completion_list** (p. **??**) after a yield

Definition at line 101 of file def_struct.h.

4.6.2.12 numb_switch

```
int numb_switch
```

counter of the worker thread that switched

Definition at line 111 of file def_struct.h.

4.6.2.13 pid

```
pid_t pid
```

PID of the original pthread

Definition at line 97 of file def_struct.h.

4.6.2.14 started

```
int started
```

counter of the worker thread which it has started executing

Definition at line 109 of file def_struct.h.

4.6.2.15 yield_priority

```
int yield_priority
```

flag used for determining if the current scheduler thread has already done a down(&sem)

Definition at line 100 of file def_struct.h.

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

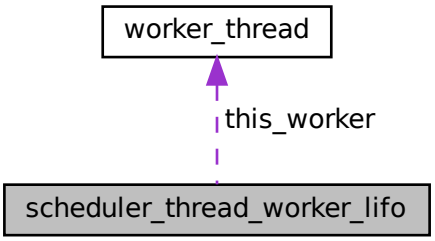
- Headers/ **def_struct.h**

4.7 scheduler_thread_worker_lifo Struct Reference

Strucute used by a UMS Scheduler thread to save the order of the worker threads called.

`#include <def_struct.h>`

Collaboration diagram for scheduler_thread_worker_lifo:



Data Fields

- struct **worker_thread** * **this_worker**
- struct list_head **next**

4.7.1 Detailed Description

Strucute used by a UMS Scheduler thread to save the order of the worker threads called.

Definition at line 83 of file def_struct.h.

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

- Headers/ **def_struct.h**

4.8 ums_device_data_s Struct Reference

structure containing the data needed by module to initialize the UMS device driver

`#include <def_struct.h>`

Data Fields

- struct class * **class**
- struct device * **device**
- int **major**

4.8.1 Detailed Description

structure containing the data needed by module to initialize the UMS device driver

Definition at line 34 of file def_struct.h.

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

- Headers/ **def_struct.h**

4.9 UMS_sched_data Struct Reference

Structure used by the kernel module to mantain differrent UMS Scheduler.

`#include <def_struct.h>`

Data Fields

- struct list_head **scheduler_thread**
- struct list_head **next**
- unsigned long **owner**
- unsigned long int **id_counter**
- struct proc_dir_entry * **ent**
- struct proc_dir_entry * **ent_write**
- struct proc_dir_entry * **father**

4.9.1 Detailed Description

Structure used by the kernel module to mantain differrent UMS Scheduler.

Definition at line 126 of file def_struct.h.

4.9.2 Field Documentation

4.9.2.1 ent

`struct proc_dir_entry* ent`

pointer to proc_entry for "/proc/ums/id_counter"

Definition at line 134 of file def_struct.h.

4.9.2.2 ent_write

```
struct proc_dir_entry* ent_write
```

pointer to proc_entry for "/proc/ums/id_counter/schedulers"

Definition at line 135 of file def_struct.h.

4.9.2.3 father

```
struct proc_dir_entry* father
```

pointer to proc_entry for "/proc/ums"

Definition at line 136 of file def_struct.h.

4.9.2.4 id_counter

```
unsigned long int id_counter
```

ID of the UMS Scheduler(we are using filep)

Definition at line 133 of file def_struct.h.

4.9.2.5 owner

```
unsigned long owner
```

pid of the owner

Definition at line 132 of file def_struct.h.

4.9.2.6 scheduler_thread

```
struct list_head  scheduler_thread
```

used to mantain al the UMS Scheduler threads related to this UMS Scheduler

Definition at line 129 of file def_struct.h.

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

- Headers/ **def_struct.h**

4.10 ums_worker_thread_data Struct Reference

Struct used to share **ums_worker_thread_data** (p. **??**) infos with the kernel.

`#include <user_struct.h>`

Collaboration diagram for ums_worker_thread_data:

Data Fields

- ums_pid_t **pid**
- ums_pid_t **completion_list_id**
- int(∗ **work**)(void ∗)
- void ∗ **args**
- struct **ums_worker_thread_data** ∗ **next**

4.10.1 Detailed Description

Struct used to share **ums_worker_thread_data** (p. **??**) infos with the kernel.

Definition at line 42 of file user_struct.h.

4.10.2 Field Documentation

4.10.2.1 args

`void* args`

argument that will be passed to **work()** (p. **??**)

Definition at line 47 of file user_struct.h.

4.10.2.2 completion_list_id

```
ums_pid_t completion_list_id
```

unsigned long identifier for the completion list who own this worker

Definition at line 45 of file user_struct.h.

4.10.2.3 next

```
struct ums_worker_thread_data* next
```

pointer to the next worker (this variable is !null onli if retrived from a completion_list_data->head)

Definition at line 48 of file user_struct.h.

4.10.2.4 pid

```
ums_pid_t pid
```

identifier of the worker thread

Definition at line 44 of file user_struct.h.

4.10.2.5 work

```
int(* work(void *)
```

pointer to a function that will be executed by the worker thread

Definition at line 46 of file user_struct.h.

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

- Headers/ **user_struct.h**

4.11 worker_thread Struct Reference

Strucute used by a UMS Scheduler to mantain Worker Thread info, used in ADD_WORKER.

```
#include <def_struct.h>
```

Data Fields

- int **state**
- ums_pid_t **pid**
- unsigned long **completion_list_id**
- spinlock_t **execute_lock**
- struct list_head **next**
- struct task_struct * **task_struct**
- int(* **work**)(void *)
- void * **args**
- unsigned long **numb_switch**
- time64_t **runnning_time**
- time64_t **starting_time**

4.11.1 Detailed Description

Strucute used by a UMS Scheduler to mantain Worker Thread info, used in ADD_WORKER.

Definition at line 46 of file def_struct.h.

4.11.2 Field Documentation

4.11.2.1 args

```
void* args
```

arguments for the work function

Definition at line 55 of file def_struct.h.

4.11.2.2 completion_list_id

```
unsigned long completion_list_id
```

id of the completion list who own this this worker

Definition at line 50 of file def_struct.h.

4.11.2.3 execute_lock

```
spinlock_t execute_lock
```

used for concurrency while managing worker

Definition at line 51 of file def_struct.h.

4.11.2.4 numb_switch

```
unsigned long numb_switch
```

args that will be passed to the **work()** (p. **??**) function

Definition at line 56 of file def_struct.h.

4.11.2.5 pid

```
ums_pid_t pid
```

id of the worker

Definition at line 49 of file def_struct.h.

4.11.2.6 state

```
int state
```

State of the worker

Definition at line 48 of file def_struct.h.

4.11.2.7 task_struct

```
struct task_struct* task_struct
```

task struct related to this worker

Definition at line 53 of file def_struct.h.

4.11.2.8 work

```
int(* work(void *)
```

function to be executed from this worker

Definition at line 54 of file def_struct.h.

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

- Headers/ **def_struct.h**

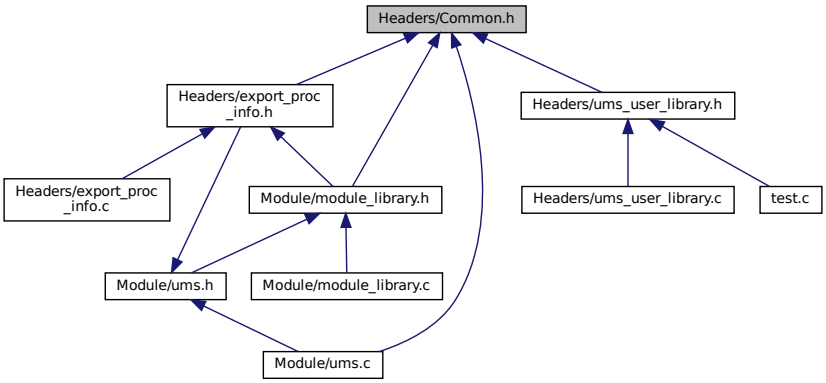
Chapter 5

File Documentation

5.1 Headers/Common.h File Reference

Contains constants and macros used both by the module and the user library.

