

F.R.I.D.A.Y.

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# Chapter 1

## F.R.I.D.A.Y.

NOTE: Run ``doxygen Doxyfile`` to generate full documentation.

### 1.1 F.R.I.D.A.Y. Programmer Manual R3/R4

#### 1.1.0.1 Contents

1. Overview
2. OS Lifecycle
3. Extending Systems
  - (a) `kmain()` and Startup
  - (b) The Command Handler
  - (c) Registering a Command
    - Command Function
    - Adding Command to Help
4. Conclusion

#### 1.1.1 1. Overview

F.R.I.D.A.Y. is a light-weight OS built to run on QEMU. You can use this documentation to extend the existing systems and add more functionality.

#### 1.1.2 2. OS Lifecycle

When the OS kernel is booted, the first function `kmain()` is called. This function bootstraps most of the core functionality of the OS. Once bootstrapping is done, control is passed to `comhand()` for the command handler.

Once the command handler has finished, `comhand()` will return, thus giving control back to `kmain()`. `kmain()` then begins the shutdown process and exits.

### 1.1.3 3. Extending Systems

#### 1.1.3.1 3.i. kmain() and Startup

`kmain()` is the first function called after the bootloader for the OS. This function is located in `kmain.c` and is responsible for bootstrapping most of the OS' core functionality. After all core systems have been initialized, full control is passed to the `comhand()` function in `comhand.c`. If something needs to be initialized, put the method call for it before the call to `comhand()`.

#### 1.1.3.2 3.ii. The Command Handler

`comhand()` is what defines the OS' command handling system. When `kmain()` calls this function, the command handler welcomes the user and begins listening for user input. The command handler requests user input via a `sys_req()` call. The input gathered from this method is then used to run the command that matches the input, if any.

#### 1.1.3.3 3.iii. Registering a Command

All commands are 'registered' via the `comm_funcs` array inside `comhand.c`. This array contains pointers to functions that follow the format:

```
bool cmd_((COMMAND_NAME))(const char *command);
```

Note that the name of the method is **not** required to be followed, but should to maintain convention. Any new command **should** be placed in user space, preferably in the `commands.c` file. The return value of the function should signify if the command matched the **label** of the command. i.e. the command `help junk-option1 junk-option2` should still return true for the help command, even though the options are not valid.

**Command Function** The start of a command function should resemble:

```
bool cmd_name(const char *comm)
{
    const char *label = "name";

    if (!matches_cmd(comm, label))
        return false;

    //cmd logic
    return true;
}
```

Use the `matches_cmd(const char *cmd, const char *label)` function to check if the command's label matches.

**Adding Command to Help** Once you've added a command, you should add a help message for it. Use the `help_messages` array to add an instance of the `help_info` struct. Doing so should resemble:

```
{.str_label = "name", .help_message = "The %s command does X and then does Y.\nYou should include Z arguments"
```

After adding this, running `help name` command will then recognize the added struct and return the `help_↵` message formatted with the command's name.

#### 1.1.3.4 4. Conclusion

The information above covers most important information on how to extend F.R.I.D.A.Y. Please use the included Doxygen documentation for more information on how the internal systems work. If you'd like to learn how to use the system from a user's perspective, please refer to our [User Manual](#)

## Chapter 2

# Preparing Windows for MPX Development

Windows is not suited for native MPX development. Instead, you will need to set up a Linux distribution in a either virtual machine or using the Windows Subsystem for Linux (WSL).

### 2.1 Virtual Machine

The recommended virtual machine is LOUD, the LCSEE Optimized Ubuntu Distribution. Follow the directions at <https://lcseesystems.wvu.edu/services/loud>. If you encounter issues where the virtual machine hangs at a black screen, or is unusably slow (indicated by a turtle icon in the bottom-right hand corner of the VirtualBox window), consider WSL instead.

### 2.2 WSL

WSL is an optional component of Windows 10 and later. First, you will need to ensure that WSL itself is enabled, and that a distribution is installed. Open an elevated Command Prompt or PowerShell window by pressing the Windows Key + X, and choosing "Command Prompt (Admin)" or "PowerShell (Admin)". In this window, run:

```
wsl --install -d ubuntu
```

This will enable WSL if it isn't already, and install Ubuntu along with it. If WSL wasn't already installed, you may need to reboot before you can launch an Ubuntu window. The first time you open an Ubuntu window, you'll be prompted to create a username and password. This will become the local account within the Ubuntu environment, and the password will become the one you need later to run commands with `sudo`. Once the account is set up, follow the steps for Ubuntu below.

### 2.3 Preparing Ubuntu and Other Debian Derivatives for MPX Development

Ubuntu is the primary development environment for MPX and the basis for LOUD, so no extensive preparation is needed. Simply open a terminal window and run the following commands:

```
sudo apt update
sudo apt install -y clang make nasm git binutils-i686-linux-gnu qemu-system-x86 gdb
```

## 2.4 Preparing macOS for MPX Development

All commands need to be run from a Terminal. You should be able to find the Terminal application in the `/Applications` folder of your system's internal disk. Alternatively, pressing `Command+Space` and typing `Terminal` should bring it up.

### 2.4.1 Install XCode Tools

First, you need to install the XCode development tools. This includes the compiler, clang, and GNU make. This command will open a pop-up window for confirmation. Once confirmed, this may take some time to complete.

```
xcode-select --install
```

### 2.4.2 Install Homebrew

Next, install the Homebrew package manager from <https://brew.sh>. There should be a command under the label "Install Homebrew" that you can copy and paste into your Terminal window. Note that this makes use of the XCode tools installed in the first step, so that **must** be complete prior to this step.

It is likely that installing Homebrew will prompt you for your password so that it can elevate privileges using `sudo`. This is the same password you use to unlock your account when you turn on your system.

Note also that once the command you paste from the web site completes, there are a few additional steps you need to take to finalize the installation of Homebrew. In your terminal window, there will be some output beginning with the bold words **\*\*==> Next steps:\*\***. You must follow the instructions in your Terminal window to complete the Homebrew installation.

### 2.4.3 Install Remaining Tools

Once Homebrew is installed, you can easily install NASM, QEMU, the cross-linker, and cross-debugger.

```
brew install nasm qemu i686-elf-binutils i386-elf-gdb
```

If you get an error here, make sure that you followed the **\*\*==> Next steps:\*\*** portion of the Homebrew installation process. You may need to open a new Terminal window for the changes to take effect.

## Chapter 3

# Class Index

### 3.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

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<a href="#">page_dir</a>	. . . . .	??
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<a href="#">pcb</a>	The definition of a process control block . . . . .	??





## Chapter 4

# File Index

### 4.1 File List

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

include/ <a href="#">bomb_catcher.h</a>	??
include/ <a href="#">cli.h</a>	
Contains useful commands for interfacing with the CLI	??
include/ <a href="#">color.h</a>	??
include/ <a href="#">commands.h</a>	
This file contains headers for commands run by the command handler	??
include/ <a href="#">ctype.h</a>	
A subset of standard C library functions	??
include/ <a href="#">dragon_maze.h</a>	??
include/ <a href="#">hash_map.h</a>	
The header file for the hash map structure	??
include/ <a href="#">linked_list.h</a>	
This file represents the functionality and structure of a linked list	??
include/ <a href="#">math.h</a>	
A header full of useful math type functions	??
include/ <a href="#">memory.h</a>	
MPX-specific dynamic memory functions	??
include/ <a href="#">mine_sweeper.h</a>	
Contains the entry point for the mine sweeper game	??
include/ <a href="#">print_format.h</a>	??
include/ <a href="#">processes.h</a>	
Provided system process and user processes for testing	??
include/ <a href="#">stdio.h</a>	
Contains useful functions for standard IO	??
include/ <a href="#">stdlib.h</a>	
A subset of standard C library functions	??
include/ <a href="#">string.h</a>	
A subset of standard C library functions	??
include/ <a href="#">sys_req.h</a>	
System request function and constants	??
include/ <a href="#">time_zone.h</a>	??
include/mpx/ <a href="#">alarm.h</a>	
A header file for alarm functions	??
include/mpx/ <a href="#">clock.h</a>	
Contains functions for interacting with the system clock	??

include/mpx/ <a href="#">comhand.h</a>	??
include/mpx/ <a href="#">device.h</a>	??
include/mpx/ <a href="#">gdt.h</a>	
Kernel functions to initialize the Global Descriptor Table	??
include/mpx/ <a href="#">heap.h</a>	
Heap file contains functions useful for allocating and freeing memory	??
include/mpx/ <a href="#">interrupts.h</a>	
Kernel functions related to software and hardware interrupts	??
include/mpx/ <a href="#">io.h</a>	
Kernel macros to read and write I/O ports	??
include/mpx/ <a href="#">panic.h</a>	
Common system functions and definitions	??
include/mpx/ <a href="#">pcb.h</a>	
This file contains all of the structure and functions for a PCB and its context	??
include/mpx/ <a href="#">r3cmd.h</a>	
LoadR3 Loads the contents of R3 while cycling through each process	??
include/mpx/ <a href="#">serial.h</a>	
Kernel functions and constants for handling serial I/O	??
include/mpx/ <a href="#">vm.h</a>	
Kernel functions for virtual memory and primitive allocation	??
kernel/ <a href="#">alarm.c</a>	
Contains logic to create alarms for the OS	??
kernel/ <a href="#">heap.c</a>	
The implementation file for <a href="#">heap.h</a>	??
kernel/ <a href="#">sys_call.c</a>	
This file contains the sys_call function which is used to do context switching	??

## Chapter 5

# Class Documentation

### 5.1 alarm\_params Struct Reference

The parameters used to pass into the alarm function.

#### Public Attributes

- int \* **time\_ptr**  
*A pointer to where the time is stored.*
- char \* **str\_ptr**  
*A pointer to where the message is stored.*
- time\_zone\_t \* **time\_zone**  
*The timezone used to create the alarm.*
- unsigned char **buffer** [100]  
*The data to store.*

#### 5.1.1 Detailed Description

The parameters used to pass into the alarm function.

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

- kernel/[alarm.c](#)

### 5.2 code Struct Reference

#### Public Attributes

- char \* **err\_msg**
- int **err\_code**

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

- kernel/serial.c

## 5.3 context Struct Reference

The context to save onto a PCB.

```
#include <pcb.h>
```

### Public Attributes

- int **gs**

*The segment registers.*

- int **fs**
- int **es**
- int **ds**
- int **ss**
- int **edi**

*The general purpose registers.*

- int **esi**
- int **ebp**
- int **esp**
- int **ebx**
- int **edx**
- int **ecx**
- int **eax**
- int **eip**

*The status control registers, ordered as they are added for interrupts.*

- int **cs**
- int **eflags**

### 5.3.1 Detailed Description

The context to save onto a PCB.

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

- [include/mpx/pcb.h](#)

## 5.4 coordinate\_t Struct Reference

A struct for a 2d coordinate.

### Public Attributes

- int **x**

*The y coordinate.*

- int **y**

*The z coordinate.*

### 5.4.1 Detailed Description

A struct for a 2d coordinate.

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

- user/games/dragon\_maze.c

## 5.5 dcb\_t Struct Reference

A descriptor for a device.

### Public Attributes

- device **dev**  
*The device this control block is describing.*
- bool **allocated**  
*Whether or not the control block is allocated.*
- dcb\_status\_t **operation**  
*The operation this device is currently doing.*
- bool **event**  
*Whether or not there is an event to be handled.*
- struct pcb \* **pcb**  
*The PCB currently using this DCB.*
- size\_t **io\_bytes**  
*The amount of bytes in the IO operation.*
- size\_t **io\_requested**  
*The amount of bytes requested.*
- size\_t **line\_pos**  
*The line position for the cursor, used for read ops.*
- char \* **io\_buffer**  
*The active IO buffer for this DCB.*
- char **escape\_buffer** [6]  
*A buffer used specifically for handling ASCII escape characters.*
- int **escape\_buf\_pos**  
*The position in the escape buffer.*
- size\_t **r\_buffer\_len**  
*The total length of the ring buffer.*
- size\_t **r\_buffer\_size**  
*The current size of the ring buffer.*
- char \* **r\_buffer\_start**  
*The beginning of the ring buffer.*
- int **read\_index**  
*The read index for the ring buffer.*
- int **write\_index**  
*The write index for the ring buffer.*
- linked\_list \* **pending\_iocb**  
*This list contains all pending operations.*

### 5.5.1 Detailed Description

A descriptor for a device.

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

- kernel/serial.c

## 5.6 gdt\_descriptor Struct Reference

### Public Attributes

- uint16\_t **size**
- struct [gdt\\_entry](#) \* **base**

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

- kernel/core.c

## 5.7 gdt\_entry Struct Reference

### Public Attributes

- uint16\_t **limit\_low**
- uint16\_t **base\_low**  
*first 16 bits of limit*
- uint8\_t **base\_mid**  
*first 16 bits of base*
- uint8\_t **access**  
*bits 16-23 of base*
- uint8\_t **flags**  
*next 8 bits; access flags*
- uint8\_t **base\_high**  
*page granularity, size*

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

- kernel/core.c

## 5.8 hash\_map\_node\_t Struct Reference

The structure definition for holding a node in a hash map.

```
#include <hash_map.h>
```

## Public Attributes

- void \* **key**  
*The hash m.*
- void \* **value**  
*The value being held in this node.*
- int **hash\_code**  
*The hash code for the value being held.*

### 5.8.1 Detailed Description

The structure definition for holding a node in a hash map.