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



Macros

- #define **DEVICE_NAME** "ums_scheduler"
- #define **MODULE_NAME_LOG** "UMS_SCHEDULER: "
- #define **CLASS_NAME** "ums_scheduler_class"
- #define **OPEN_PATH** "/dev/ums_scheduler"
- #define **DEBUG_M_VAR** 0
- #define **DEBUG_DO_PPRINTK**(fmt, ...)

  function used by the kernel to print debug msgs
- #define **DEBUG_DO_PRINTK**(fmt)

  function used by the kernel to print debug msgs
- #define **ERR_PPRINTK**(fmt, ...) printk(KERN_ERR fmt, ##__VA_ARGS__);

  function used by the kernel to print error msgs

- #define **ERR_PRINTK**(fmt) printk(KERN_ERR fmt);

  function used by the kernel to print error msgs
- #define **NOTIFY_EXEC_ERR_M_VAR** 0
- #define **NOTIFY_EXEC_ERR_PPRINTK**(fmt, ...) if(NOTIFY_EXEC_ERR_M_VAR)printk(KERN_ERR fmt, ##__VA_ARGS__);

  function used by the kernel to print error_exec msgs
- #define **MAGIC_K_VALUE** 'K'
- #define **ENTER_UMS_SCHEDULING_MODE** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 0, sizeof(**sched_thread_data**))

  ENTER_UMS_SCHEDULING_MODE.
- #define **DEQUEUE_UMS_COMPLETION_LIST_ITEMS** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_V↩ ALUE, 1, 8UL)

  DEQUEUE_UMS_COMPLETION_LIST_ITEMS.
- #define **EXECUTE_UMS_THREAD** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 2, 8UL)

  EXECUTE_UMS_THREAD.
- #define **UMS_THREAD_YIELD** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 3, 8UL)

  UMS_THREAD_YIELD.
- #define **EXIT_WORKER_THREAD** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 4, 8UL)

  EXIT_WORKER_THREAD.
- #define **CREATE_COMP_LIST** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 5, 8UL)

  CREATE_COMP_LIST.
- #define **ADD_WORKER** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 6, 8UL)

  ADD_WORKER.
- #define **DESTROY_COMP_LIST** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 7, 8UL)

  DESTROY_COMP_LIST.
- #define **RELEASE_UMS** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 8, 8UL)

  RELEASE_UMS.
- #define **DEQUEUE_SIZE_REQUEST** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 9, 8UL)

  DEQUEUE_SIZE_REQUEST.
- #define **EXIT_FROM_YIELD** _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 10, 8UL)

  EXIT_FROM_YIELD.

5.1.1 Detailed Description

Contains constants and macros used both by the module and the user library.

5.1.2 Macro Definition Documentation

5.1.2.1 ADD_WORKER

```
#define ADD_WORKER _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 6, 8UL)
```

ADD_WORKER.

Parameters

ums_worker_thread_data∗	pointer to **ums_worker_thread_data** (p. **??**)

Returns

0 on success, err otherwise and errno is setted.

```
This function takes as input *ums_worker_thread_data

add the ums_worker_thread_data to the desired completion list

return 0 on success, err otherwise and errno is setted.

in the case of readers/writers or publish/subscribe or master/slaves use 2 different completion_list

errno:
-EACCES, the completion list is marked to be destroyied.
```

Definition at line 230 of file Common.h.

5.1.2.2 CREATE_COMP_LIST

```
#define CREATE_COMP_LIST _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 5, 8UL)
```

CREATE_COMP_LIST.

Parameters

completion_list_data∗	pointer to **completion_list_data** (p. **??**)

Returns

0 on success, err otherwise and errno is setted

this function takes as input ∗completion_list_data

generate a new **completion_list** (p. **??**), and store the id in the passed ∗completion_list_data

return 0 on success, err otherwise and errno is setted

errno: -ENOMEM no more space in the kernel

Definition at line 206 of file Common.h.

5.1.2.3 DEBUG_DO_PPRINTK

```
#define DEBUG_DO_PPRINTK(
               fmt,
               ...  )
```

Value:

```
    if (DEBUG_M_VAR)                          \
    {                                         \
        printk(KERN_INFO fmt, ##__VA_ARGS__); \
    }
```

function used by the kernel to print debug msgs

Definition at line 26 of file Common.h.

5.1.2.4 DEBUG_DO_PRINTK

```
#define DEBUG_DO_PRINTK(
               fmt )
```

Value:

```
    if (DEBUG_M_VAR)           \
    {                          \
        printk(KERN_INFO fmt); \
    }
```

function used by the kernel to print debug msgs

Definition at line 36 of file Common.h.

5.1.2.5 DEQUEUE_SIZE_REQUEST

```
#define DEQUEUE_SIZE_REQUEST _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 9, 8UL)
```

DEQUEUE_SIZE_REQUEST.

Parameters

pointer	to **completion_list_data** (p. **??**)

Returns

0 on success, err otherwise and errno is setted

```
This function return the size to be allocated in user space
in order to recive the list of ums_worker_thread_data(user space struct)

copy to args *completion_list_data with:
-requested_size setted
```

Definition at line 275 of file Common.h.

5.1.2.6 DEQUEUE_UMS_COMPLETION_LIST_ITEMS

```
#define DEQUEUE_UMS_COMPLETION_LIST_ITEMS _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 1, 8UL)
```

DEQUEUE_UMS_COMPLETION_LIST_ITEMS.

Parameters

completion_list_data∗	pointer to **completion_list_data** (p. **??**)

Returns

0 on success, err otherwise and errno is setted

This function read from args ∗completion_list_data

if the completion list is empty(no worker to be executed) the UMS scheduler thread will sleep if the completion list is not empty: 1)the funciotn will check the max space allowed to be written form completion_list_Data 2)then copy (only the allowed infos) **worker_thread(kernel structre)** (p. **??**) to each **ums_worker_thread_data(user structure)** (p. **??**) entry in **completion_list_data** (p. **??**) if no more space or no more worker the function exits return 0 on succedd, err otherwise errno wil be set errno:

- 404: the UMS called the UMS_RELEASE, this pthread should stop calling the device we suggest to return 0(see **ums_user_library.c** (p. **??**) example)

Definition at line 109 of file Common.h.

5.1.2.7 DESTROY_COMP_LIST

```
#define DESTROY_COMP_LIST _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 7, 8UL)
```

DESTROY_COMP_LIST.

Parameters

completion_list_data∗	pointer to a **completion_list_data** (p. **??**)

Returns

0 on success, err otherwise and errno is setted.

```
DESTROY_COMP_LIST
takes as input a *completion_list_data
this function simply mark the completion_list to destroy
```

Definition at line 245 of file Common.h.

5.1.2.8 ENTER_UMS_SCHEDULING_MODE

```
#define ENTER_UMS_SCHEDULING_MODE _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 0, sizeof( sched↩
_thread_data))
```

ENTER_UMS_SCHEDULING_MODE.

Parameters

sched_thread_data∗	pointer to **sched_thread_data** (p. **??**)

Returns

0 on success, err otherwise and errno is setted

```
reads from args *sched_thread_data with:
-entrypoint
-args(for the entry point)
-the completion list id

Then call create_ums_thread.

returns 0 on success, err otherwise, the errno is setted
```

Definition at line 84 of file Common.h.

5.1.2.9 ERR_PPRINTK

```
#define ERR_PPRINTK(
              fmt,
              ...  ) printk(KERN_ERR fmt, ##__VA_ARGS__);
```

function used by the kernel to print error msgs

Definition at line 46 of file Common.h.

5.1.2.10 ERR_PRINTK

```
#define ERR_PRINTK(
              fmt ) printk(KERN_ERR fmt);
```

function used by the kernel to print error msgs

Definition at line 51 of file Common.h.

5.1.2.11 EXECUTE_UMS_THREAD

```
#define EXECUTE_UMS_THREAD _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 2, 8UL)
```

EXECUTE_UMS_THREAD.

Parameters

ums_worker_thread_data∗	pointer to **ums_worker_thread_data** (p. **??**)

Returns

0 on success, err otherwise and errno is setted

```
called from a scheduler thread, it executes the passed worker thread by switching the entire context

this function takes as input a *ums_worker_thread_data
if the worker is not RUNNABLE or not exists the function exits
otherwise set all the information in the current scheduler and then return ums_worker_thread_data filled
with at least *work and *args
The worker will be set to RUNNING

errno:
- EFBIG, no more space in kernel to allow a new scheduler_thread_worker_lifo
- EBADF, worker not found
- EACCES, the worker is not RUNNABLE
 with one of this errno the default operation is to try to execute the next worker;
```

Definition at line 136 of file Common.h.

5.1.2.12 EXIT_FROM_YIELD

```
#define EXIT_FROM_YIELD _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 10, 8UL)
```

EXIT_FROM_YIELD.

Returns

0 on success, err otherwise and errno is setted

```
This is a helper function, should be called after an UMS_THREAD_YIELD
this simply decrement a yield counter in the scheduler
not calling this function will have no consequences on the exectuion
but scheudler infos will be messed up, so that RELEASE will fails when call
```

Definition at line 288 of file Common.h.

5.1.2.13 EXIT_WORKER_THREAD

```
#define EXIT_WORKER_THREAD _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 4, 8UL)
```

EXIT_WORKER_THREAD.

Parameters

sched_thread_data∗	pointer to **sched_thread_data** (p. **??**)

Returns

0 on success, err otherwise and errno is setted

```
This functions must be called at the end of a worker_thread *work function.
This function takes as input *sched_thread_data

Then the worker will be set to EXIT, and rmeoved from:
the completion_list and from the list of the UMS scheduler thread.



at the end like the execute pass sched_thread_data to the user filled with entry_point and args

errno:
- EBUSY, no other worker to execute, but you come from a UMS_THREAD_YIELD,
         you have simply to return 0 from the current function;
```

Definition at line 184 of file Common.h.

5.1.2.14 NOTIFY_EXEC_ERR_PPRINTK

```
#define NOTIFY_EXEC_ERR_PPRINTK(
              fmt,
              ...  ) if(NOTIFY_EXEC_ERR_M_VAR)printk(KERN_ERR fmt, ##__VA_ARGS__);
```

function used by the kernel to print error_exec msgs

Definition at line 58 of file Common.h.

5.1.2.15 RELEASE_UMS

```
#define RELEASE_UMS _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 8, 8UL)
```

RELEASE_UMS.

Returns

0 on success, err otherwise and errno is setted. RELEASE_UMS

this funciton simply relelase the current UMS Scheduler

Definition at line 259 of file Common.h.

5.1.2.16 UMS_THREAD_YIELD

```
#define UMS_THREAD_YIELD _IOC(_IOC_WRITE | _IOC_READ, MAGIC_K_VALUE, 3, 8UL)
```

UMS_THREAD_YIELD.

Parameters

sched_thread_data∗	pointer to **sched_thread_data** (p. **??**)

Returns

err and errno is setted

```
UMS_THREAD_YIELD

called from a worker thread, it pauses the execution of the current thread and the UMS scheduler entry poin

Takes as input *sched_thread_data and fill it with *entry_point and *args
The worker will be set to YIELD

* errno:
- EBUSY, no other workers, this mean that you should just call the EXIT_FROM_YIELD
- EAGAIN, worker found, you have to call the entrypoint before call the EXIT_FROM_YIELD
```

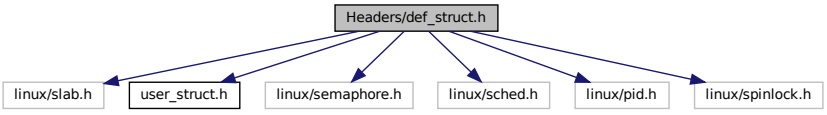
Definition at line 159 of file Common.h.

5.2 Headers/def_struct.h File Reference

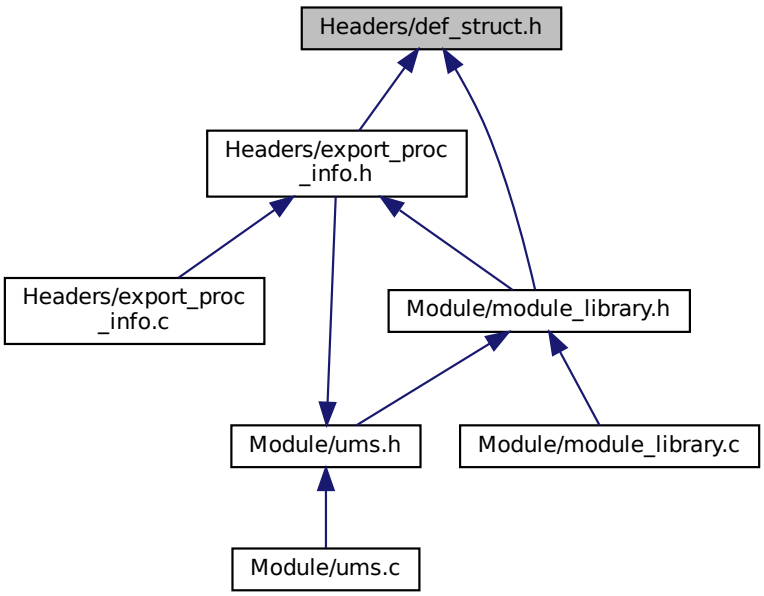
Contains the definitions of every custom type used in the Kernel module code.

```
#include <linux/slab.h>
#include "user_struct.h"
#include <linux/semaphore.h>
#include <linux/sched.h>
#include <linux/pid.h>
#include <linux/spinlock.h>
```

Include dependency graph for def_struct.h:



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



Data Structures

- struct **ums_device_data_s**

  structure containing the data needed by module to initialize the UMS device driver
- struct **worker_thread**

  Strucute used by a UMS Scheduler to mantain Worker Thread info, used in ADD_WORKER.
- struct **completion_list**

  Structure used by an UMS Scheduler to mantain Completion list infos, used in CREATE_COMP_LIST.
- struct **scheduler_thread_worker_lifo**

  Strucute used by a UMS Scheduler thread to save the order of the worker threads called.
- struct **scheduler_thread**

  Structure used by an UMS Scheduler to mantain scheduler thread infos, used in ENTER_SCHEDULING_MODE.
- struct **UMS_sched_data**

  Structure used by the kernel module to mantain differrent UMS Scheduler.

Macros

- #define **EXIT** 0
- #define **RUNNING** 1
- #define **RUNNABLE** 2
- #define **IOWAIT** 3
- #define **SYSWAIT** 4
- #define **YIELD** 5
- #define **UNITIALIZED** 6
- #define **PRIO** 1
- #define **NOT_PRIO** 0

Typedefs

- typedef struct **ums_device_data_s ums_device_data_t**

  structure containing the data needed by module to initialize the UMS device driver
- typedef struct **worker_thread worker_thread**

  Strucute used by a UMS Scheduler to mantain Worker Thread info, used in ADD_WORKER.
- typedef struct **completion_list completion_list**

  Structure used by an UMS Scheduler to mantain Completion list infos, used in CREATE_COMP_LIST.
- typedef struct **scheduler_thread_worker_lifo scheduler_thread_worker_lifo**

  Strucute used by a UMS Scheduler thread to save the order of the worker threads called.
- typedef struct **scheduler_thread scheduler_thread**

  Structure used by an UMS Scheduler to mantain scheduler thread infos, used in ENTER_SCHEDULING_MODE.
- typedef struct **UMS_sched_data UMS_sched_data**

  Structure used by the kernel module to mantain differrent UMS Scheduler.

5.2.1 Detailed Description

Contains the definitions of every custom type used in the Kernel module code.

5.2.2 Typedef Documentation

5.2.2.1 completion_list

`typedef struct` **`completion_list completion_list`**

Structure used by an UMS Scheduler to mantain Completion list infos, used in CREATE_COMP_LIST.

5.2.2.2 scheduler_thread

`typedef struct` **`scheduler_thread scheduler_thread`**

Structure used by an UMS Scheduler to mantain scheduler thread infos, used in ENTER_SCHEDULING_MODE.

5.2.2.3 scheduler_thread_worker_lifo

`typedef struct` **`scheduler_thread_worker_lifo scheduler_thread_worker_lifo`**

Strucute used by a UMS Scheduler thread to save the order of the worker threads called.

5.2.2.4 UMS_sched_data

`typedef struct` **`UMS_sched_data`** **`UMS_sched_data`**

Structure used by the kernel module to mantain differrent UMS Scheduler.

5.2.2.5 worker_thread

`typedef struct` **`worker_thread`** **`worker_thread`**

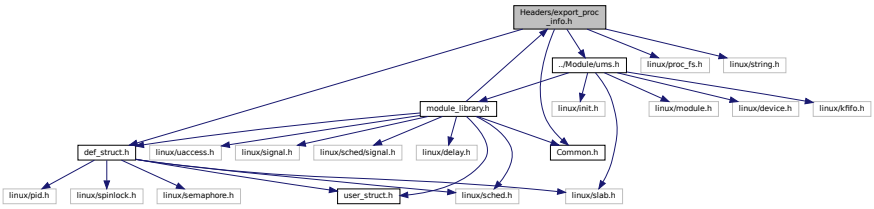
Strucute used by a UMS Scheduler to mantain Worker Thread info, used in ADD_WORKER.