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

- include/[hash\\_map.h](#)

## 5.9 hash\_map\_t Struct Reference

The definition for the structure holding the hash map data.

```
#include <hash_map.h>
```

## Public Attributes

- int **size**  
*The size of the hash map.*
- int **contamination**  
*The total amount of elements + tombstones in the map.*
- int **capacity**  
*The capacity of the hash map.*
- bool(\* **equality\_func**)(void \*value1, void \*value2)  
*The function to use for equality checking for given values.*
- int(\* **hash\_func**)(void \*value)  
*The hash function to use for the values in this map.*
- [hash\\_map\\_node\\_t](#) \*\* **values**  
*The values we're holding in this map.*

### 5.9.1 Detailed Description

The definition for the structure holding the hash map data.

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

- include/[hash\\_map.h](#)

## 5.10 help\_info Struct Reference

Used to store information on a specific label of the 'help' command.

### Public Attributes

- char \* **str\_label** [15]  
*The label of the command for the help message.*
- char \* **help\_message**  
*The help message to send for this struct.*

### 5.10.1 Detailed Description

Used to store information on a specific label of the 'help' command.

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

- user/commands.c

## 5.11 idt\_descriptor Struct Reference

The metadata for the IDT.

### Public Attributes

- uint16\_t **size**
- struct [idt\\_entry](#) \* **base**

### 5.11.1 Detailed Description

The metadata for the IDT.

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

- kernel/core.c

## 5.12 idt\_entry Struct Reference

A single entry in the IDT.



## Public Attributes

- uint16\_t **base\_low**
- uint16\_t **sselect**  
*offset bits 0..15*
- uint8\_t **zero**  
*stack selector in gdt or ldt*
- uint8\_t **flags**  
*this stays zero; unused*
- uint16\_t **base\_high**  
*attributes*

### 5.12.1 Detailed Description

A single entry in the IDT.

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

- kernel/core.c

## 5.13 iocb\_t Struct Reference

A descriptor for pending IO operations.

## Public Attributes

- dcb\_t \* **device**  
*A pointer to the device this IOCB belongs to.*
- struct pcb \* **pcb**  
*A pointer to the process this IOCB belongs to.*
- dcb\_status\_t **operation**  
*The operation this IOCB is attempting.*
- size\_t **buf\_len**  
*The length of the buffer.*
- char \* **buffer**  
*The buffer.*

### 5.13.1 Detailed Description

A descriptor for pending IO operations.

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

- kernel/serial.c

## 5.14 line\_entry Struct Reference

Used to store a specific line previously entered.

### Public Attributes

- void \* **\_dont\_use\_1**  
*These are a hacky way to use linked lists without excessive allocation (temp until R5)*
- void \* **\_dont\_use\_2**  
*These are a hacky way to use linked lists without excessive allocation (temp until R5)*
- char \* **line**  
*The line that was entered.*
- size\_t **line\_length**  
*The line's length, not including the null terminator.*

### 5.14.1 Detailed Description

Used to store a specific line previously entered.

### 5.14.2 Member Data Documentation

#### 5.14.2.1 line

```
char* line_entry::line
```

The line that was entered.

Does not include null terminator.

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

- kernel/serial.c

## 5.15 linked\_list\_ Struct Reference

The main linked list structure.

```
#include <linked_list.h>
```

## Public Attributes

- `int _size`  
*The size of the linked list.*
- `int _max_size`  
*The maximum size of the linked list, set to -1 for infinite.*
- `int(* sort_func)(void *, void *)`  
*A pointer to the sorting function.*
- `ll_node * _first`  
*The first node in the linked list.*
- `ll_node * _last`  
*The second node in the linked list.*

### 5.15.1 Detailed Description

The main linked list structure.

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

- `include/linked_list.h`

## 5.16 linked\_list\_node\_ Struct Reference

The node used for all linked lists.

```
#include <linked_list.h>
```

## Public Attributes

- `void * _item`  
*The pointer to the item we're storing.*
- `struct linked_list_node_ * _next`  
*The next node in the list.*

### 5.16.1 Detailed Description

The node used for all linked lists.

Note that

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

- `include/linked_list.h`

## 5.17 maze\_board\_t Struct Reference

The maze board struct.

### Public Attributes

- char **board\_pieces** [MAZE\_HEIGHT][MAZE\_LENGTH]  
*The pieces that make up the board.*
- [coordinate\\_t](#) **hero\_location**  
*The location of the hero.*
- [coordinate\\_t](#) **dragon\_location**  
*The dragon's location.*
- [coordinate\\_t](#) **princess\_location**  
*The princess' location.*

### 5.17.1 Detailed Description

The maze board struct.

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

- user/games/dragon\_maze.c

## 5.18 mem\_block Struct Reference

A structure that contains memory.

### Public Attributes

- struct [mem\\_block](#) \* **prev**  
*The previous memory block.*
- struct [mem\\_block](#) \* **next**  
*The next memory block.*
- int **start\_address**  
*The start address of this block.*
- size\_t **size**  
*The size of this block.*

### 5.18.1 Detailed Description

A structure that contains memory.

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

- kernel/[heap.c](#)

## 5.19 page\_dir Struct Reference

### Public Attributes

- [page\\_table](#) \* **tables** [1024]
- uint32\_t **tables\_phys** [1024]

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

- kernel/core.c

## 5.20 page\_entry Struct Reference

### Public Attributes

- uint32\_t **present**:1
- uint32\_t **writeable**:1
- uint32\_t **usermode**:1
- uint32\_t **accessed**:1
- uint32\_t **dirty**:1
- uint32\_t **reserved**:7
- uint32\_t **frameaddr**:20

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

- kernel/core.c

## 5.21 page\_table Struct Reference

### Public Attributes

- [page\\_entry](#) **pages** [1024]

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

- kernel/core.c

## 5.22 pcb Struct Reference

The definition of a process control block.

```
#include <pcb.h>
```

## Public Attributes

- void \* **\_next**  
*This exists as an extremely hacky way to use them in the linked list without allocating memory.*
- void \* **\_item**  
*This exists as an extremely hacky way to use them in the linked list without allocating memory.*
- const char \* **name**  
*The name of the PCB, max length of 8.*
- enum [pcb\\_class](#) **process\_class**  
*The process class type.*
- int **priority**  
*Integer priority of PCB, 0-9, lower = higher priority;.*
- enum [pcb\\_exec\\_state](#) **exec\_state**  
*The execution state of this PCB.*
- enum [pcb\\_dispatch\\_state](#) **dispatch\_state**  
*The dispatch state of this PCB.*
- void \* **stack\_ptr**  
*A pointer to the next available byte in the stack.*
- unsigned char **stack** [[PCB\\_STACK\\_SIZE](#)]  
*The stack itself.*

### 5.22.1 Detailed Description

The definition of a process control block.

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

- [include/mpx/pcb.h](#)

## Chapter 6

# File Documentation

### 6.1 bomb\_catcher.h

```
00001 //
00002 // Created by Andrew Bowie on 1/27/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_BOMB_CATCHER_H
00006 #define F_R_I_D_A_Y_BOMB_CATCHER_H
00007
00011 void start_bombcatcher(void);
00012
00013 #endif //F_R_I_D_A_Y_BOMB_CATCHER_H
```

### 6.2 include/cli.h File Reference

Contains useful commands for interfacing with the CLI.

#### Functions

- void [set\\_cli\\_prompt](#) (const char \*prompt)  
*Sets the CLI prompt to be used when prompting input.*
- void [set\\_cli\\_history](#) (bool enabled)  
*Sets if the CLI is enabled.*
- void [set\\_command\\_formatting](#) (bool enabled)  
*If command color formatting should be enabled.*
- void [set\\_invisible](#) (bool enabled)  
*Sets if the input for the line should be invisible.*
- void [set\\_tab\\_completions](#) (bool enabled)  
*Sets if the input should use tab completions.*

#### 6.2.1 Detailed Description

Contains useful commands for interfacing with the CLI.

## 6.2.2 Function Documentation

### 6.2.2.1 set\_cli\_history()

```
void set_cli_history (
    bool enabled )
```

Sets if the CLI is enabled.

#### Parameters

<i>enabled</i>	if the CLI should be enabled.
----------------	-------------------------------

### 6.2.2.2 set\_cli\_prompt()

```
void set_cli_prompt (
    const char * prompt )
```

Sets the CLI prompt to be used when prompting input.

Can be set to NULL if no prompt should be printed.

#### Parameters

<i>prompt</i>	the prompt to use.
---------------	--------------------

### 6.2.2.3 set\_command\_formatting()

```
void set_command_formatting (
    bool enabled )
```

If command color formatting should be enabled.

#### Parameters

<i>enabled</i>	if it should be enabled.
----------------	--------------------------

### 6.2.2.4 set\_invisible()

```
void set_invisible (
```



```
bool enabled )
```

Sets if the input for the line should be invisible.

#### Parameters

<i>enabled</i>	if it's enabled or not.
----------------	-------------------------

#### 6.2.2.5 set\_tab\_completions()

```
void set_tab_completions (
    bool enabled )
```

Sets if the input should use tab completions.

#### Parameters

<i>enabled</i>	if it's enabled or not.
----------------	-------------------------

## 6.3 cli.h

[Go to the documentation of this file.](#)

```
00001 //
00002 // Created by Andrew Bowie on 1/27/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_CLI_H
00006 #define F_R_I_D_A_Y_CLI_H
00007
00018 void set_cli_prompt(const char *prompt);
00019
00024 void set_cli_history(bool enabled);
00025
00030 void set_command_formatting(bool enabled);
00031
00036 void set_invisible(bool enabled);
00037
00042 void set_tab_completions(bool enabled);
00043
00044 #endif //F_R_I_D_A_Y_CLI_H
```

## 6.4 color.h

```
00001 //
00002 // Created by Andrew Bowie on 1/27/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_COLOR_H
00006 #define F_R_I_D_A_Y_COLOR_H
00007
00014 typedef struct {
00016     const char *color_label;
00018     const int color_num;
00019 } color_t;
00020
00025 void set_output_color(const color_t *color);
00026
00031 const color_t *get_output_color(void);
```

```

00032
00038 const color_t *get_color(const char *label);
00039
00044 const color_t **get_colors(void);
00045
00046 #endif //F_R_I_D_A_Y_COLOR_H

```

## 6.5 include/commands.h File Reference

This file contains headers for commands run by the command handler.

```
#include "stdbool.h"
```

### Functions

- const char \* [find\\_best\\_match](#) (const char \*cmd)  
*Finds the best match for the given command, or NULL if it doesn't match OR matches multiple OR is equal to the command.*
- bool [command\\_exists](#) (const char \*cmd)  
*Checks if the given command exists.*
- bool [cmd\\_version](#) (const char \*comm)  
*The version command, used to handle when the user asks for a version number.*
- bool [cmd\\_shutdown](#) (const char \*comm)  
*The shutdown command.*
- bool [cmd\\_get\\_time\\_menu](#) (const char \*comm)  
*The get time command, used to get the time on the system.*
- bool [cmd\\_help](#) (const char \*comm)  
*The help command, used to help the user when they are struggling.*
- bool [cmd\\_set\\_time](#) (const char \*comm)  
*The set time command, used to set time user wants.*
- bool [cmd\\_set\\_date](#) (const char \*comm)  
*The set date command, used to set time user wants.*
- bool [cmd\\_set\\_tz](#) (const char \*comm)  
*The set timezone command, used to set the system timezone.*
- bool [cmd\\_clear](#) (const char \*comm)  
*The clear command, used to clear the console.*
- bool [cmd\\_color](#) (const char \*comm)  
*The color command, used to change text color for the terminal.*
- bool [cmd\\_yield](#) (const char \*comm)  
*the yield command, causes the command handler to yield immediately.*
- bool [cmd\\_pcb](#) (const char \*comm)  
*The pcb command, used to interact with the pcb system.*
- bool [cmd\\_alarm](#) (const char \*comm)  
*The alarm command, used to create the alarm function.*
- bool [cmd\\_free\\_memory](#) (const char \*comm)  
*The free memory command, frees heap memory.*
- bool [cmd\\_allocate\\_memory](#) (const char \*comm)  
*The allocate memory, which allocates memory in the heap.*
- bool [cmd\\_show\\_allocate](#) (const char \*comm)  
*The show allocated memory command, where each command will cycle through the list.*

- bool `cmd_show_free` (const char \*comm)  
*The free memory command, where each command will cycle through the list.*
- bool `cmd_dragonmaze` (const char \*comm)  
*The dragonmaze command, used to start the dragon maze game.*
- bool `cmd_minesweeper` (const char \*comm)  
*The minesweeper command, used to start the minesweeper game.*

### 6.5.1 Detailed Description

This file contains headers for commands run by the command handler.

### 6.5.2 Function Documentation

#### 6.5.2.1 `cmd_alarm()`

```
bool cmd_alarm (  
    const char * comm )
```

The alarm command, used to create the alarm function.

##### Parameters

<i>comm</i>	the command string.
-------------	---------------------

##### Returns

true if it was handled, false if not.

##### Parameters

<i>comm</i>	
<i>message</i>	

##### Returns

##### Authors

Jared Crowley

### 6.5.2.2 cmd\_allocate\_memory()

```
bool cmd_allocate_memory (
    const char * comm )
```

The allocate memory, which allocates memory in the heap.

#### Parameters

<i>comm</i>	the command string.
-------------	---------------------

#### Returns

true if it was handled, false if not.

### 6.5.2.3 cmd\_clear()

```
bool cmd_clear (
    const char * comm )
```

The clear command, used to clear the console.

#### Parameters

<i>comm</i>	the command string.
-------------	---------------------

#### Returns

true if it was handled, false if not.