5.3 Headers/export_proc_info.h File Reference

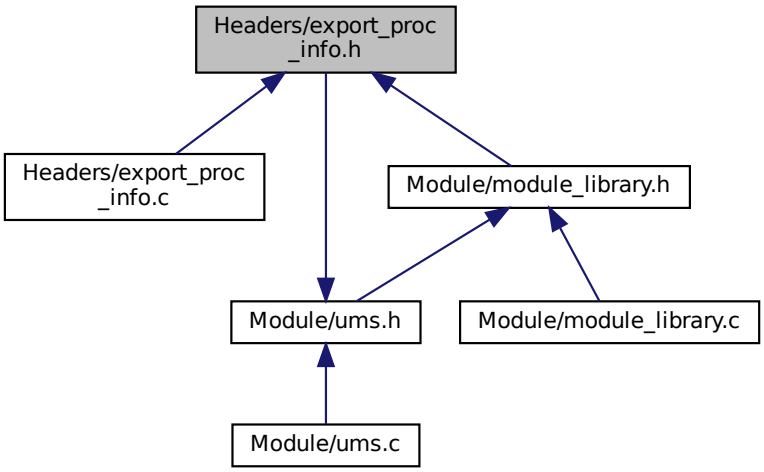
This file containts, macros and functions used to manage the /proc files.

```
#include "def_struct.h"
#include <linux/proc_fs.h>
#include "Common.h"
#include "../Module/ums.h"
#include <linux/string.h>
```

Include dependency graph for export_proc_info.h:



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



Macros

- #define **ums_standard_path** "ums"
- #define **schedulers_dir** "schedulers"
- #define **workers_dir** "workers"
- #define **scheduler_info** "info"
- #define **scheduler_standard_path** "ums/%lu"
- #define **scheduler_thread_standard_path** "ums/%lu/scheduler/%lu"
- #define **worker_standard_path** "ums/%lu/scheduler/%lu/workers/%lu"
- #define **PATH_CREATE_SIZE** 1024
- #define **PATH_RM_SIZE** 2048
- #define **RETRIVE_NAME_SIZE** 2048
- #define **WORKER** 1
- #define **SCHEDULER** 2
- #define **SCHEDULER_THREAD** 3
- #define **BUFSIZE** 4096

Functions

- int **create_proc_ums** (struct proc_dir_entry ∗∗ent)
  Create an ums dir in /proc.
- int **create_proc_ums_scheduler** (unsigned long filep, struct **UMS_sched_data** ∗scheduler, struct proc_↩ dir_entry ∗father)
  Create a <filep> dir under /proc/ums, and /proc/ums/<filep>/shedulers, <filep> is the identifier of an UMS Scheduler.
- int **create_proc_ums_scheduler_thread** (unsigned long filep, struct **scheduler_thread** ∗sched, struct proc_dir_entry ∗father)
  Create: a <pid> dir under /proc/ums/<filep>/schedulers,file "info" and a "workers" dir under /proc/ums/<filep>/schedulers/<pid>. <pid> is the identifier of an UMS Scheduler thread.
- int **create_proc_worker** (struct **worker_thread** ∗worker, struct **scheduler_thread** ∗sched)
  Create a <pid> file under /proc/ums/<filep>/schedulers/<father_pid>/workers.
- int **rm_proc_ums** (void)
  Remove the "ums" dir under /proc.
- int **rm_proc_ums_scheduler** (unsigned long filep, struct **UMS_sched_data** ∗scheduler)
  remove the <filep> dir under /proc/ums
- int **rm_proc_ums_scheduler_thread** (unsigned long filep, struct **scheduler_thread** ∗sched)
  remove the <pid> dir under /proc/ums/<filep>/schedulers
- int **rm_proc_worker** (struct **worker_thread** ∗worker, struct **scheduler_thread** ∗sched)
  remove the <pid> file under /proc/ums/<filep>/schedulers/<father-pid>/workers

5.3.1 Detailed Description

This file containts, macros and functions used to manage the /proc files.

5.3.2 Function Documentation

5.3.2.1 create_proc_ums()

```
int create_proc_ums (
            struct proc_dir_entry ** ent )
```

Create an ums dir in /proc.

Parameters

ent	double pointer to a proc_dir_entry that will recive the new pointer to the dir

Returns

int 0 on success, -1 otherwise

Definition at line 101 of file export_proc_info.c.

5.3.2.2 create_proc_ums_scheduler()

```
int create_proc_ums_scheduler (
            unsigned long filep,
            struct  UMS_sched_data * scheduler,
            struct proc_dir_entry * father )
```

Create a <filep> dir under /proc/ums, and /proc/ums/<filep>/shedulers, <filep> is the identifier of an UMS Scheduler.

Parameters

filep	id of the UMS Scheduler
scheduler	pointer to the UMS_Sched_data that will recive in the [ent,ent_write,father] the proc_dir_entry pointers.
father	pointer to the father proc_dir_entry

Returns

int 0 on success, err otherwise

Definition at line 111 of file export_proc_info.c.

5.3.2.3 create_proc_ums_scheduler_thread()

```
int create_proc_ums_scheduler_thread (
            unsigned long filep,
            struct  scheduler_thread * sched,
            struct proc_dir_entry * father )
```

Create: a <pid> dir under /proc/ums/<filep>/schedulers,file "info" and a "workers" dir under /proc/ums/<filep>/schedulers/<pid>. <pid> is the identifier of an UMS Scheduler thread.

Parameters

filep	id of the UMS Scheduler
sched	pointer to the **scheduler_thread** (p. **??**) that will recive in the [ent,ent_write,father] the proc_dir_entry pointers.
father	pointer to the father proc_dir_entry

Returns

int 0 on success, err otherwise

Definition at line 140 of file export_proc_info.c.

5.3.2.4 create_proc_worker()

```
int create_proc_worker (
            struct  worker_thread * worker,
            struct  scheduler_thread * sched )
```

Create a <pid> file under /proc/ums/<filep>/schedulers/<father_pid>/workers.

Parameters

worker	pointer to a **worker_thread** (p. **??**) struct to retrive the worker infos
sched	pointer to the scheduler thread who manage this worker

Returns

int 0 on success, err otherwise

Definition at line 168 of file export_proc_info.c.

5.3.2.5 rm_proc_ums()

```
int rm_proc_ums (
            void  )
```

Remove the "ums" dir under /proc.

Returns

int 0 on success, err otherwise

Definition at line 183 of file export_proc_info.c.

5.3.2.6 rm_proc_ums_scheduler()

```
int rm_proc_ums_scheduler (
            unsigned long filep,
            struct  UMS_sched_data * scheduler )
```

remove the <filep> dir under /proc/ums

Parameters

filep	id of the UMS Scheduler
scheduler	pointer to the UMS Scheduler

Returns

int 0 on success, err otherwise

Definition at line 188 of file export_proc_info.c.

5.3.2.7 rm_proc_ums_scheduler_thread()

```
int rm_proc_ums_scheduler_thread (
            unsigned long filep,
            struct  scheduler_thread * sched )
```

remove the <pid> dir under /proc/ums/<filep>/schedulers

Parameters

filep	id of the UMS Scheduler who manage this Ums scheduler thread
sched	pointer to the UMS scheduler thread

Returns

int 0 on success, err otherwise

Definition at line 201 of file export_proc_info.c.

5.3.2.8 rm_proc_worker()

```
int rm_proc_worker (
            struct  worker_thread * worker,
            struct  scheduler_thread * sched )
```

remove the <pid> file under /proc/ums/<filep>/schedulers/<father-pid>/workers

Parameters

worker	pointer to the desired worker to eliminate
sched	pointer to the UMS scheduler thread who manage this worker

Returns

int 0 on success, err otherwise

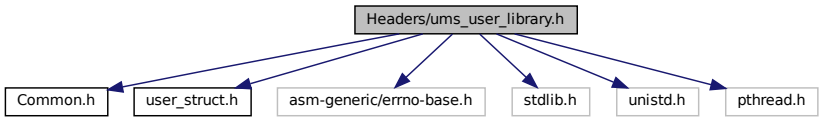
Definition at line 213 of file export_proc_info.c.

5.4 Headers/ums_user_library.h File Reference

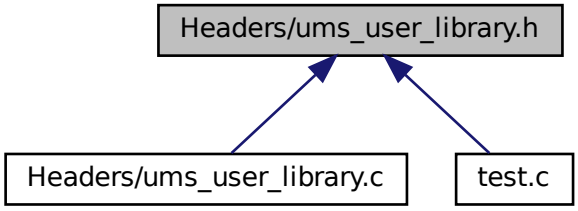
This library contains the definitions of every function that can be used from user space to interact with the UMS Scheduler device.

```
#include "Common.h"
#include "user_struct.h"
#include <asm-generic/errno-base.h>
#include <stdlib.h>
#include <unistd.h>
#include <pthread.h>
```

Include dependency graph for ums_user_library.h:



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



Macros

- #define **DEBUG_USER_M_VAR** 0
- #define **DEBUG_USER_DO_PPRINTF**(fmt, ...)

  function used by the library to print debug msgs
- #define **DEBUG_USER_DO_PRINTF**(fmt)

  function used by the library to print debug msgs

- #define **ERR_USER_M_VAR** 1
- #define **ERR_USER_PPRINTF**(fmt, ...)

  function used by the library to print err msgs
- #define **ERR_USER_PRINTF**(fmt)

  function used by the library to print err msgs
- #define **ERR_USER_EXEC_M_VAR** 0
- #define **ERR_USER_EXEC_PPRINTF**(fmt, ...)

  function used by the library to print err_exec msgs
- #define **ERR_USER_EXEC_PRINTF**(fmt)

  function used by the library to print err_exec msgs

Functions

- int **ums_init** ()

  Initialize a new UMS.
- int **ums_close** (int fd)

  Release all the structures related to the fd UMS.
- int **enter_ums_scheduling_mode** (int fd, int(∗entry_point)(void ∗), void ∗entrypoint_args, ums_pid_↩ t completion_list_id)