### 6.5.2.4 cmd\_color()

```
bool cmd_color (
    const char * comm )
```

The color command, used to change text color for the terminal.

#### Parameters

<i>comm</i>	the command string.
-------------	---------------------

#### Returns

true if it was handled, false if not.

#### 6.5.2.5 cmd\_dragonmaze()

```
bool cmd_dragonmaze (
    const char * comm )
```

The dragonmaze command, used to start the dragon maze game.

##### Parameters

<i>comm</i>	the command string.
-------------	---------------------

##### Returns

true if it was handled, false if not.

#### 6.5.2.6 cmd\_free\_memory()

```
bool cmd_free_memory (
    const char * comm )
```

The free memory command, frees heap memory.

##### Parameters

<i>comm</i>	the command string.
-------------	---------------------

##### Returns

true if it was handled, false if not.

#### 6.5.2.7 cmd\_get\_time\_menu()

```
bool cmd_get_time_menu (
    const char * comm )
```

The get time command, used to get the time on the system.

##### Parameters

<i>comm</i>	the command string.
-------------	---------------------

**Returns**

true if the command was handled, false if not.

**6.5.2.8 cmd\_help()**

```
bool cmd_help (
    const char * comm )
```

The help command, used to help the user when they are struggling.

**Parameters**

<i>comm</i>	the command string.
-------------	---------------------

**Returns**

true if it was handled, false if not.

**6.5.2.9 cmd\_minesweeper()**

```
bool cmd_minesweeper (
    const char * comm )
```

The minesweeper command, used to start the minesweeper game.

**Parameters**

<i>comm</i>	the command string.
-------------	---------------------

**Returns**

true if it was handled, false if not.

**6.5.2.10 cmd\_pcb()**

```
bool cmd_pcb (
    const char * comm )
```

The pcb command, used to interact with the pcb system.

**Parameters**

<i>comm</i>	the command string.
-------------	---------------------

**Returns**

true if it was handled, false if not.

**6.5.2.11 cmd\_set\_date()**

```
bool cmd_set_date (  
    const char * comm )
```

The set date command, used to set time user wants.

**Parameters**

<i>comm</i>	the command string.
-------------	---------------------

**Returns**

true if it was handled, false if not.

**6.5.2.12 cmd\_set\_time()**

```
bool cmd_set_time (  
    const char * comm )
```

The set time command, used to set time user wants.

**Parameters**

<i>comm</i>	the command string.
-------------	---------------------

**Returns**

true if it was handled, false if not.

**6.5.2.13 cmd\_set\_tz()**

```
bool cmd_set_tz (  
    const char * comm )
```

The set timezone command, used to set the system timezone.



**Parameters**

<i>comm</i>	the command string.
-------------	---------------------

**Returns**

true if it was handled, false if not.

**6.5.2.14 cmd\_show\_allocate()**

```
bool cmd_show_allocate (  
    const char * comm )
```

The show allocated memory command, where each command will cycle through the list.

**Parameters**

<i>comm</i>	the command string.
-------------	---------------------

**Returns**

true if it was handled, false if not.

**6.5.2.15 cmd\_show\_free()**

```
bool cmd_show_free (  
    const char * comm )
```

The free memory command, where each command will cycle through the list.

**Parameters**

<i>comm</i>	the command string.
-------------	---------------------

**Returns**

true if it was handled, false if not.

**6.5.2.16 cmd\_shutdown()**

```
bool cmd_shutdown (  
    const char * comm )
```

The shutdown command.

If ran, will re-prompt the user for confirmation.

#### Parameters

<i>comm</i>	the command string.
-------------	---------------------

#### Returns

true if the command was handled, false if not.

### 6.5.2.17 cmd\_version()

```
bool cmd_version (
    const char * comm )
```

The version command, used to handle when the user asks for a version number.

Must Include Compilation date

#### Parameters

<i>comm</i>	the command string.
-------------	---------------------

#### Returns

true if the command was handled, false if not.

### 6.5.2.18 cmd\_yield()

```
bool cmd_yield (
    const char * comm )
```

the yield command, causes the command handler to yield immediately.

#### Parameters

<i>comm</i>	the command string.
-------------	---------------------

#### Returns

true if it was handled, false if not.

### 6.5.2.19 command\_exists()

```
bool command_exists (
    const char * cmd )
```

Checks if the given command exists.

#### Parameters

<i>cmd</i>	the command to check for.
------------	---------------------------

#### Returns

true if it does, false if not.

#### Authors

Andrew Bowie

### 6.5.2.20 find\_best\_match()

```
const char * find_best_match (
    const char * cmd )
```

Finds the best match for the given command, or NULL if it doesn't match OR matches multiple OR is equal to the command.

#### Parameters

<i>cmd</i>	the command.
------------	--------------

#### Returns

the best match for it.

#### Authors

Andrew Bowie

## 6.6 commands.h

[Go to the documentation of this file.](#)

```
00001 //
00002 // Created by Andrew Bowie on 1/18/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_COMMANDS_H
00006 #define F_R_I_D_A_Y_COMMANDS_H
```

```

00007
00008 #include "stdbool.h"
00009
00023 const char *find_best_match(const char *cmd);
00024
00031 bool command_exists(const char *cmd);
00032
00038 bool cmd_version(const char *comm);
00039
00045 bool cmd_shutdown(const char *comm);
00046
00052 bool cmd_get_time_menu(const char *comm);
00053
00059 bool cmd_help(const char *comm);
00060
00066 bool cmd_set_time(const char* comm);
00067
00073 bool cmd_set_date(const char* comm);
00074
00080 bool cmd_set_tz(const char *comm);
00081
00087 bool cmd_clear(const char *comm);
00088
00094 bool cmd_color(const char *comm);
00095
00101 bool cmd_yield(const char *comm);
00102
00103
00109 bool cmd_pcb(const char *comm);
00115 bool cmd_alarm(const char *comm);
00121 bool cmd_free_memory(const char* comm);
00127 bool cmd_allocate_memory(const char* comm);
00133 bool cmd_show_allocate(const char* comm);
00139 bool cmd_show_free(const char* comm);
00140
00146 bool cmd_dragonmaze(const char *comm);
00147
00153 bool cmd_minesweeper(const char *comm);
00154 #endif //F_R_I_D_A_Y_COMMANDS_H

```

## 6.7 include/ctype.h File Reference

A subset of standard C library functions.

### Functions

- int [isspace](#) (int c)  
*Determine if a character is whitespace.*
- int [isdigit](#) (int c)  
*Determine if a character is a digit.*
- int [toint](#) (int c)  
*Return int value of character if is digit.*
- int [isupper](#) (int c)  
*Determine if a character is uppercase.*
- int [islower](#) (int c)  
*Determine if a character is lowercase.*
- int [tolower](#) (int c)  
*Converts the given character to lowercase.*
- int [toupper](#) (int c)  
*Converts the given character to uppercase.*

### 6.7.1 Detailed Description

A subset of standard C library functions.

## 6.7.2 Function Documentation

### 6.7.2.1 isdigit()

```
int isdigit (
    int c )
```

Determine if a character is a digit.

#### Parameters

<i>c</i>	Character to check
----------	--------------------

#### Returns

Non-zero if digit, 0 if not digit

### 6.7.2.2 islower()

```
int islower (
    int c )
```

Determine if a character is lowercase.

If the character is not alphabetical, 0 is returned.

#### Parameters

<i>c</i>	Character to check.
----------	---------------------

#### Returns

Non-zero if lower, 0 if not lower.

### 6.7.2.3 isspace()

```
int isspace (
    int c )
```

Determine if a character is whitespace.

**Parameters**

<i>c</i>	Character to check
----------	--------------------

**Returns**

Non-zero if space, 0 if not space

**6.7.2.4 isupper()**

```
int isupper (
    int c )
```

Determine if a character is uppercase.

If the character is not alphabetical, 0 is returned.

**Parameters**

<i>c</i>	Character to check.
----------	---------------------

**Returns**

Non-zero if upper, 0 if not upper.

**6.7.2.5 todigit()**

```
int todigit (
    int c )
```

Return int value of character if is digit.

**Parameters**

<i>c</i>	Character to check
----------	--------------------

**Returns**

Negative not digit, value of digit otherwise

### 6.7.2.6 tolower()

```
int tolower (
    int c )
```

Converts the given character to lowercase.

#### Parameters

<code>c</code>	the character to convert.
----------------	---------------------------

#### Returns

the lowercase character.

### 6.7.2.7 toupper()

```
int toupper (
    int c )
```

Converts the given character to uppercase.

#### Parameters

<code>c</code>	the character to convert.
----------------	---------------------------

#### Returns

the uppercase character.

## 6.8 ctype.h

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_CTYPE_H
00002 #define MPX_CTYPE_H
00003
00014 int isspace(int c);
00015
00021 int isdigit(int c);
00027 int todigit(int c);
00028
00035 int isupper(int c);
00036
00043 int islower(int c);
00044
00050 int tolower(int c);
00051
00057 int toupper(int c);
00058
00059 #endif
```

## 6.9 dragon\_maze.h

```

00001 //
00002 // Created by Andrew Bowie on 3/29/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_DRAGON_MAZE_H
00006 #define F_R_I_D_A_Y_DRAGON_MAZE_H
00007
00011 void start_dragonmaze_game(void);
00012
00013 #endif //F_R_I_D_A_Y_DRAGON_MAZE_H

```

## 6.10 include/hash\_map.h File Reference

The header file for the hash map structure.

```
#include "stdbool.h"
```

### Classes

- struct [hash\\_map\\_node\\_t](#)  
*The structure definition for holding a node in a hash map.*
- struct [hash\\_map\\_t](#)  
*The definition for the structure holding the hash map data.*

### Functions

- [hash\\_map\\_t \\* new\\_map](#) (bool(\*equality\_func)(void \*value1, void \*value2), int(\*hash\_func)(void \*value))  
*Creates a new hash map with the given equality and hash functions.*
- void \* [put](#) ([hash\\_map\\_t](#) \*map, void \*key, void \*value)  
*Puts the given item into the map, returning the old item if it is contained.*
- void \* [get](#) ([hash\\_map\\_t](#) \*map, void \*key)  
*Gets the value out of the hash map with the given key.*
- bool [contains\\_key](#) ([hash\\_map\\_t](#) \*map, void \*key)  
*Checks if the map contains the given key.*
- void [clear](#) ([hash\\_map\\_t](#) \*map)  
*Clears the map, freeing all nodes (NOT THE ITEMS INSIDE THE NODES).*
- void [clear\\_free](#) ([hash\\_map\\_t](#) \*map, bool free\_keys, bool free\_values)  
*Clears the map, freeing all nodes and the items they're holding.*

### 6.10.1 Detailed Description

The header file for the hash map structure.

### 6.10.2 Function Documentation

#### 6.10.2.1 clear()

```
void clear (
    hash\_map\_t * map )
```

Clears the map, freeing all nodes (NOT THE ITEMS INSIDE THE NODES).



## Parameters

<i>map</i>	the map to clear.
------------	-------------------

**6.10.2.2 clear\_free()**

```
void clear_free (
    hash_map_t * map,
    bool free_keys,
    bool free_values )
```

Clears the map, freeing all nodes and the items they're holding.

## Parameters

<i>map</i>	the map to clear.
<i>free_keys</i>	if we should free the keys associated with the map.
<i>free_values</i>	if we should free the values associated with the map.

**6.10.2.3 contains\_key()**

```
bool contains_key (
    hash_map_t * map,
    void * key )
```

Checks if the map contains the given key.

## Parameters

<i>map</i>	the map.
<i>key</i>	the key.

## Returns

true if the key is in the map.

**6.10.2.4 get()**

```
void * get (
    hash_map_t * map,
    void * key )
```

Gets the value out of the hash map with the given key.

**Parameters**

<i>map</i>	the map.
<i>key</i>	the key stored in the map.

**Returns**

the old value or NULL.

**6.10.2.5 new\_map()**

```
hash_map_t * new_map (
    bool(*) (void *value1, void *value2) equality_func,
    int(*) (void *value) hash_func )
```

Creates a new hash map with the given equality and hash functions.

These CANNOT be NULL!

**Parameters**

<i>equality_func</i>	the equality function.
<i>hash_func</i>	the hash function.

**Returns**

a pointer to the new map, which was dynamically allocated, or NULL if the given values were invalid (or heap is full).

**6.10.2.6 put()**

```
void * put (
    hash_map_t * map,
    void * key,
    void * value )
```

Puts the given item into the map, returning the old item if it is contained.

**Parameters**

<i>map</i>	the map to put it into.
<i>item</i>	the item to place into this map.

**Returns**

the old value or NULL.

## 6.11 hash\_map.h

[Go to the documentation of this file.](#)

```

00001 //
00002 // Created by Andrew Bowie on 3/29/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_HASH_MAP_H
00006 #define F_R_I_D_A_Y_HASH_MAP_H
00007
00008 #include "stdbool.h"
00009
00016 typedef struct {
00018     void *key;
00020     void *value;
00022     int hash_code;
00023 } hash_map_node_t;
00024
00026 typedef struct {
00028     int size;
00030     int contamination;
00032     int capacity;
00034     bool (*equality_func)(void *value1, void *value2);
00036     int (*hash_func)(void *value);
00037
00039     hash_map_node_t **values;
00040 } hash_map_t;
00041
00049 hash_map_t *new_map(bool (*equality_func)(void *value1, void *value2), int (*hash_func)(void *value));
00050
00058 void *put(hash_map_t *map, void *key, void *value);
00059
00067 void *get(hash_map_t *map, void *key);
00068
00076 bool contains_key(hash_map_t *map, void *key);
00077
00082 void clear(hash_map_t *map);
00083
00091 void clear_free(hash_map_t *map, bool free_keys, bool free_values);
00092
00093 #endif //F_R_I_D_A_Y_HASH_MAP_H

```

## 6.12 include/linked\_list.h File Reference

This file represents the functionality and structure of a linked list.