  Converts a standard pthread in a UMS Scheduler thread, the function takes as input a file descriptor, a completion list ID of worker threads and a entry point function.
- **completion_list_data** ∗ **dequeue_ums_completion_list_items** (int fd)

  called from the scheduler thread obtains a list of current available thread to be run, if no thread is available to be run the function should be blocking until a thread becomes available
- int **execute_ums_thread** (int fd, ums_pid_t worker_id, **completion_list_data** ∗list_data)

  called from a scheduler thread, it executes the passed worker thread by switching the entire context, if -EACCES or -EBADF are returned try again with a different worker_id.
- int **ums_thread_yield** (int fd)

  called from a worker thread, it pauses the execution of the current thread and the UMS scheduler entry point is executed for determining the next thread to be scheduled;
- int **exit_worker_thread** (int fd)

  *This function must be called at the end of every **worker_thread** (p. **??**).*
- **completion_list_data** ∗ **create_completion_list** (int fd)

  *Create a completion list object, the ID is located in create_completion_list->id, in the case of readers/writers or publish/subscribe or master/slaves use 2 different **completion_list** (p. **??**) for the two groups of workers.*
- int **add_worker_thread** (int fd, int(∗work)(void ∗), void ∗ **args**, ums_pid_t completion_list_id)

  Create and add a worker thread to the desired completion list.
- int **destroy_comp_list** (int fd, ums_pid_t completion_list_id)

  destroy the selected completion list
- int **release_ums** (int fd)

  destroy the UMS

5.4.1 Detailed Description

This library contains the definitions of every function that can be used from user space to interact with the UMS Scheduler device.

5.4.2 Macro Definition Documentation

5.4.2.1 DEBUG_USER_DO_PPRINTF

```
#define DEBUG_USER_DO_PPRINTF(
                fmt,
                ...  )
```

Value:

```
    if (DEBUG_USER_M_VAR)               \
    {                                   \
        printf(fmt, ##__VA_ARGS__);     \
    }
```

function used by the library to print debug msgs

Definition at line 21 of file ums_user_library.h.

5.4.2.2 DEBUG_USER_DO_PRINTF

```
#define DEBUG_USER_DO_PRINTF(
                fmt )
```

Value:

```
    if (DEBUG_USER_M_VAR)          \
    {                              \
        printf(fmt);               \
    }
```

function used by the library to print debug msgs

Definition at line 30 of file ums_user_library.h.

5.4.2.3 ERR_USER_EXEC_PPRINTF

```
#define ERR_USER_EXEC_PPRINTF(
                fmt,
                ...  )
```

Value:

```
    if (ERR_USER_EXEC_M_VAR)            \
        printf(fmt, ##__VA_ARGS__);
```

function used by the library to print err_exec msgs

Definition at line 58 of file ums_user_library.h.

5.4.2.4 ERR_USER_EXEC_PRINTF

```
#define ERR_USER_EXEC_PRINTF(
               fmt )
```

Value:

```
    if (ERR_USER_EXEC_M_VAR)      \
        printf(fmt);
```

function used by the library to print err_exec msgs

Definition at line 66 of file ums_user_library.h.

5.4.2.5 ERR_USER_PPRINTF

```
#define ERR_USER_PPRINTF(
               fmt,
               ...  )
```

Value:

```
    if (ERR_USER_M_VAR)            \
        printf(fmt, ##__VA_ARGS__);
```

function used by the library to print err msgs

Definition at line 40 of file ums_user_library.h.

5.4.2.6 ERR_USER_PRINTF

```
#define ERR_USER_PRINTF(
               fmt )
```

Value:

```
    if (ERR_USER_M_VAR)      \
        printf(fmt);
```

function used by the library to print err msgs

Definition at line 48 of file ums_user_library.h.

5.4.3 Function Documentation

5.4.3.1 add_worker_thread()

```
int add_worker_thread (
             int fd,
             int(*)(void *) work,
             void * args,
             ums_pid_t completion_list_id )
```

Create and add a worker thread to the desired completion list.

Parameters

fd	File descriptor related to the UMS
work	pointer to a function that will be executed by the worker thread
args	argument that will be passed to work()
completion_list_id	unsigned long identifier for the completion list who will own this worker

Returns

int 0 on success, -1 otherwise

Definition at line 388 of file ums_user_library.c.

5.4.3.2 create_completion_list()

```
completion_list_data* create_completion_list (
            int fd )
```

Create a completion list object, the ID is located in create_completion_list->id, in the case of readers/writers or publish/subscribe or master/slaves use 2 different **completion_list** (p. **??**) for the two groups of workers.

Parameters

fd	File descriptor related to the UMS

Returns

completion_list_data* on success, NULL otherwise

Definition at line 371 of file ums_user_library.c.

5.4.3.3 dequeue_ums_completion_list_items()

```
completion_list_data* dequeue_ums_completion_list_items (
            int fd )
```

called from the scheduler thread obtains a list of current available thread to be run, if no thread is available to be run the function should be blocking until a thread becomes available

Parameters

fd	File descriptor related to the UMS

Returns

struct completionm_list_data* pointer to a **completion_list_data** (p. **??**)

Definition at line 192 of file ums_user_library.c.

5.4.3.4 destroy_comp_list()

```
int destroy_comp_list (
            int fd,
            ums_pid_t completion_list_id )
```

destroy the selected completion list

Parameters

fd	File descriptor related to the UMS
completion_list_id	ID of the completion list to destroy

Returns

int 0 on success, -1 otherwise

Definition at line 413 of file ums_user_library.c.

5.4.3.5 enter_ums_scheduling_mode()

```
int enter_ums_scheduling_mode (
            int fd,
            int(*)(void *) entry_point,
            void * entrypoint_args,
            ums_pid_t completion_list_id )
```

Converts a standard pthread in a UMS Scheduler thread, the function takes as input a file descriptor, a completion list ID of worker threads and a entry point function.

Parameters

fd	File descriptor related to the UMS schduler
entry_point	Pointer to a Scheduling function
completion_list_id	ID of a completion list that will be schedule on this UMS Scheduler thread
entrypoint_args	pointer to entry_point funtion's parameters

Returns

int returns 0 on success, -1 otherwise

Definition at line 155 of file ums_user_library.c.

5.4.3.6 execute_ums_thread()

```
int execute_ums_thread (
            int fd,
            ums_pid_t worker_id,
             completion_list_data * list_data )
```

called from a scheduler thread, it executes the passed worker thread by switching the entire context, if -EACCES or -EBADF are returned try again with a different worker_id.

Parameters

fd	File descriptor related to the UMS
worker_id	id of the worker to be executed, the id is contenuto in the struct **ums_worker_thread_data** (p. **??**) contenua in the struct completion_list_data->head
list_data	pointer to the **completion_list** (p. **??**) retrived from the dequeue, this list will be free

Returns

int returns job's return value on success, -EBADF or -EACCES if a worker is already running, err otherwise

Definition at line 256 of file ums_user_library.c.

Here is the call graph for this function:

5.4.3.7 exit_worker_thread()

```
int exit_worker_thread (
            int fd )
```

This function must be called at the end of every **worker_thread** (p. **??**).

Parameters

fd	File descriptor related to the UMS

Returns

int return 0 on success, -1 otherwise

Definition at line 336 of file ums_user_library.c.

Here is the caller graph for this function:

5.4.3.8 release_ums()

```
int release_ums (
            int fd )
```

destroy the UMS

Parameters

fd	File descriptor related to the UMS

Returns

int 0 on success, -1 otherwise

Definition at line 429 of file ums_user_library.c.

5.4.3.9 ums_close()

```
int ums_close (
            int fd )
```

Release all the structures related to the fd UMS.

Returns

int return 0 on success, -1 otherwise

Definition at line 136 of file ums_user_library.c.

5.4.3.10 ums_init()

```
int ums_init ( )
```

Initialize a new UMS.

Returns

int returns the file descriptor of the device driver, -1 otherwise

Definition at line 124 of file ums_user_library.c.

5.4.3.11 ums_thread_yield()

```
int ums_thread_yield (
            int fd )
```

called from a worker thread, it pauses the execution of the current thread and the UMS scheduler entry point is executed for determining the next thread to be scheduled;

Parameters

fd	File descriptor related to the UMS

Returns

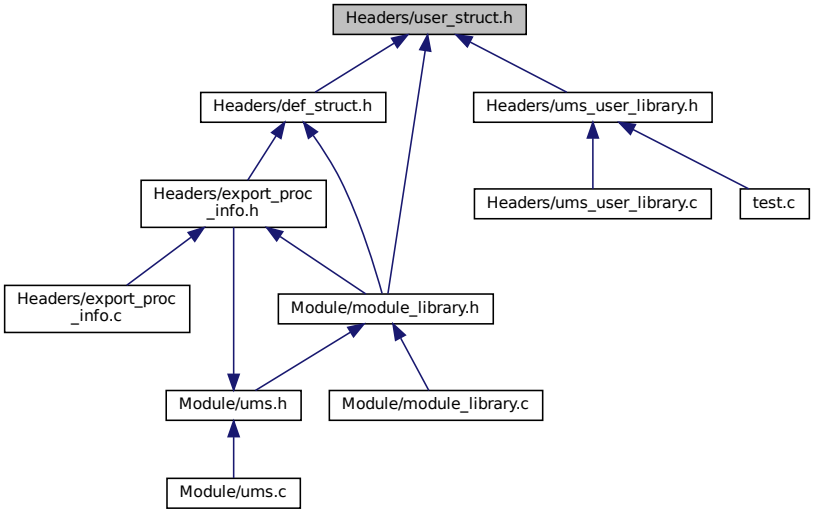
int return 0 on success, -1 otherwise

Definition at line 296 of file ums_user_library.c.

5.5 Headers/user_struct.h File Reference

Contains the definitions of every custom type used in user space.

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



Data Structures

- struct **sched_thread_data**

  *Struct used to share **sched_thread_data** (p. **??**) info with the kernel.*
- struct **completion_list_data**

  *Struct used to share **completion_list_data** (p. **??**) info with the kernel.*
- struct **ums_worker_thread_data**

  *Struct used to share **ums_worker_thread_data** (p. **??**) infos with the kernel.*

Typedefs

- typedef unsigned long long **ums_pid_t**
- typedef struct **sched_thread_data** **sched_thread_data**

  *Struct used to share **sched_thread_data** (p. **??**) info with the kernel.*
- typedef struct **completion_list_data** **completion_list_data**

  *Struct used to share **completion_list_data** (p. **??**) info with the kernel.*
- typedef struct **ums_worker_thread_data** **ums_worker_thread_data**

  *Struct used to share **ums_worker_thread_data** (p. **??**) infos with the kernel.*

5.5.1 Detailed Description

Contains the definitions of every custom type used in user space.

5.5.2 Typedef Documentation

5.5.2.1 completion_list_data

```
typedef struct  completion_list_data  completion_list_data
```

Struct used to share **completion_list_data** (p. **??**) info with the kernel.

5.5.2.2 sched_thread_data

```
typedef struct  sched_thread_data  sched_thread_data
```

Struct used to share **sched_thread_data** (p. **??**) info with the kernel.

5.5.2.3 ums_worker_thread_data

```
typedef struct  ums_worker_thread_data  ums_worker_thread_data
```

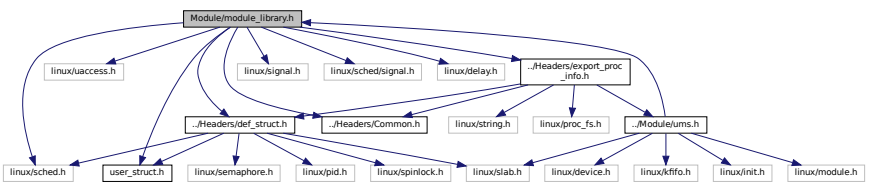
Struct used to share **ums_worker_thread_data** (p. **??**) infos with the kernel.

5.6 Module/module_library.h File Reference

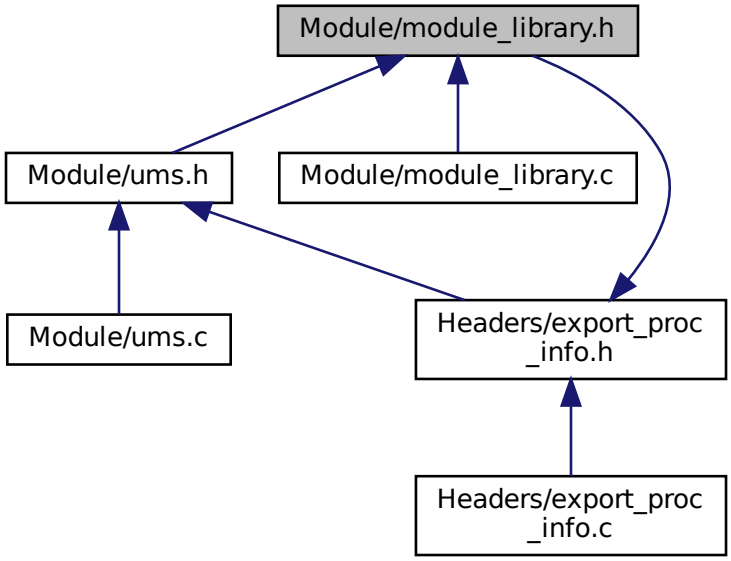
Contains the helper functions called from the UMS device.

```
#include <linux/sched.h>
#include <linux/uaccess.h>
#include "../Headers/def_struct.h"
#include "../Headers/Common.h"
#include <linux/signal.h>
#include "../Headers/user_struct.h"
#include <linux/sched/signal.h>
#include <linux/delay.h>
#include "../Headers/export_proc_info.h"
```

Include dependency graph for module_library.h:



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



Functions

- int **create_ums_thread** (struct list_head ∗sched_data, unsigned long int filep, int(∗entry_point)(void ∗), void ∗ **args**, struct list_head ∗comp_lists, ums_pid_t _completion_list)

  *Create a new **scheduler_thread** (p. **??**) struct, by relating entry_point and _completion_list.*
- struct **completion_list** ∗ **retrive_current_list** (struct list_head ∗sched_data, unsigned long int filep)

  *retive the completion list managed by the current **scheduler_thread** (p. **??**)*
- struct **scheduler_thread** ∗ **retrive_current_scheduler_thread** (struct list_head ∗sched_data, unsigned long int filep)

  *Retrive the current **scheduler_thread** (p. **??**) structure.*
- int **release_scheduler** (struct list_head ∗sched_data, unsigned long int filep)

  release the current UMS Scheduler and the relative compeltion_lists(if possibile) and scheduler_threads, if the schedulers are currently executing a worker this function returs -5;
- struct **completion_list** ∗ **retrive_list** (struct list_head ∗comp_lists, ums_pid_t id)

  *Retrive the desired **completion_list** (p. **??**).*
- struct **worker_thread** ∗ **retrive_worker_thread** (struct **completion_list** ∗current_list, ums_pid_t pid)

  *retrive the desired **worker_thread** (p. **??**)*
- int **list_copy_to_user** (struct **completion_list_data** ∗to_write, struct **completion_list** ∗from_read)

  Create a copy of the current completion list for the user.
- int **del_worker_thread** (struct list_head worker_list, struct **worker_thread** ∗worker_to_del)

  free the desired worker
- char ∗ **_retrive_worker_thread_proc** (time64_t pid, struct list_head ∗comp_lists)

  retrive the infos form the worker's struct in a char∗
- char ∗ **_retrive_schduler_thread_proc** (time64_t pid, struct list_head ∗sched_data)

  retrive the infos form the schduler_thread's struct in a char∗
- int **destoy_comp_list_set_destroy** (unsigned long arg, struct list_head ∗comp_lists)

Destroy the choosen comp list with id:completion_list_id.

- int **add_worker** (unsigned long arg, ums_pid_t worker_counter, struct list_head ∗comp_lists)

  *This function generate a new **worker_thread** (*p. **??***) form **ums_worker_thread_data** (*p. **??***) and then add it to the desired **completion_list** (*p. **??***).*
- int **exit_worker_thread** (struct list_head ∗sched_data, unsigned long int filep, unsigned long arg)

  This functions delete the worker and pass to the user new entry_point function.
- int **exit_from_yield** (struct list_head ∗sched_data, unsigned long int filep)

  This function update the running time of thw worker and decrement the nesting variable.
- int **ums_thread_yield** (struct list_head ∗sched_data, unsigned long int filep, unsigned long arg)

  Pause the execution of the current worker and write in (sched_thread_data∗)arg entry_point and args.
- int **_execute_ums_thread** (struct list_head ∗sched_data, unsigned long int filep, unsigned long arg, struct **scheduler_thread** ∗cur_scheduler, struct **scheduler_thread_worker_lifo** ∗worker_lifo_aux)

  Retrive from the user te id of the worker to execute, if found save the worker in the UMS SCheduler thread list of worker and pass to the user the work and args.
- int **execute_ums_thread** (struct list_head ∗sched_data, unsigned long int filep, unsigned long arg, struct **scheduler_thread_worker_lifo** ∗worker_lifo_aux)

  this functions is a wrapper for _execute_ums_thread, to manage the data statistics
- int **dequeue_size_request** (struct list_head ∗sched_data, unsigned long int filep, unsigned long arg)

  *This function return the size to be allocated in user space in order to recive the list of **ums_worker_thread_data(user space struct)** (*p. **??***)*
- int **enter_ums_scheduling_mode** (struct list_head ∗sched_data, unsigned long int filep, unsigned long arg, struct list_head ∗comp_lists)

  This function converts a standard pthread in a UMS Scheduler thread.

5.6.1 Detailed Description

Contains the helper functions called from the UMS device.

5.6.2 Function Documentation

5.6.2.1 _execute_ums_thread()

```
int _execute_ums_thread (
            struct list_head * sched_data,
            unsigned long int filep,
            unsigned long arg,
            struct  scheduler_thread * cur_scheduler,
            struct  scheduler_thread_worker_lifo * worker_lifo_aux )
```

Retrive from the user te id of the worker to execute, if found save the worker in the UMS SCheduler thread list of worker and pass to the user the work and args.