```
#include "stdbool.h"
```

**Classes**

- struct [linked\\_list\\_node\\_](#)  
*The node used for all linked lists.*
- struct [linked\\_list\\_](#)  
*The main linked list structure.*

**Typedefs**

- typedef struct [linked\\_list\\_node\\_ ll\\_node](#)  
*The node used for all linked lists.*
- typedef struct [linked\\_list\\_ linked\\_list](#)  
*The main linked list structure.*

### 6.12.1 Detailed Description

This file represents the functionality and structure of a linked list.

Any item added to this list, MUST contain the necessary data as defined by the `ll_node` type.

### 6.12.2 Typedef Documentation

#### 6.12.2.1 ll\_node

```
typedef struct linked_list_node_ ll_node
```

The node used for all linked lists.

Note that

## 6.13 linked\_list.h

[Go to the documentation of this file.](#)

```
00001 //
00002 // Created by Andrew Bowie on 9/18/22.
00003 //
00004
00005 #ifndef LINKEDLIST_H
00006 #define LINKEDLIST_H
00007
00008 #include "stdbool.h"
00009
00019 typedef struct linked_list_node_
00020 {
00022     void *_item; //8 bytes
00024     struct linked_list_node_ *_next; //8 bytes
00025 } ll_node;
00026
00030 typedef struct linked_list_ {
00032     int _size;
00034     int _max_size;
00036     int (*sort_func)(void*, void*);
00038     ll_node *_first;
00040     ll_node *_last;
00041 } linked_list;
00042
00047 linked_list
00048 *nl_unbounded(void);
00049
00054 linked_list
00055 *nl_maxsize(int max_size);
00056
00063 ll_node
00064 *get_first_node(linked_list *list);
00065
00072 ll_node
00073 *next_node(ll_node *node);
00074
00081 void
00082 *get_item_node(ll_node *node);
00083
00088 int
00089 list_size(linked_list *list);
00090
00098 void *
00099 get_item(linked_list *list, int index);
00100
00106 void
00107 destroy_list(linked_list *list, int destroy_values);
```

```

00108
00115 int
00116 add_item(linked_list *list, void *item);
00117
00125 int
00126 add_item_index(linked_list *list, int index, void *item);
00127
00134 void
00135 remove_item(linked_list *list, int index);
00136
00143 int
00144 remove_item_ptr(linked_list *list, void *item_ptr);
00145
00153 void
00154 *remove_item_unsafe(linked_list *list, int index);
00155
00161 void
00162 set_sort_func(linked_list *list, int sort_func(void *, void *));
00163
00169 void
00170 for_each_ll(linked_list *list, void call(void *node));
00171
00177 void
00178 ll_clear(linked_list *list);
00179
00184 void
00185 ll_clear_free(linked_list *list, bool free_items);
00186
00187 #endif //LINKEDLIST_H

```

## 6.14 include/math.h File Reference

A header full of useful math type functions.

```
#include "stdbool.h"
```

### Functions

- int [abs](#) (int x)  
*Gets the absolute value of the number.*
- unsigned int [ui\\_realmod](#) (int x, int mod)  
*Calculates the real modulo value of X modulo 'mod'.*
- double [pow](#) (double a, double b)  
*Calculates the Answer from a variable and a exponent.*
- unsigned long long [get\\_seed](#) (void)  
*Gets the current seed for the random.*
- void [s\\_rand](#) (unsigned long long seed)  
*Seeds the random number generator.*
- unsigned int [next\\_random](#) (void)  
*Returns the next random 30 bits from the LCRNG.*
- unsigned int [next\\_random\\_lim](#) (int limit)  
*Generates the next random with the given limit.*
- bool [next\\_rand\\_bool](#) (void)  
*Generates the next random boolean.*

#### 6.14.1 Detailed Description

A header full of useful math type functions.

## 6.14.2 Function Documentation

### 6.14.2.1 `abs()`

```
int abs (  
    int x )
```

Gets the absolute value of the number.

#### Parameters

<code>x</code>	the number.
----------------	-------------

#### Returns

the absolute value.

### 6.14.2.2 `get_seed()`

```
unsigned long long get_seed (  
    void )
```

Gets the current seed for the random.

#### Returns

the seed.

#### Authors

Andrew Bowie

### 6.14.2.3 `next_rand_bool()`

```
bool next_rand_bool (  
    void )
```

Generates the next random boolean.

#### Returns

the next bool.

#### 6.14.2.4 next\_random()

```
unsigned int next_random (
    void )
```

Returns the next random 30 bits from the LCRNG.

##### Returns

the next random number.

#### 6.14.2.5 next\_random\_lim()

```
unsigned int next_random_lim (
    int limit )
```

Generates the next random with the given limit.

##### Parameters

<i>limit</i>	the limit.
--------------	------------

##### Returns

the next random number.

#### 6.14.2.6 pow()

```
double pow (
    double a,
    double b )
```

Calculates the Answer from a variable and a exponent.

##### Parameters

<i>a</i>	is the variable
<i>b</i>	is the exponent

##### Returns

The new value from the  $a^b$

### 6.14.2.7 s\_rand()

```
void s_rand (
    unsigned long long seed )
```

Seeds the random number generator.

#### Parameters

<i>seed</i>	the seed.
-------------	-----------

### 6.14.2.8 ui\_realmmod()

```
unsigned int ui_realmmod (
    int x,
    int mod )
```

Calculates the real modulo value of X modulo 'mod'.

#### Parameters

<i>x</i>	the value.
<i>mod</i>	the modulo.

#### Returns

the modulo value of x modulo 'mod'

## 6.15 math.h

[Go to the documentation of this file.](#)

```
00001 //
00002 // Created by Andrew Bowie on 1/19/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_MATH_H
00006 #define F_R_I_D_A_Y_MATH_H
00007
00008 #include "stdbool.h"
00009
00020 int abs(int x);
00021
00028 unsigned int ui_realmmod(int x, int mod);
00029
00036 double pow(double a, double b);
00037
00044 unsigned long long get_seed(void);
00045
00050 void s_rand(unsigned long long seed);
00051
00056 unsigned int next_random(void);
00063 unsigned int next_random_lim(int limit);
00068 bool next_rand_bool(void);
00069 #endif //F_R_I_D_A_Y_MATH_H
```



## 6.16 include/memory.h File Reference

MPX-specific dynamic memory functions.

```
#include <stddef.h>
```

### Functions

- void \* [sys\\_alloc\\_mem](#) (size\_t size)  
*Allocate dynamic memory.*
- int [sys\\_free\\_mem](#) (void \*ptr)  
*Free dynamic memory.*
- void [sys\\_set\\_heap\\_functions](#) (void \*(\*alloc\_fn)(size\_t), int(\*free\_fn)(void \*))  
*Installs user-supplied heap management functions.*

### 6.16.1 Detailed Description

MPX-specific dynamic memory functions.

### 6.16.2 Function Documentation

#### 6.16.2.1 sys\_alloc\_mem()

```
void * sys_alloc_mem (  
    size_t size )
```

Allocate dynamic memory.

##### Parameters

<i>size</i>	The amount of memory, in bytes, to allocate
-------------	---

##### Returns

NULL on error, otherwise the address of the newly allocated memory

#### 6.16.2.2 sys\_free\_mem()

```
int sys_free_mem (  
    void * ptr )
```

Free dynamic memory.

**Parameters**

<i>ptr</i>	The address of dynamically allocated memory to free
------------	---

**Returns**

0 on success, non-zero on error

**6.16.2.3 sys\_set\_heap\_functions()**

```
void sys_set_heap_functions (
    void *(*)(size_t) alloc_fn,
    int (*)(void *) free_fn )
```

Installs user-supplied heap management functions.

**Parameters**

<i>alloc_fn</i>	A function that dynamically allocates memory
<i>free_fn</i>	A function that frees dynamically allocated memory

**6.17 memory.h**

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_MEMORY_H
00002 #define MPX_MEMORY_H
00003
00004 #include <stddef.h>
00005
00016 void *sys_alloc_mem(size_t size);
00017
00023 int sys_free_mem(void *ptr);
00024
00030 void sys_set_heap_functions(void *(*alloc_fn)(size_t), int (*free_fn)(void *));
00031
00032 #endif
```

**6.18 include/mine\_sweeper.h File Reference**

Contains the entry point for the mine sweeper game.

**Functions**

- void [start\\_minesweeper\\_game](#) (unsigned long long game\_seed)  
*Starts a new game of minesweeper.*

### 6.18.1 Detailed Description

Contains the entry point for the mine sweeper game.

### 6.18.2 Function Documentation

#### 6.18.2.1 start\_minesweeper\_game()

```
void start_minesweeper_game (
    unsigned long long game_seed )
```

Starts a new game of minesweeper.

##### Parameters

<i>game_seed</i>	the game seed to start it with.
------------------	---------------------------------

##### Authors

Andrew Bowie

## 6.19 mine\_sweeper.h

[Go to the documentation of this file.](#)

```
00001 //
00002 // Created by Andrew Bowie on 4/21/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_MINE_SWEEPER_H
00006 #define F_R_I_D_A_Y_MINE_SWEEPER_H
00007
00018 void start_minesweeper_game(unsigned long long game_seed);
00019
00020 #endif //F_R_I_D_A_Y_MINE_SWEEPER_H
```

## 6.20 include/mpx/alarm.h File Reference

A header file for alarm functions.

### Functions

- bool [create\\_new\\_alarm](#) (int \*time\_array, const char \*message)  
*Creates a new pcb that will display message at or after given time.*

### 6.20.1 Detailed Description

A header file for alarm functions.

## 6.20.2 Function Documentation

### 6.20.2.1 `create_new_alarm()`

```
bool create_new_alarm (
    int * time_array,
    const char * message )
```

Creates a new pcb that will display message at or after given time.

#### Parameters

<i>time_array</i>	the time to display message
<i>message</i>	message to display

#### Returns

true if the alarm was created, false if it failed.

#### Author

Kolby Eisenhauer, Andrew Bowie

## 6.21 `alarm.h`

[Go to the documentation of this file.](#)

```
00001 #ifndef F_R_I_D_A_Y_ALARM_H
00002 #define F_R_I_D_A_Y_ALARM_H
00003
00016 bool create_new_alarm(int *time_array, const char* message);
00017
00018 #endif
```

## 6.22 `include/mpx/clock.h` File Reference

Contains functions for interacting with the system clock.

```
#include "time_zone.h"
```

## Functions

- `const time_zone_t * get_clock_timezone` (void)  
*Gets the current timezone for the clock.*
- `void set_timezone` (const time\_zone\_t \*offset)  
*Sets the timezone hour offset.*
- `int print_time` (void)  
*Prints the time and date of the system.*
- `int * adj_timezone` (int time[6], int tz\_offset\_hr, int tz\_offset\_min)  
*Adjusts the given time array to the specified timezone.*
- `int * get_time` (int t\_buf[7])  
*Gets the time and stores it in the given array in the form: {year, month, date, week\_day, hours, mins, seconds}.*
- `bool set_time_clock` (unsigned int hr, unsigned int min, unsigned int sec)  
*Sets the time of the system clock to the provided values.*
- `bool set_date_clock` (unsigned int month, unsigned int day, unsigned int year)  
*Sets the date of the system clock to the provided values.*
- `unsigned char decimal_to_bcd` (unsigned int decimal)  
*Converts the given decimal number to BCD.*
- `int bcd_to_decimal` (unsigned char bcd)  
*Converts the given BCD number to decimal.*
- `bool is_valid_date_or_time` (int word\_len, char buf[][word\_len], int buff\_len)  
*Checks if the given array of time values is validly defined.*
- `unsigned int get_days_in_month` (int month, int year)  
*Gets the amount of days in the provided month and returns it in BCD.*

### 6.22.1 Detailed Description

Contains functions for interacting with the system clock.

### 6.22.2 Function Documentation

#### 6.22.2.1 adj\_timezone()

```
int * adj_timezone (
    int time[6],
    int tz_offset_hr,
    int tz_offset_min )
```

Adjusts the given time array to the specified timezone.

#### Parameters

<i>time</i>	the time array, should be passed in with the format {year, month, date, week_day, hours, mins}.
<i>tz_offset_hr</i>	the hour offset.
<i>tz_offset_min</i>	the minute offset.

**Returns**

a pointer to the adjusted array.

**6.22.2.2 bcd\_to\_decimal()**

```
int bcd_to_decimal (
    unsigned char bcd )
```

Converts the given BCD number to decimal.

**Parameters**

<i>bcd</i>	the number to convert.
------------	------------------------

**Returns**

the converted number.

**6.22.2.3 decimal\_to\_bcd()**

```
unsigned char decimal_to_bcd (
    unsigned int decimal )
```

Converts the given decimal number to BCD.

**Parameters**

<i>decimal</i>	the number to convert.
----------------	------------------------

**Returns**

the converted number.

**6.22.2.4 get\_clock\_timezone()**

```
const time_zone_t * get_clock_timezone (
    void )
```

Gets the current timezone for the clock.

**Returns**

the timezone.

### 6.22.2.5 get\_days\_in\_month()

```
unsigned int get_days_in_month (
    int month,
    int year )
```

Gets the amount of days in the provided month and returns it in BCD.

#### Parameters

<i>month</i>	the month of the year, in BCD.
<i>year</i>	the year, in BCD. (Used for leap years)

#### Returns

the amount of days in the month, in BCD.

### 6.22.2.6 get\_time()

```
int * get_time (
    int t_buf[7] )
```

Gets the time and stores it in the given array in the form: {year, month, date, week\_day, hours, mins, seconds}.

#### Parameters

<i>t_buf</i>	the buffer to store the time in. Can be NULL.
--------------	---

#### Returns

the time array.

### 6.22.2.7 is\_valid\_date\_or\_time()

```
bool is_valid_date_or_time (
    int word_len,
    char buf[][word_len],
    int buff_len )
```

Checks if the given array of time values is validly defined.

All strings in the array must be valid, positive, 2 digit numbers.

**Parameters**

<i>word_len</i>	the length of 2nd dimension of the array.
<i>buf</i>	the array.
<i>buff_len</i>	the length of the 1st dimension of the array.

**Returns**

if the provided array is valid.

**6.22.2.8 print\_time()**

```
int print_time (
    void )
```

Prints the time and date of the system.

**Returns**

0 if successful, negative if not.

**6.22.2.9 set\_date\_clock()**

```
bool set_date_clock (
    unsigned int month,
    unsigned int day,
    unsigned int year )
```

Sets the date of the system clock to the provided values.

**Parameters**

<i>month</i>	the month, in BCD.
<i>day</i>	the day, in BCD.
<i>year</i>	the year, in BCD.

**Returns**

true if the time was changed, false if the values were invalid.



### 6.22.2.10 set\_time\_clock()

```
bool set_time_clock (
    unsigned int hr,
    unsigned int min,
    unsigned int sec )
```

Sets the time of the system clock to the provided values.

#### Parameters

<i>hr</i>	the hours, in BCD.
<i>min</i>	the minutes, in BCD.
<i>sec</i>	the seconds, in BCD.

#### Returns

true if the time was changed, false if the values were invalid.

### 6.22.2.11 set\_timezone()

```
void set_timezone (
    const time_zone_t * offset )
```

Sets the timezone hour offset.

#### Parameters

<i>offset</i>	the hour offset.
---------------	------------------

## 6.23 clock.h

[Go to the documentation of this file.](#)

```
00001 #ifndef F_R_I_D_A_Y_SET_TIME_H
00002 #define F_R_I_D_A_Y_SET_TIME_H
00003
00004 #include "time_zone.h"
00005
00015 const time_zone_t *get_clock_timezone(void);
00016
00021 void set_timezone(const time_zone_t *offset);
00022
00027 int print_time(void);
00028
00037 int *adj_timezone(int time[6], int tz_offset_hr, int tz_offset_min);
00038
00045 int *get_time(int t_buf[7]);
00046
00054 bool set_time_clock(unsigned int hr, unsigned int min, unsigned int sec);
00055
00063 bool set_date_clock(unsigned int month, unsigned int day, unsigned int year);
00064
00070 unsigned char decimal_to_bcd(unsigned int decimal);
00071
```

```

00077 int    bcd_to_decimal(unsigned char bcd);
00078
00087 bool    is_valid_date_or_time(int word_len, char buf[][word_len], int buff_len);
00088
00095 unsigned int    get_days_in_month(int month, int year);
00096 #endif

```

## 6.24 comhand.h

```

00001
00002 #ifndef F_R_I_D_A_Y_COMHAND_H
00003 #define F_R_I_D_A_Y_COMHAND_H
00004
00005 #define CMD_PROMPT "» "
00006
00017 void signal_shutdown(void);
00018
00022 void comhand(void);
00023
00024 #endif //F_R_I_D_A_Y_COMHAND_H

```

## 6.25 device.h

```

00001 #ifndef MPX_DEVICES_H
00002 #define MPX_DEVICES_H
00003
00004 typedef enum {
00005     COM1 = 0x3f8,
00006     COM2 = 0x2f8,
00007     COM3 = 0x3e8,
00008     COM4 = 0x2e8,
00009 } device;
00010
00011 #endif

```

## 6.26 include/mpx/gdt.h File Reference

Kernel functions to initialize the Global Descriptor Table.

### Functions

- void **gdt\_init** (void)  
*Creates and installs the Global Descriptor Table.*

### 6.26.1 Detailed Description

Kernel functions to initialize the Global Descriptor Table.

## 6.27 gdt.h

[Go to the documentation of this file.](#)

```

00001 #ifndef MPX_GDT_H
00002 #define MPX_GDT_H
00003
00010 void gdt_init(void);
00011
00012 #endif

```

## 6.28 include/mpx/heap.h File Reference

the heap file contains functions useful for allocating and freeing memory.

```
#include "stddef.h"
#include "stdbool.h"
```

### Functions

- void [print\\_list](#) (bool list)  
*Prints one of the given list based upon the bool.*
- void [print\\_partial\\_list](#) (bool list)  
*Prints memory and size of list based upon the bool.*
- void [initialize\\_heap](#) (size\_t size)  
*Initializes the heap with the given size.*
- void \* [allocate\\_memory](#) (size\_t size)  
*Allocates memory to the heap, returns NULL if it can't find enough room for the memory.*
- int [free\\_memory](#) (void \*pointer)  
*Frees the Memory Block at the given pointer.*

### 6.28.1 Detailed Description

the heap file contains functions useful for allocating and freeing memory.

### 6.28.2 Function Documentation

#### 6.28.2.1 [allocate\\_memory\(\)](#)

```
void * allocate_memory (
    size_t size )
```

Allocates memory to the heap, returns NULL if it can't find enough room for the memory.

#### Parameters

<i>size</i>	the amount of bytes to allocate.
-------------	----------------------------------

#### Returns

the pointer to the allocated memory, or NULL.

**Authors**

Andrew Bowie, Jared Crowley

**6.28.2.2 free\_memory()**

```
int free_memory (
    void * pointer )
```

Frees the Memory Block at the given pointer.

**Parameters**

<i>pointer</i>	the address of the MB.
----------------	------------------------

**Returns**

0 on success

**Authors**

Kolby Eisenhower

**6.28.2.3 initialize\_heap()**

```
void initialize_heap (
    size_t size )
```

Initializes the heap with the given size.

**Parameters**

<i>size</i>	the size of the new heap.
-------------	---------------------------

**Authors**

Andrew Bowie

**6.28.2.4 print\_list()**

```
void print_list (
    bool list )
```

Prints one of the given list based upon the bool.

## Parameters

<i>list</i>	the list to print, free if true, alloc if false.
-------------	--

## Authors

Andrew Bowie

## 6.28.2.5 print\_partial\_list()

```
void print_partial_list (
    bool list )
```

Prints memory and size of list based upon the bool.

## Parameters

<i>list</i>	the list to print, free if true, alloc if false.
-------------	--

## Authors

Zachary Ebert

## 6.29 heap.h

[Go to the documentation of this file.](#)

```
00001 //
00002 // Created by Andrew Bowie on 3/24/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_HEAP_H
00006 #define F_R_I_D_A_Y_HEAP_H
00007
00008 #include "stddef.h"
00009 #include "stdbool.h"
00010
00022 void print_list(bool list);
00029 void print_partial_list(bool list);
00036 void initialize_heap(size_t size);
00037
00045 void *allocate_memory(size_t size);
00046
00053 int free_memory(void* pointer);
00054
00055
00056 #endif //F_R_I_D_A_Y_HEAP_H
```

## 6.30 include/mpx/interrupts.h File Reference

Kernel functions related to software and hardware interrupts.

## Macros

- `#define sti() __asm__ volatile ("sti")`  
*Disable interrupts.*
- `#define cli() __asm__ volatile ("cli")`  
*Enable interrupts.*

## Functions

- `void irq_init (void)`  
*Installs the initial interrupt handlers for the first 32 IRQ lines.*
- `void pic_init (void)`  
*Initializes the programmable interrupt controllers and performs the necessary remapping of IRQs.*
- `void idt_init (void)`  
*Creates and installs the Interrupt Descriptor Table.*
- `void idt_install (int vector, void(*handler)(void *))`  
*Installs an interrupt handler.*

### 6.30.1 Detailed Description

Kernel functions related to software and hardware interrupts.

### 6.30.2 Function Documentation

#### 6.30.2.1 irq\_init()

```
void irq_init (  
    void )
```

Installs the initial interrupt handlers for the first 32 IRQ lines.

Most do a panic for now.

#### 6.30.2.2 pic\_init()

```
void pic_init (  
    void )
```

Initializes the programmable interrupt controllers and performs the necessary remapping of IRQs.

Leaves interrupts turned off.

## 6.31 interrupts.h

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_INTERRUPTS_H
00002 #define MPX_INTERRUPTS_H
00003
00010 #define sti() __asm__ volatile ("sti")
00011
00013 #define cli() __asm__ volatile ("cli")
00014
00019 void irq_init(void);
00020
00025 void pic_init(void);
00026
00028 void idt_init(void);
00029
00031 void idt_install(int vector, void (*handler)(void *));
00032
00033 #endif
```

## 6.32 include/mpx/io.h File Reference

Kernel macros to read and write I/O ports.

### Macros

- `#define outb(port, data) __asm__ volatile ("outb %%al, %%dx" :: "a" (data), "d" (port))`  
*Write one byte to an I/O port.*
- `#define inb(port)`  
*Read one byte from an I/O port.*

### 6.32.1 Detailed Description

Kernel macros to read and write I/O ports.

### 6.32.2 Macro Definition Documentation

#### 6.32.2.1 inb

```
#define inb(  
    port )
```

#### Value:

```
{  
    unsigned char r;  
    __asm__ volatile ("inb %%dx, %%al" : "=a" (r) : "d" (port));  
    r;  
}
```

Read one byte from an I/O port.

**Parameters**

<i>port</i>	The port to read from
-------------	-----------------------

**Returns**

A byte of data read from the port

**6.32.2.2 outb**

```
#define outb(
    port,
    data ) __asm__ volatile ("outb %al, %%dx" :: "a" (data), "d" (port))
```

Write one byte to an I/O port.

**Parameters**

<i>port</i>	The port to write to
<i>data</i>	The byte to write to the port

**6.33 io.h**

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_IO_H
00002 #define MPX_IO_H
00003
00014 #define outb(port, data) \
00015     __asm__ volatile ("outb %al, %%dx" :: "a" (data), "d" (port))
00016
00022 #define inb(port) ({ \
00023     unsigned char r; \
00024     __asm__ volatile ("inb %%dx, %%al" : "=a" (r) : "d" (port)); \
00025     r; \
00026 })
00027
00028 #endif
```

**6.34 include/mpx/panic.h File Reference**

Common system functions and definitions.

```
#include <stdnoreturn.h>
```

**Functions**

- `noreturn __attribute__((no_caller_saves_registers)) void kpanic(const char *msg)`  
*Kernel panic.*



### 6.34.1 Detailed Description

Common system functions and definitions.

### 6.34.2 Function Documentation

#### 6.34.2.1 `__attribute__()`

```
noreturn __attribute__ (
    (no_caller_saved_registers) ) const
```

Kernel panic.

Prints an error message and halts.

#### Parameters

<code>msg</code>	A message to display before halting
------------------	-------------------------------------

## 6.35 panic.h

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_PANIC_H
00002 #define MPX_PANIC_H
00003
00004 #include <stdnoreturn.h>
00005
00015 /*
00016  non-standard attribute is required for clang < 15
00017  */
00018 noreturn __attribute__((no_caller_saved_registers)) void kpanic(const char *msg);
00019
00020 #endif
```

## 6.36 include/mpx/pcb.h File Reference

This file contains all of the structure and functions for a PCB and its context.