Parameters

sched_data	pointer to a UMS Scheduler list_head who manage this scheduler thread
filep	id of the UMS Scheduler
arg	pointer to a user space sched_thread_data∗ passed with the id of the choosed woker, than will be filled with entry_point and ∗args
worker_lifo_aux	structure that will contain the choosed wroker to be added to the UMS SCheduler thread
cur_scheduler	pointer to the current UMS Scheduler thread

Returns

int 0 on success, err otherwise. err:

- -EFBIG, no more space in kernel to allow a new **scheduler_thread_worker_lifo** (p. **??**)
- -EBADF, worker not found
- -EACCES, the worker is not RUNNABLE with one of this errno the default operation is to try to execute the next worker;

Definition at line 939 of file module_library.c.

5.6.2.2 _retrive_schduler_thread_proc()

```
char* _retrive_schduler_thread_proc (
            time64_t pid,
            struct list_head * sched_data )
```

retrive the infos form the schduler_thread's struct in a char*

Parameters

pid	the selected schduler_thread id
sched_data	pointer to a UMS Scheduler list_head where the scheduler thread is stored

Returns

char* !=NULL on success, NULL otherwise

Definition at line 567 of file module_library.c.

Here is the caller graph for this function:

5.6.2.3 _retrive_worker_thread_proc()

```
char* _retrive_worker_thread_proc (
            time64_t pid,
            struct list_head * comp_lists )
```

retrive the infos form the worker's struct in a char*

Parameters

pid	the selected worker id
comp_lists	pointer to a Completion list list_head where the worker is stored

Returns

char∗ !=NULL on success, NULL otherwise

Definition at line 606 of file module_library.c.

Here is the caller graph for this function:

5.6.2.4 add_worker()

```
int add_worker (
              unsigned long arg,
              ums_pid_t worker_counter,
              struct list_head * comp_lists )
```

This function generate a new **worker_thread** (p. **??**) form **ums_worker_thread_data** (p. **??**) and then add it to the desired **completion_list** (p. **??**).

Parameters

arg	pointer to a user space **ums_worker_thread_data** (p. **??**) ∗ that contains the new woker infos
worker_to_add	worker passed from user space
new_worker_thread	struct allocated from the kernel to be filled
worker_counter	monotonic counter of the worker
comp_lists	pointer to the **completion_list** (p. **??**) list_head who manage the choosen **completion_list** (p. **??**)

Returns

int 0 on succees, err otherwise,if err=EACCES the completion list is marked to be destroyied.

Definition at line 697 of file module_library.c.

5.6.2.5 create_ums_thread()

```
int create_ums_thread (
             struct list_head * sched_data,
             unsigned long int filep,
             int(*)(void *) entry_point,
             void * args,
             struct list_head * comp_lists,
             ums_pid_t _completion_list )
```

Create a new **scheduler_thread** (p. **??**) struct, by relating entry_point and _completion_list.

Parameters

sched_data	pointer to the UMS Scheduler global variable that manage all the UMS Scheduler
filep	identifier of the file descriptoy
entry_point	scheduling function
args	pointer to the args to pass to the entry_point function
comp_lists	pointer to the UMS Scheduler global variable that manage all the completion lists
_completion_list	identifier of the completion list to relate to this scheduler thread

Returns

int 0 on success err otherwise for the possible err values, they are same of the relative ioctl

Definition at line 106 of file module_library.c.

5.6.2.6 del_worker_thread()

```
int del_worker_thread (
             struct list_head worker_list,
             struct  worker_thread * worker_to_del )
```

free the desired worker

Parameters

worker_list	the list_head who own this worker
worker_to_del	pointer to the worker to del

Returns

int 0 on success, -1 otherwise

Definition at line 536 of file module_library.c.

5.6.2.7 dequeue_size_request()

```
int dequeue_size_request (
            struct list_head * sched_data,
            unsigned long int filep,
            unsigned long arg )
```

This function return the size to be allocated in user space in order to recive the list of **ums_worker_thread_data(user space struct)** (p. **??**)

Parameters

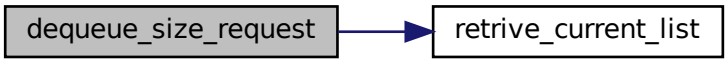
sched_data	pointer to a UMS Scheduler list_head who manage this scheduler thread
filep	id of the UMS Scheduler
arg	pointer to a user space completion_list_data* used to set the requeste_size var

Returns

int 0 on success, err otherwise

Definition at line 1081 of file module_library.c.

Here is the call graph for this function:



5.6.2.8 destoy_comp_list_set_destroy()

```
int destoy_comp_list_set_destroy (
            unsigned long arg,
            struct list_head * comp_lists )
```

Destroy the choosen comp list with id:completion_list_id.

Parameters

arg	pointer to teh completion_list_data* that contains the info of the choosed completion list
comp_lists	pointer to the list_head who own all the **completion_list** (p. **??**) for this UMS Scheduler
completion_list_id	the id of the completion list to destroy

Returns

int 0 on success, err otherwise, if err=ENOMEM no more space in the kernel

Definition at line 668 of file module_library.c.

5.6.2.9 enter_ums_scheduling_mode()

```
int enter_ums_scheduling_mode (
            struct list_head * sched_data,
            unsigned long int filep,
            unsigned long arg,
            struct list_head * comp_lists )
```

This function converts a standard pthread in a UMS Scheduler thread.

Parameters

sched_data	pointer to a UMS Scheduler list_head who manage this scheduler thread
filep	id of the UMS Scheduler
arg	pointer to a user space sched_thread_data∗ used to read the information needed to convert a pthread into a UMS Scheduler threads
comp_lists	pointer to the **completion_list** (p. **??**) list_head who manage the choosen **completion_list** (p. **??**)

Returns

0 on success, err otherwise

Definition at line 1122 of file module_library.c.

5.6.2.10 execute_ums_thread()

```
int execute_ums_thread (
            struct list_head * sched_data,
            unsigned long int filep,
            unsigned long arg,
            struct  scheduler_thread_worker_lifo * worker_lifo_aux )
```

this functions is a wrapper for _execute_ums_thread, to manage the data statistics

Parameters

sched_data	pointer to a UMS Scheduler list_head who manage this scheduler thread
filep	id of the UMS Scheduler
arg	pointer to a user space sched_thread_data∗ passed with the id of the choosed woker, than will be filled with entry_point and ∗args
worker_lifo_aux	structure that will contain the choosed wroker to be added to the UMS SCheduler thread

Returns

int 0 on success, err otherwise. err:

- -EFBIG, no more space in kernel to allow a new **scheduler_thread_worker_lifo** (p. **??**)
- -EBADF, worker not found
- -EACCES, the worker is not RUNNABLE with one of this errno the default operation is to try to execute the next worker;

Definition at line 1024 of file module_library.c.

5.6.2.11 exit_from_yield()

```
int exit_from_yield (
            struct list_head * sched_data,
            unsigned long int filep )
```

This function update the running time of thw worker and decrement the nesting variable.

Parameters

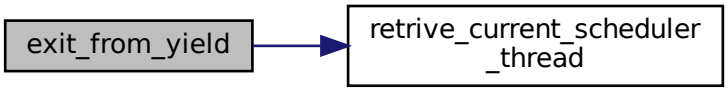
sched_data	pointer to a UMS Scheduler list_head who manage this scheduler thread
filep	id of the UMS Scheduler

Returns

int 0 on success, err otherwise

Definition at line 863 of file module_library.c.

Here is the call graph for this function:



5.6.2.12 exit_worker_thread()

```
int exit_worker_thread (
            struct list_head * sched_data,
            unsigned long int filep,
            unsigned long arg )
```

This functions delete the worker and pass to the user new entry_point function.

Parameters

sched_data	pointer to a UMS Scheduler list_head who manage this scheduler thread
filep	id of the UMS Scheduler
arg	pointer passed fro user space

Returns

int 0 on success, err otherwise, if err=-EBUSY :no other worker to execute

Definition at line 761 of file module_library.c.

5.6.2.13 list_copy_to_user()

```
int list_copy_to_user (
            struct  completion_list_data * to_write,
            struct  completion_list * from_read )
```

Create a copy of the current completion list for the user.

Parameters

to_write	pointer to a **completion_list_data** (p. **??**) struct, given by the user
from_read	pointer to a **completion_list** (p. **??**) struct, given by the kernel

Returns

int 0 on success, err otherwise

Definition at line 443 of file module_library.c.

5.6.2.14 release_scheduler()

```
int release_scheduler (
            struct list_head * sched_data,
            unsigned long int filep )
```

release the current UMS Scheduler and the relative compeltion_lists(if possibile) and scheduler_threads, if the schedulers are currently executing a worker this function returs -5;

Parameters

sched_data	pointer to the UMS Scheduler global variable that manage all the UMS Scheduler
filep	identifier of the file descriptoy

Returns

int 0 on success err otherwise

Definition at line 291 of file module_library.c.