```
#include "stdbool.h"
#include "stddef.h"
```

### Classes

- struct [pcb](#)  
*The definition of a process control block.*
- struct [context](#)  
*The context to save onto a PCB.*

## Macros

- #define **PCB\_MAX\_NAME\_LEN** 8  
*The maximum length of a PCB's name.*
- #define **PCB\_STACK\_SIZE** 2048  
*The initial size of a PCB's stack.*

## Enumerations

- enum **pcb\_class** { **USER** = 0 , **SYSTEM** = 1 }  
*The clas of a PCB.*
- enum **pcb\_exec\_state** { **READY** = 0 , **RUNNING** = 1 , **BLOCKED** = 2 }  
*The execution state of a PCB.*
- enum **pcb\_dispatch\_state** { **NOT\_SUSPENDED** = 0 , **SUSPENDED** = 1 }  
*An enum of dispatch state for PCBs.*

## Functions

- void **setup\_queue** (void)  
*Sets up queue for PCBS.*
- struct **pcb** \* **peek\_next\_pcb** (void)  
*Peeks the next available PCB, or returns NULL if it's empty.*
- struct **pcb** \* **poll\_next\_pcb** (void)  
*Polls the next available PCB, or returns NULL if it's empty.*
- struct **pcb** \* **pcb\_alloc** (void)  
*Allocates memory for a PCB block.*
- int **pcb\_free** (struct **pcb** \*pcb\_ptr)  
*Frees the memory associated with the given PCB block.*

### 6.36.1 Detailed Description

This file contains all of the structure and functions for a PCB and its context.

### 6.36.2 Function Documentation

#### 6.36.2.1 **pcb\_alloc()**

```
struct pcb * pcb_alloc (  
    void )
```

Allocates memory for a PCB block.

#### Returns

A pointer to the allocated PCB.

#### Authors

Andrew Bowie, Kolby Eisenhower

### 6.36.2.2 `pcb_free()`

```
int pcb_free (
    struct pcb * pcb_ptr )
```

Frees the memory associated with the given PCB block.

#### Parameters

<code>pcb_ptr</code>	the pointer to the pcb.
----------------------	-------------------------

#### Returns

0 on success, non-zero on failure.

#### Authors

Andrew Bowie

### 6.36.2.3 `peek_next_pcb()`

```
struct pcb * peek_next_pcb (
    void )
```

Peeks the next available PCB, or returns NULL if it's empty.

#### Returns

the next PCB or NULL.

### 6.36.2.4 `poll_next_pcb()`

```
struct pcb * poll_next_pcb (
    void )
```

Polls the next available PCB, or returns NULL if it's empty.

#### Returns

the next PCB or NULL.

### 6.36.2.5 setup\_queue()

```
void setup_queue (
    void )
```

Sets up queue for PCBS.

#### Authors

Andrew Bowie

## 6.37 pcb.h

[Go to the documentation of this file.](#)

```
00001 #include "stdbool.h"
00002 #include "stddef.h"
00003 #ifndef MPX_PCB_H
00004 #define MPX_PCB_H
00005
00012 #define PCB_MAX_NAME_LEN 8
00014 #define PCB_STACK_SIZE 2048
00015
00017 enum pcb_class {
00018     USER = 0,
00019     SYSTEM = 1,
00020 };
00021
00023 enum pcb_exec_state {
00024     READY = 0,
00025     RUNNING = 1,
00026     BLOCKED = 2,
00027 };
00028
00030 enum pcb_dispatch_state {
00031     NOT_SUSPENDED = 0,
00032     SUSPENDED = 1,
00033 };
00034
00036 struct pcb {
00037     void *_next;
00040     void *_item;
00041
00043     const char *name;
00045     enum pcb_class process_class;
00047     int priority;
00049     enum pcb_exec_state exec_state;
00051     enum pcb_dispatch_state dispatch_state;
00053     void *stack_ptr;
00055     unsigned char stack[PCB_STACK_SIZE];
00056 };
00057
00059 struct context {
00061     int gs, fs, es, ds, ss;
00063     int edi, esi, ebp, esp, ebx, edx, ecx, eax;
00065     int eip, cs, eflags;
00066 };
00067
00072 void setup_queue(void);
00073
00078 struct pcb *peek_next_pcb(void);
00079
00084 struct pcb *poll_next_pcb(void);
00085
00092 struct pcb *pcb_alloc(void);
00093
00101 int pcb_free(struct pcb* pcb_ptr);
00102
00112 struct pcb *pcb_setup(const char *name, int class, int priority);
00113
00119 void pcb_insert(struct pcb* pcb_ptr);
00120
00127 struct pcb *pcb_find(const char *name);
00128
00136 bool pcb_remove(struct pcb *pcb_ptr);
00137
00147 bool generate_new_pcb(const char *name,
```

```

00148             int priority,
00149             enum pcb_class class,
00150             void *begin_ptr,
00151             const char *input,
00152             size_t input_len,
00153             size_t param_ptrs);
00154
00160 void exec_pcb_cmd(const char *comm);
00161
00162
00163 #endif

```

## 6.38 include/mpx/r3cmd.h File Reference

LoadR3 Loads the contents of R3 while cycling through each process.

### Functions

- bool [loadr3](#) (const char \*comm)

#### 6.38.1 Detailed Description

LoadR3 Loads the contents of R3 while cycling through each process.

#### 6.38.2 Function Documentation

##### 6.38.2.1 loadr3()

```

bool loadr3 (
    const char * comm )

```

##### Parameters

<i>comm</i>	the command.
-------------	--------------

##### Authors

Zachary Ebert

## 6.39 r3cmd.h

[Go to the documentation of this file.](#)

```

00001 #ifndef _r3cmd_H
00002 #define _r3cmd_H
00012 bool loadr3(const char *comm);
00013
00014 #endif

```

## 6.40 include/mpx/serial.h File Reference

Kernel functions and constants for handling serial I/O.

```
#include "sys_req.h"
#include <stddef.h>
#include "mpx/pcb.h"
#include <mpx/device.h>
```

### Enumerations

- enum [io\\_req\\_result](#) {  
[INVALID\\_PARAMS](#) , [DEVICE\\_CLOSED](#) , [DEVICE\\_BUSY](#) , [PARTIALLY\\_SERVICED](#) ,  
[SERVICED](#) }

*An enumeration of all possible results for an IO request.*

### Functions

- struct [pcb](#) \* [check\\_completed](#) (void)  
*Checks for any completed PCBs that were doing IO operations.*
- [io\\_req\\_result](#) [io\\_request](#) (struct [pcb](#) \*[pcb](#), op\_code operation, device dev, char \*buffer, size\_t length)  
*Performs an IO operation on the given device, returning the result.*
- int [serial\\_init](#) (device dev)  
*Initializes devices for user input and output.*
- int [serial\\_open](#) (device dev, int speed)  
*Initializes devices for user input and output.*
- int [serial\\_close](#) (device dev)  
*Closes the given device.*
- int [serial\\_out](#) (device dev, const char \*buffer, size\_t len)  
*Writes a buffer to a serial port.*
- int [serial\\_write](#) (device dev, char \*buffer, size\_t len)  
*Writes len bytes from the given buffer to the device.*
- int [serial\\_read](#) (device dev, char \*buf, size\_t len)  
*Reads input on the given device.*
- int [serial\\_poll](#) (device dev, char \*buffer, size\_t len)  
*Reads a string from a serial port.*

### 6.40.1 Detailed Description

Kernel functions and constants for handling serial I/O.

### 6.40.2 Enumeration Type Documentation

#### 6.40.2.1 io\_req\_result

```
enum io\_req\_result
```

An enumeration of all possible results for an IO request.

## Enumerator

INVALID_PARAMS	If one or more of the provided parameters were invalid.
DEVICE_CLOSED	Returned if the requested device isn't open.
DEVICE_BUSY	Returned if the device is currently busy.
PARTIALLY_SERVICED	Returned if the request was only partially serviced.
SERVICED	Returned if the request was fully serviced.

### 6.40.3 Function Documentation

#### 6.40.3.1 check\_completed()

```
struct pcb * check_completed (
    void )
```

Checks for any completed PCBs that were doing IO operations.

## Returns

a PCB to load, or NULL.

#### 6.40.3.2 io\_request()

```
io_req_result io_request (
    struct pcb * pcb,
    op_code operation,
    device dev,
    char * buffer,
    size_t length )
```

Performs an IO operation on the given device, returning the result.

## Parameters

<i>pcb</i>	the PCB requesting this operation.
<i>operation</i>	the operation.
<i>dev</i>	the device.
<i>buffer</i>	the buffer.
<i>length</i>	the amount of characters to transfer.

## Returns

the result of the operation.

### 6.40.3.3 serial\_close()

```
int serial_close (
    device dev )
```

Closes the given device.

#### Parameters

<i>dev</i>	the device to close.
------------	----------------------

#### Returns

0 on success, negative values on error.

### 6.40.3.4 serial\_init()

```
int serial_init (
    device dev )
```

Initializes devices for user input and output.

#### Parameters

<i>device</i>	A serial port to initialize (COM1, COM2, COM3, or COM4)
---------------	---

#### Returns

0 on success, non-zero on failure

### 6.40.3.5 serial\_open()

```
int serial_open (
    device dev,
    int speed )
```

Initializes devices for user input and output.

#### Parameters

<i>device</i>	A serial port to initialize (COM1, COM2, COM3, or COM4)
---------------	---



**Returns**

0 on success, non-zero on failure

**6.40.3.6 serial\_out()**

```
int serial_out (
    device dev,
    const char * buffer,
    size_t len )
```

Writes a buffer to a serial port.

**Parameters**

<i>device</i>	The serial port to output to
<i>buffer</i>	A pointer to an array of characters to output
<i>len</i>	The number of bytes to write

**Returns**

The number of bytes written

**6.40.3.7 serial\_poll()**

```
int serial_poll (
    device dev,
    char * buffer,
    size_t len )
```

Reads a string from a serial port.

**Parameters**

<i>device</i>	The serial port to read data from
<i>buffer</i>	A buffer to write data into as it is read from the serial port
<i>count</i>	The maximum number of bytes to read

**Returns**

The number of bytes read on success, a negative number on failure

### 6.40.3.8 serial\_read()

```
int serial_read (
    device dev,
    char * buf,
    size_t len )
```

Reads input on the given device.

#### Parameters

<i>dev</i>	the device to read on.
<i>buf</i>	the buffer to read with.
<i>len</i>	the length of the buffer.

#### Returns

0 on success, negative values on error.

### 6.40.3.9 serial\_write()

```
int serial_write (
    device dev,
    char * buffer,
    size_t len )
```

Writes len bytes from the given buffer to the device.

#### Parameters

<i>dev</i>	the device to write to.
<i>buffer</i>	the buffer to read from.
<i>len</i>	the amount of bytes to write.

#### Returns

the number of bytes written.

## 6.41 serial.h

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_SERIAL_H
00002 #define MPX_SERIAL_H
00003
00004 #include "sys_req.h"
00005 #include <stddef.h>
00006 #include "mpx/pcb.h"
00007 #include <mpx/device.h>
00008
00015 typedef enum {
```

```

00017     INVALID_PARAMS,
00019     DEVICE_CLOSED,
00021     DEVICE_BUSY,
00023     PARTIALLY_SERVICED,
00025     SERVICED,
00026 } io_req_result;
00027
00032 struct pcb *check_completed(void);
00033
00044 io_req_result io_request(struct pcb *pcb, op_code operation, device dev, char *buffer, size_t length);
00045
00051 int serial_init(device dev);
00052
00058 int serial_open(device dev, int speed);
00059
00066 int serial_close(device dev);
00067
00075 int serial_out(device dev, const char *buffer, size_t len);
00076
00084 int serial_write(device dev, char *buffer, size_t len);
00085
00094 int serial_read(device dev, char *buf, size_t len);
00095
00104 int serial_poll(device dev, char *buffer, size_t len);
00105
00106 #endif

```

## 6.42 include/mpx/vm.h File Reference

Kernel functions for virtual memory and primitive allocation.

```
#include <stddef.h>
```

### Functions

- void \* **kmalloc** (size\_t size, int align, void \*\*phys\_addr)  
*Allocates memory from a primitive heap.*
- void **vm\_init** (void)  
*Initializes the kernel page directory and initial kernel heap area.*

### 6.42.1 Detailed Description

Kernel functions for virtual memory and primitive allocation.

### 6.42.2 Function Documentation

#### 6.42.2.1 kmalloc()

```

void * kmalloc (
    size_t size,
    int align,
    void ** phys_addr )

```

Allocates memory from a primitive heap.

**Parameters**

<i>size</i>	The size of memory to allocate
<i>align</i>	If non-zero, align the allocation to a page boundary
<i>phys_addr</i>	If non-NULL, a pointer to a pointer that will hold the physical address of the new memory

**Returns**

The newly allocated memory

**6.42.2.2 vm\_init()**

```
void vm_init (
    void )
```

Initializes the kernel page directory and initial kernel heap area.

Performs identity mapping of the kernel frames such that the virtual addresses are equivalent to the physical addresses.

**6.43 vm.h**

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_VM_H
00002 #define MPX_VM_H
00003
00009 #include <stddef.h>
00010
00019 void *kmalloc(size_t size, int align, void **phys_addr);
00020
00026 void vm_init(void);
00027
00028 #endif
```

**6.44 print\_format.h**

```
00001 //
00002 // Created by Andrew Bowie on 2/1/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_PRINT_FORMAT_H
00006 #define F_R_I_D_A_Y_PRINT_FORMAT_H
00007
00008 #include "color.h"
00009 #include "stdbool.h"
00010
00012 typedef enum {
00013     BOLD = 0,
00014     UNDERLINE = 1,
00015     ITALIC = 2,
00016     INVISIBLE = 3,
00017     INVERSE = 4,
00018     BLINKING = 5,
00019     STRIKETHROUGH = 6,
00020 } format_code_t;
00021
00028 bool is_format_code(format_code_t format_code);
00029
00036 void set_format_code(format_code_t format_code, bool active);
00037
00041 void clear_formats();
00042
00043 #endif //F_R_I_D_A_Y_PRINT_FORMAT_H
```

## 6.45 include/processes.h File Reference

Provided system process and user processes for testing.

### Functions

- void **proc1** (void)  
*A test process that prints a message then yields, exiting after 1 iteration.*
- void **proc2** (void)  
*A test process that prints a message then yields, exiting after 2 iterations.*
- void **proc3** (void)  
*A test process that prints a message then yields, exiting after 3 iterations.*
- void **proc4** (void)  
*A test process that prints a message then yields, exiting after 4 iterations.*
- void **proc5** (void)  
*A test process that prints a message then yields, exiting after 5 iterations.*
- void **sys\_idle\_process** (void)  
*System idle process.*
- void **comwrite** (void)  
*This process attempts to write a message to the serial device.*
- void **comread** (void)  
*This process writes a prompt to the serial device, and then reads user input which is then printed back to the device.*
- void **iocom25** (void)  
*This process attempts to write a message to the serial device 25 times and then exits.*
- void **iocom** (void)  
*This process attempts to write a message to the serial device until suspended and terminated.*

### 6.45.1 Detailed Description

Provided system process and user processes for testing.

### 6.45.2 Function Documentation

#### 6.45.2.1 comwrite()

```
void comwrite (  
    void )
```

This process attempts to write a message to the serial device.

This should be the first test process executed when testing R6.

### 6.45.2.2 sys\_idle\_process()

```
void sys_idle_process (
    void )
```

System idle process.

Used in dispatching. It will be dispatched if NO other processes are available to execute. Must be a system process.

## 6.46 processes.h

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_PROCESSES_H
00002 #define MPX_PROCESSES_H
00003
00009 /* *****
00010  The following functions are needed for Module R3.
00011  ***** */
00012
00016 void proc1(void);
00017
00021 void proc2(void);
00022
00026 void proc3(void);
00027
00031 void proc4(void);
00032
00036 void proc5(void);
00037
00038 /* *****
00039  The following function is needed for Module R4.
00040  ***** */
00041
00046 void sys_idle_process(void);
00047
00048 /* *****
00049  The following functions are needed for Module R6.
00050  ***** */
00051
00056 void comwrite(void);
00057
00062 void comread(void);
00063
00067 void iocom25(void);
00068
00072 void iocom(void);
00073
00074 #endif
```

## 6.47 include/stdio.h File Reference

Contains useful functions for standard IO.

```
#include "stddef.h"
#include "stdbool.h"
```

## Functions

- char `getc` (void)  
*Reads a single ASCII character from standard input.*
- char `pollc` (void)  
*Polls a single ASCII character from standard input.*
- char \* `gets` (char \*str\_buf, size\_t buf\_len)  
*Reads a string of input from the standard input source.*
- void `print` (const char \*str)  
*Prints a null-terminated string to standard output.*
- int `printf` (const char \*str,...)  
*Prints the string with formatting to standard output.*
- void `println` (const char \*str)  
*Prints a null-terminated string, then a new line, to standard output.*
- void `clearscr` (void)  
*Clears the screen.*

### 6.47.1 Detailed Description

Contains useful functions for standard IO.

### 6.47.2 Function Documentation

#### 6.47.2.1 `getc()`

```
char getc (  
    void )
```

Reads a single ASCII character from standard input.

##### Returns

The character read

#### 6.47.2.2 `gets()`

```
char * gets (  
    char * str_buf,  
    size_t buf_len )
```

Reads a string of input from the standard input source.

**Parameters**

<i>str_buf</i>	the buffer to store the string in.
<i>buf_len</i>	the amount of bytes to read. (The buffer should be at least one byte longer)

**Returns**

a pointer to the read array.

**6.47.2.3 pollc()**

```
char pollc (  
    void )
```

Polls a single ASCII character from standard input.

If no characters are available, 0 is returned.

**Returns**

The character polled.

**6.47.2.4 print()**

```
void print (  
    const char * str )
```

Prints a null-terminated string to standard output.

**Parameters**

<i>str</i>	the string.
------------	-------------

**6.47.2.5 printf()**

```
int printf (  
    const char * str,  
    ... )
```

Prints the string with formatting to standard output.



**Parameters**

<i>str</i>	the string to print.
...	the formatting objects.

**Returns**

0 if successful, -1 if there was a formatting error.

**6.47.2.6 println()**

```
void println (
    const char * str )
```

Prints a null-terminated string, then a new line, to standard output.

**Parameters**

<i>str</i>	the string.
------------	-------------

**6.48 stdio.h**

[Go to the documentation of this file.](#)

```
00001 //
00002 // Created by Andrew Bowie on 1/13/23.
00003 //
00004
00005 #ifndef F_R_I_D_A_Y_STDIO_H
00006 #define F_R_I_D_A_Y_STDIO_H
00007
00008 #include "stddef.h"
00009 #include "stdbool.h"
00010
00020 char getc(void);
00021
00027 char pollc(void);
00028
00035 char *gets(char *str_buf, size_t buf_len);
00036
00041 void print(const char *str);
00042
00049 int printf(const char *str, ...);
00050
00055 void println(const char *str);
00056
00060 void clearscr(void);
00061
00062 #endif //F_R_I_D_A_Y_STDIO_H
```

**6.49 include/stdlib.h File Reference**

A subset of standard C library functions.

## Functions

- `int atoi (const char *s)`  
*Convert an ASCII string to an integer.*
- `char * itoa (int i, char *str_buf, int buf_len)`  
*Convert a signed integer to a string.*
- `char * itoa_base (int i, int base, char *str_buf, int buf_len)`  
*Convert a signed integer to a string.*
- `int atox (const char *s)`  
*Convert a hex string to integer.*

### 6.49.1 Detailed Description

A subset of standard C library functions.

### 6.49.2 Function Documentation

#### 6.49.2.1 `atoi()`

```
int atoi (
    const char * s )
```

Convert an ASCII string to an integer.

##### Parameters

<code>s</code>	A NUL-terminated string
----------------	-------------------------

##### Returns

The value of the string converted to an integer

#### 6.49.2.2 `atox()`

```
int atox (
    const char * s )
```

Convert a hex string to integer.

##### Parameters

<code>s</code>	the string to convert
----------------	-----------------------

**Returns**

the created integer from the string

**6.49.2.3 itoa()**

```
char * itoa (
    int i,
    char * str_buf,
    int buf_len )
```

Convert a signed integer to a string.

**Parameters**

<i>i</i>	the integer to convert
<i>str_buf</i>	the buffer to store the integer in
<i>buf_len</i>	the string buffer length

**Returns**

the created string from the integer

**6.49.2.4 itoa\_base()**

```
char * itoa_base (
    int i,
    int base,
    char * str_buf,
    int buf_len )
```

Convert a signed integer to a string.

**Parameters**

<i>i</i>	the integer to convert
<i>base</i>	the base of the number
<i>str_buf</i>	the buffer to store the integer in
<i>buf_len</i>	the string buffer length

**Returns**

the created string from the integer

**6.50 stdlib.h**

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_STDLIB_H
00002 #define MPX_STDLIB_H
00003
00014 int atoi(const char *s);
00015
00023 char *itoa(int i, char *str_buf, int buf_len);
00024
00033 char *itoa_base(int i, int base, char *str_buf, int buf_len);
00034
00040 int atox(const char *s);
00041
00042 #endif
```

**6.51 include/string.h File Reference**

A subset of standard C library functions.

```
#include <stddef.h>
#include "stdarg.h"
#include "stdbool.h"
```

**Functions**

- bool [first\\_label\\_matches](#) (const char \*str1, const char \*label)  
*Checks if the given string's first part matches the label.*
- void \* [memcpy](#) (void \*restrict dst, const void \*restrict src, size\_t n)  
*Copy a region of memory.*
- void \* [memset](#) (void \*address, int c, size\_t n)  
*Fill a region of memory.*
- char \* [strcpy](#) (char \*str\_dest, const char \*str\_src, size\_t maxlen)  
*Copies the data from the string source into the string destination.*
- int [strcmp](#) (const char \*s1, const char \*s2)  
*Compares two strings.*
- int [stricmp](#) (const char \*s1, const char \*s2)  
*Compares two strings, ignoring case.*
- char \* [str\\_strip\\_whitespace](#) (char \*str, char \*buffer, size\_t buf\_len)  
*Strips leading and trailing whitespace from the given string.*
- size\_t [strlen](#) (const char \*s)  
*Returns the length of a string.*
- char \* [str\\_to\\_upper](#) (char \*str, char \*buffer, int buf\_len)  
*Converts the given string to upper case.*
- char \* [str\\_to\\_lower](#) (char \*str, char \*buffer, int buf\_len)  
*Converts the given string to lower case.*
- char \* [strtok](#) (char \*restrict s1, const char \*restrict s2)  
*Split string into tokens TODO.*

- char \* [sprintf](#) (const char \*format, char \*str, size\_t buf\_len,...)  
*Formats the string with normal C formatting options.*
- char \* [vsprintf](#) (const char \*format, char \*str, size\_t buf\_len, va\_list varargs)  
*Formats the string with normal C formatting options.*
- char [split\\_once\\_after](#) (const char \*string, const char \*split\_after, char buff[], int buff\_len)  
*Returns string located after where to split, original string returned if not split.*
- bool [starts\\_with](#) (const char \*string, const char \*starts\_with)  
*Returns true if string starts with given string.*
- bool [ci\\_starts\\_with](#) (const char \*string, const char \*prefix)  
*Returns true if the string starts with the given prefix.*
- int [split](#) (const char \*string, char split\_at, int word\_length, char buff[][word\_length], int words)  
*Splits the given string at character saving into a 2D buffer.*
- int [substring](#) (const char \*string, int start, int end, char buff[], int buff\_size)  
*Splits the given string at character saving into a 2D buffer.*

## 6.51.1 Detailed Description

A subset of standard C library functions.

## 6.51.2 Function Documentation

### 6.51.2.1 ci\_starts\_with()

```
bool ci_starts_with (
    const char * string,
    const char * prefix )
```

Returns true if the string starts with the given prefix.

Case is ignored.

#### Parameters

<i>string</i>	the string to be tested.
<i>prefix</i>	the prefix of the string.

#### Returns

true if the string starts with the prefix.

### 6.51.2.2 first\_label\_matches()

```
bool first_label_matches (
    const char * str1,
    const char * label )
```

Checks if the given string's first part matches the label.

#### Parameters

<i>str1</i>	the string.
<i>label</i>	the label.

#### Returns

if the string matches the label.

### 6.51.2.3 memcpy()

```
void * memcpy (
    void *restrict dst,
    const void *restrict src,
    size_t n )
```

Copy a region of memory.

#### Parameters

<i>dst</i>	The destination memory region
<i>src</i>	The source memory region
<i>n</i>	The number of bytes to copy

#### Returns

A pointer to the destination memory region

### 6.51.2.4 memset()

```
void * memset (
    void * address,
    int c,
    size_t n )
```

Fill a region of memory.

#### Parameters

<i>address</i>	The start of the memory region
<i>c</i>	The byte to fill memory with
<i>n</i>	The number of bytes to fill

**Returns**

A pointer to the filled memory region

**6.51.2.5 split()**

```
int split (
    const char * string,
    char split_at,
    int word_length,
    char buff[][word_length],
    int words )
```

Splits the given string at character saving into a 2D buffer.

**Parameters**

<i>string</i>	string to be split
<i>split_at</i>	character to split at
<i>wordlength</i>	length of the column dimension of buffer must match buff dimension
<i>words</i>	number of rows (words) available in buff

**Returns**

error codes 0 is successful, negative if not

**6.51.2.6 split\_once\_after()**

```
char split_once_after (
    const char * string,
    const char * split_after,
    char buff[],
    int buff_len )
```

Returns string located after where to split, original string returned if not split.

**Parameters**

<i>string</i>	string to be split
<i>split↔ At</i>	string that chooses where to split

**Returns**

the string split or not

### 6.51.2.7 sprintf()

```
char * sprintf (
    const char * format,
    char * str,
    size_t buf_len,
    ... )
```

Formats the string with normal C formatting options.

#### Parameters

<i>format</i>	the string format.
<i>str</i>	the buffer to store the resulting string in.
<i>buf_len</i>	the length of the provided string buffer.
...	the formatting values.

#### Returns

the formatted string.

### 6.51.2.8 starts\_with()

```
bool starts_with (
    const char * string,
    const char * starts_with )
```

Returns true if string starts with given string.

#### Parameters

<i>string</i>	string to be tested
<i>starts_with</i>	given string to start with

#### Returns

if string starts with starts\_with string

### 6.51.2.9 str\_strip\_whitespace()

```
char * str_strip_whitespace (
    char * str,
    char * buffer,
    size_t buf_len )
```

Strips leading and trailing whitespace from the given string.



## Parameters

<i>str</i>	the string to strip from.
<i>buffer</i>	the buffer to store the resulting string in, or NULL if the strip should be done in place.
<i>buf_len</i>	the length of the buffer.

## Returns

a pointer to the resulting string, or NULL if it failed.

**6.51.2.10 str\_to\_lower()**

```
char * str_to_lower (
    char * str,
    char * buffer,
    int buf_len )
```

Converts the given string to lower case.

If the provided buffer is null, overwrites the original string.

## Parameters

<i>str</i>	the original string.
<i>buffer</i>	the buffer to store the string in, or NULL if the original string should be overwritten.
<i>buf_len</i>	the length of the buffer. If buffer is NULL, can be any number.

## Returns

a pointer to the lower case string, or NULL if the buffer was too small to store the resulting string.

**6.51.2.11 str\_to\_upper()**

```
char * str_to_upper (
    char * str,
    char * buffer,
    int buf_len )
```

Converts the given string to upper case.

If the provided buffer is null, overwrites the original string.

## Parameters

<i>str</i>	the original string.
<i>buffer</i>	the buffer to store the string in, or NULL if the original string should be overwritten.
<i>buf_len</i>	the length of the buffer. If buffer is NULL, can be any number.

**Returns**

a pointer to the upper case string, or NULL if the buffer was too small to store the resulting string.

**6.51.2.12 strcasecmp()**

```
int strcasecmp (
    const char * s1,
    const char * s2 )
```

Compares two strings, ignoring case.

**Parameters**

<i>s1</i>	The first string to compare
<i>s2</i>	The second string to compare

**Returns**

0 if strings are equal, <0 if *s1* is lexicographically before *s2*, >0 otherwise

**6.51.2.13 strcmp()**

```
int strcmp (
    const char * s1,
    const char * s2 )
```

Compares two strings.

**Parameters**

<i>s1</i>	The first string to compare
<i>s2</i>	The second string to compare

**Returns**

0 if strings are equal, <0 if *s1* is lexicographically before *s2*, >0 otherwise

**6.51.2.14 strcpy()**