5.6.2.15 retrive_current_list()

```
struct  completion_list* retrive_current_list (
             struct list_head * sched_data,
             unsigned long int filep )
```

retive the completion list managed by the current **scheduler_thread** (p. **??**)

Parameters

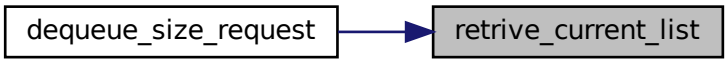
sched_data	pointer to the UMS Scheduler global variable that manage all the UMS Scheduler
filep	identifier of the file descriptoy

Returns

struct completion_list* on success NULL otherwise

Definition at line 167 of file module_library.c.

Here is the caller graph for this function:



5.6.2.16 retrive_current_scheduler_thread()

```
struct  scheduler_thread* retrive_current_scheduler_thread (
             struct list_head * sched_data,
             unsigned long int filep )
```

Retrive the current **scheduler_thread** (p. **??**) structure.

Parameters

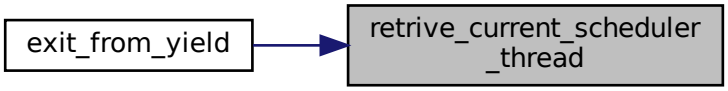
sched_data	pointer to the UMS Scheduler global variable that manage all the UMS Scheduler
filep	identifier of the file descriptoy

Returns

struct scheduler_thread∗ on success NULL otherwise

Definition at line 235 of file module_library.c.

Here is the caller graph for this function:



5.6.2.17 retrive_list()

```
struct  completion_list* retrive_list (
             struct list_head * comp_lists,
             ums_pid_t id )
```

Retrive the desired **completion_list** (p. **??**).

Parameters

comp_lists	pointer to the UMS Scheduler global variable that manage all the completion lists
id	id of the **completion_list** (p. **??**) choosen

Returns

struct completion_list∗ on success, NULL otherwise

Definition at line 398 of file module_library.c.

5.6.2.18 retrive_worker_thread()

```
struct  worker_thread* retrive_worker_thread (
             struct  completion_list * current_list,
             ums_pid_t pid )
```

retrive the desired **worker_thread** (p. **??**)

Parameters

current_list	pointer to the scheduler_thread->**completion_list** (p. **??**)
pid	id of the **worker_thread** (p. **??**)

Returns

struct worker_thread* on success, NULL otherwise

Definition at line 424 of file module_library.c.

5.6.2.19 ums_thread_yield()

```
int ums_thread_yield (
             struct list_head * sched_data,
             unsigned long int filep,
             unsigned long arg )
```

Pause the execution of the current worker and write in (sched_thread_data*)arg entry_point and args.

Parameters

sched_data	pointer to a UMS Scheduler list_head who manage this scheduler thread
filep	id of the UMS Scheduler
arg	pointer to a user space sched_thread_data* taht will be fill with entry_point and *args

Returns

errno

- errno:
  - EBUSY, no other workers, this mean that you should just call the EXIT_FROM_YIELD
  - EAGAIN, worker found, you have to call the entrypoint before call the EXIT_FROM_YIELD

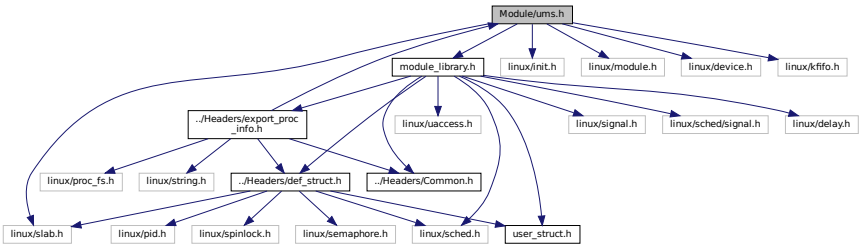
Definition at line 891 of file module_library.c.

5.7 Module/ums.h File Reference

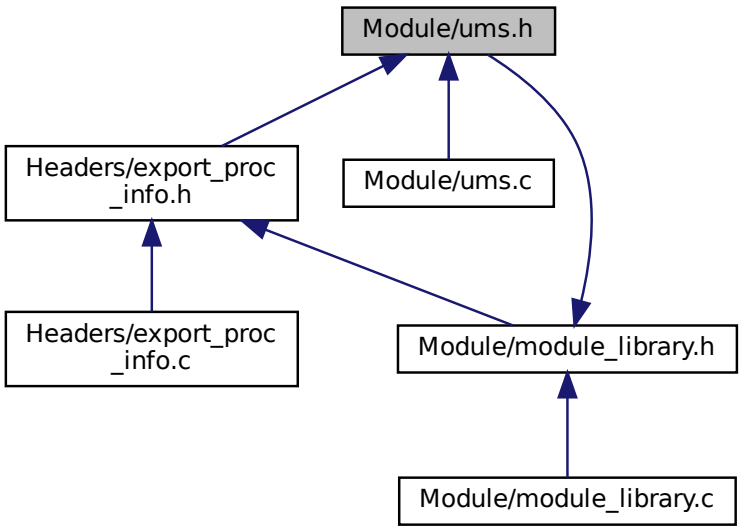
Contains the functions to interact from user space with the kernel module.

```
#include <linux/slab.h>
#include <linux/init.h>
#include <linux/module.h>
#include <linux/device.h>
#include <linux/kfifo.h>
#include "module_library.h"
```

Include dependency graph for ums.h:



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



Functions

- int **ums_dev_open** (struct inode *inodep, struct file *filep)

  Used to create a new UMS scheduler.
- int **ums_dev_release** (struct inode *inodep, struct file *filep)

  Function not implemented, to close call the ioctl(DESTROY_COMP_LIST) and then ioctl(RELEASE_UMS)
- long **ums_dev_ioctls** (struct file *filep, unsigned int cmd, unsigned long arg)

  *This function wraps: all the ioctls declared in **Common.h** (p. **??**).*
- char * **retrive_worker_thread_proc** (time64_t pid)

retrives the info of a worker thread and puts it in a buffer

- char * **retrive_schduler_thread_proc** (time64_t pid)

  retrive the info of a schduler thread and puts it in a buffer

5.7.1 Detailed Description

Contains the functions to interact from user space with the kernel module.

5.7.2 Function Documentation

5.7.2.1 retrive_schduler_thread_proc()

```
char* retrive_schduler_thread_proc (
            time64_t pid )
```

retrive the info of a schduler thread and puts it in a buffer

Parameters

pid	the selected schduler thread's id

Returns

char* !=NULL on success, NULL otherwise

Definition at line 743 of file ums.c.

Here is the call graph for this function:

5.7.2.2 retrive_worker_thread_proc()

```
char* retrive_worker_thread_proc (
            time64_t pid )
```

retrives the info of a worker thread and puts it in a buffer

Parameters

pid	the selected worker id

Returns

char∗ !=NULL on success, NULL otherwise

Definition at line 655 of file ums.c.

Here is the call graph for this function:

5.7.2.3 ums_dev_ioctls()

```
long ums_dev_ioctls (
             struct file * filep,
             unsigned int cmd,
             unsigned long arg )
```

This function wraps: all the ioctls declared in **Common.h** (p. **??**).

Parameters

filep	
cmd	the IOCTL defined in **Common.h** (p. **??**)
arg	used to copy_from/copy_to user space

Returns

long

ENTER_UMS_SCHEDULING_MODE

reads from args ∗sched_thread_data with: -entrypoint -**args(for the entry point)** (p. **??**) -the completion list id

Then call create_ums_thread.

returns 0 on success, err otherwise, the errno is setteed

UMS_THREAD_YIELD

called from a worker thread, it pauses the execution of the current thread and the UMS scheduler entry point is executed for determining the next thread to be scheduled;

Takes as input ∗sched_thread_data fill it with ∗entry_point and ∗args The worker will be set to YIELD

errno:

- EBUSY, no other workers, this mean that you should just call the EXIT_FROM_YIELD
- EAGAIN, worker found, you have to call the entrypoint before call the EXIT_FROM_YIELD

Definition at line 195 of file ums.c.

5.7.2.4 ums_dev_open()

```
int ums_dev_open (
            struct inode * inodep,
            struct file * filep )
```

Used to create a new UMS scheduler.

Parameters

inodep	
filep	

Returns

int 0 on success, err otherwise

Definition at line 125 of file ums.c.

5.7.2.5 ums_dev_release()

```
int ums_dev_release (
            struct inode * inodep,
            struct file * filep )
```

Function not implemented, to close call the ioctl(DESTROY_COMP_LIST) and then ioctl(RELEASE_UMS)

Parameters

inodep	
filep	

Returns

int 0 on success, err otherwise

Definition at line 186 of file ums.c.

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