```
char * strcpy (
    char * str_dest,
```

```
const char * str_src,
size_t maxlen )
```

Copies the data from the string source into the string destination.

If maxlen is exceeded, it only copies that amount of chars over.

#### Parameters

<i>str_dest</i>	the string destination.
<i>str_src</i>	the string source.
<i>maxlen</i>	the maximum amount of bytes to copy. Note that maxlen does not include the null terminator.

#### Returns

a pointer to the string, or NULL if there was an error.

### 6.51.2.15 strlen()

```
size_t strlen (
    const char * s )
```

Returns the length of a string.

#### Parameters

<i>s</i>	A NUL-terminated string
----------	-------------------------

#### Returns

The number of bytes in the string (not counting NUL terminator)

### 6.51.2.16 substring()

```
int substring (
    const char * string,
    int start,
    int end,
    char buff[],
    int buff_size )
```

Splits the given string at character saving into a 2D buffer.

#### Parameters

<i>string</i>	string to be spliced
<i>start</i>	index to start at
<i>end</i>	index to end at
<i>buff</i>	buffer to save result to
<i>buff_size</i>	length of buff

**Returns**

error codes 0 is successful, negative if not

**6.51.2.17 vsprintf()**

```
char * vsprintf (
    const char * format,
    char * str,
    size_t buf_len,
    va_list varargs )
```

Formats the string with normal C formatting options.

**Parameters**

<i>format</i>	the string format.
<i>str</i>	the buffer to store the resulting string in.
<i>buf_len</i>	the length of the provided string buffer.
<i>...</i>	the formatting values.

**Returns**

the formatted string.

**6.52 string.h**

[Go to the documentation of this file.](#)

```
00001 #ifndef MPX_STRING_H
00002 #define MPX_STRING_H
00003
00004 #include <stddef.h>
00005 #include "stdarg.h"
00006 #include "stdbool.h"
00007
00019 bool first_label_matches(const char *str1, const char *label);
00020
00028 void* memcpy(void * restrict dst, const void * restrict src, size_t n);
00029
00037 void* memset(void *address, int c, size_t n);
00038
00047 char *strcpy(char *str_dest, const char *str_src, size_t maxlen);
00048
00055 int strcmp(const char *s1, const char *s2);
00056
00063 int strcasecmp(const char *s1, const char *s2);
00064
00073 char *str_strip_whitespace(char *str, char *buffer, size_t buf_len);
00074
00080 size_t strlen(const char *s);
00081
00093 char *str_to_upper(char *str, char *buffer, int buf_len);
00094
00106 char *str_to_lower(char *str, char *buffer, int buf_len);
00107
00112 char* strtok(char * restrict s1, const char * restrict s2);
00113
00122 char *sprintf(const char *format, char *str, size_t buf_len, ...);
00123
00132 char *vsprintf(const char *format, char *str, size_t buf_len, va_list varargs);
00133
```

```

00140 char split_once_after(const char* string, const char* split_after, char buff[], int buff_len);
00141
00148 bool starts_with(const char* string, const char* starts_with);
00149
00157 bool ci_starts_with(const char *string, const char *prefix);
00158
00167 int split(const char *string, char split_at, int word_length, char buff[][word_length], int words);
00168
00178 int substring(const char* string, int start, int end, char buff[], int buff_size);
00179 #endif

```

## 6.53 include/sys\_req.h File Reference

System request function and constants.

```
#include <mpx/device.h>
```

### Macros

- `#define INVALID_OPERATION (-1)`
- `#define INVALID_BUFFER (-2)`
- `#define INVALID_COUNT (-3)`

### Enumerations

- enum `op_code` { `EXIT` , `IDLE` , `READ` , `WRITE` }

### Functions

- int `sys_req` (op\_code op,...)  
*Request an MPX kernel operation.*

#### 6.53.1 Detailed Description

System request function and constants.

#### 6.53.2 Function Documentation

##### 6.53.2.1 sys\_req()

```

int sys_req (
    op_code op,
    ... )

```

Request an MPX kernel operation.

**Parameters**

<i>op_code</i>	One of READ, WRITE, IDLE, or EXIT
...	As required for READ or WRITE

**Returns**

Varies by operation

## 6.54 sys\_req.h

[Go to the documentation of this file.](#)

```

00001 #ifndef MPX_SYS_REQ_H
00002 #define MPX_SYS_REQ_H
00003
00004 #include <mpx/device.h>
00005
00011 typedef enum {
00012     EXIT,
00013     IDLE,
00014     READ,
00015     WRITE
00016 } op_code;
00017
00018 // error codes
00019 #define INVALID_OPERATION    (-1)
00020 #define INVALID_BUFFER      (-2)
00021 #define INVALID_COUNT       (-3)
00022
00029 int sys_req(op_code op, ...);
00030
00031 #endif

```

## 6.55 time\_zone.h

```

00001
00002 #ifndef F_R_I_D_A_Y_TIME_ZONE_H
00003 #define F_R_I_D_A_Y_TIME_ZONE_H
00004
00011 typedef struct {
00013     const char *tz_label;
00015     const char *tz_longformat;
00017     const int tz_hour_offset;
00019     const int tz_minute_offset;
00021     const char* tz_city;
00022 } time_zone_t;
00023
00029 const time_zone_t **get_all_timezones(void);
00030
00036 const time_zone_t *get_timezone(const char *tz_label);
00037
00038 #endif //F_R_I_D_A_Y_TIME_ZONE_H

```

## 6.56 kernel/alarm.c File Reference

Contains logic to create alarms for the OS.

```

#include "stdio.h"
#include "stddef.h"
#include "mpx/pcb.h"
#include "string.h"
#include "mpx/clock.h"
#include "sys_req.h"
#include "stdlib.h"

```

## Classes

- struct [alarm\\_params](#)

*The parameters used to pass into the alarm function.*

## Typedefs

- typedef struct [alarm\\_params](#) **alarm\_structure**

*The parameters used to pass into the alarm function.*

## Functions

- bool [is\\_time\\_after](#) (const int \*now, const int \*check)  
*Check if the given time array of hours, minutes, seconds is after the other.*
- bool **shouldAlarm** (const int \*time\_array, time\_zone\_t \*tz)
- void [alarm\\_function](#) (int \*time\_array, const char \*message, time\_zone\_t \*time\_zone)  
*The alarm function used by the alarm processes.*
- bool [create\\_new\\_alarm](#) (int \*time\_array, const char \*message)  
*Creates a new pcb that will display message at or after given time.*

### 6.56.1 Detailed Description

Contains logic to create alarms for the OS.

### 6.56.2 Function Documentation

#### 6.56.2.1 [alarm\\_function\(\)](#)

```
void alarm_function (  
    int * time_array,  
    const char * message,  
    time_zone_t * time_zone )
```

The alarm function used by the alarm processes.

#### Parameters

<i>time_array</i>	the time array to go off at.
<i>message</i>	the message to send to the user.
<i>time_zone</i>	the timezone to use for the alarm.

#### Authors

Kolby Eisenhauer

### 6.56.2.2 create\_new\_alarm()

```
bool create_new_alarm (
    int * time_array,
    const char * message )
```

Creates a new pcb that will display message at or after given time.

#### Parameters

<i>time_array</i>	the time to display message
<i>message</i>	message to display

#### Returns

true if the alarm was created, false if it failed.

#### Author

Kolby Eisenhower, Andrew Bowie

### 6.56.2.3 is\_time\_after()

```
bool is_time_after (
    const int * now,
    const int * check )
```

Check if the given time array of hours, minutes, seconds is after the other.

#### Parameters

<i>now</i>	the time array considered to be 'now'
<i>check</i>	the time to check at.

#### Returns

true if it is after.

## 6.57 kernel/heap.c File Reference

The implementation file for [heap.h](#).

```
#include "mpx/heap.h"
#include "stddef.h"
```



```
#include "mpx/vm.h"
#include "stdbool.h"
#include "stdio.h"
```

## Classes

- struct [mem\\_block](#)  
*A structure that contains memory.*

## Typedefs

- typedef struct [mem\\_block](#) **mem\_block\_t**  
*A structure that contains memory.*

## Functions

- void [print\\_block](#) ([mem\\_block\\_t](#) \*block)  
*Prints the block and its given data to std output.*
- void **print\_partial\_block** ([mem\\_block\\_t](#) \*block)
- void [print\\_partial\\_list](#) (bool list)  
*Prints memory and size of list based upon the bool.*
- void [print\\_list](#) (bool list)  
*Prints one of the given list based upon the bool.*
- void [rem\\_mcb\\_free](#) ([mem\\_block\\_t](#) \*block)  
*Removes a memory control block from its respective list.*
- void [merge\\_blocks](#) ([mem\\_block\\_t](#) \*freed\_block)  
*Merges the newly freed block with neighboring free blocks.*
- void [insert\\_block](#) ([mem\\_block\\_t](#) \*mblock, bool list)  
*Inserts a memory block into its respective list.*
- void \* [allocate\\_memory](#) (size\_t size)  
*Allocates memory to the heap, returns NULL if it can't find enough room for the memory.*
- void [initialize\\_heap](#) (size\_t size)  
*Initializes the heap with the given size.*
- bool [block\\_exists](#) (void \*mcb\_address)  
*Checks if the given block exists in the allocated memory linked list.*
- int [free\\_memory](#) (void \*free)  
*Frees the Memory Block at the given pointer.*

## Variables

- [mem\\_block\\_t](#) \* **free\_list**  
*The beginning of the free list of memory blocks.*
- [mem\\_block\\_t](#) \* **alloc\_list**  
*The beginning of the allocated list of memory blocks.*

### 6.57.1 Detailed Description

The implementation file for [heap.h](#).

Contains the definition of the memory block and some other useful functions.

### 6.57.2 Function Documentation

#### 6.57.2.1 `allocate_memory()`

```
void * allocate_memory (
    size_t size )
```

Allocates memory to the heap, returns NULL if it can't find enough room for the memory.

##### Parameters

<code>size</code>	the amount of bytes to allocate.
-------------------	----------------------------------

##### Returns

the pointer to the allocated memory, or NULL.

##### Authors

Andrew Bowie, Jared Crowley

#### 6.57.2.2 `block_exists()`

```
bool block_exists (
    void * mcb_address )
```

Checks if the given block exists in the allocated memory linked list.

##### Parameters

<code>mcb_address</code>	the beginning address of the MCB.
--------------------------	-----------------------------------

##### Returns

true if it does, false if not.

**Authors**

Kolby Eisenhauer

**6.57.2.3 free\_memory()**

```
int free_memory (
    void * pointer )
```

Frees the Memory Block at the given pointer.

**Parameters**

<i>pointer</i>	the address of the MB.
----------------	------------------------

**Returns**

0 on success

**Authors**

Kolby Eisenhauer

**6.57.2.4 initialize\_heap()**

```
void initialize_heap (
    size_t size )
```

Initializes the heap with the given size.

**Parameters**

<i>size</i>	the size of the new heap.
-------------	---------------------------

**Authors**

Andrew Bowie

**6.57.2.5 insert\_block()**

```
void insert_block (
    mem_block_t * mblock,
    bool list )
```

Inserts a memory block into its respective list.

## Parameters

<i>mblock</i>	the block to insert.
<i>list</i>	the list in which to insert the block, true if free, false if allocated.

## Authors

Andrew Bowie

**6.57.2.6 merge\_blocks()**

```
void merge_blocks (
    mem_block_t * freed_block )
```

Merges the newly freed block with neighboring free blocks.

## Parameters

<i>freed_block</i>	the freed block.
--------------------	------------------

## Authors

Andrew Bowie

**6.57.2.7 print\_block()**

```
void print_block (
    mem_block_t * block )
```

Prints the block and its given data to std output.

## Parameters

<i>block</i>	the block to print.
--------------	---------------------

## Authors

Andrew Bowie

**6.57.2.8 print\_list()**

```
void print_list (
    bool list )
```

Prints one of the given list based upon the bool.

#### Parameters

<i>list</i>	the list to print, free if true, alloc if false.
-------------	--

#### Authors

Andrew Bowie

### 6.57.2.9 print\_partial\_list()

```
void print_partial_list (
    bool list )
```

Prints memory and size of list based upon the bool.

#### Parameters

<i>list</i>	the list to print, free if true, alloc if false.
-------------	--

#### Authors

Zachary Ebert

### 6.57.2.10 rem\_mcb\_free()

```
void rem_mcb_free (
    mem_block_t * block )
```

Removes a memory control block from its respective list.

#### Parameters

<i>block</i>	the block to remove.
--------------	----------------------

#### Authors

Andrew Bowie

## 6.58 kernel/sys\_call.c File Reference

This file contains the sys\_call function which is used to do context switching.

```
#include "mpx/pcb.h"
#include "sys_req.h"
#include "linked_list.h"
#include "mpx/device.h"
#include "mpx/serial.h"
```

## Functions

- struct `pcb` \* `get_next_pcb` ()  
*Gets the next PCB to replace the current one.*
- struct `context` \* `next_pcb` (struct `pcb` \*next\_pcb, struct `context` \*current\_context, enum `pcb_exec_state` next←\_state)  
*Want to check if next PCB is blocked, unblocked, IDLE, NULL, etc.*
- struct `context` \* `sys_call` (op\_code action, struct `context` \*ctx)  
*The main system call function, implementing the IDLE and EXIT system requests.*

### 6.58.1 Detailed Description

This file contains the `sys_call` function which is used to do context switching.

### 6.58.2 Function Documentation

#### 6.58.2.1 `get_next_pcb()`

```
struct pcb * get_next_pcb ( )
```

Gets the next PCB to replace the current one.

The PCB can be sourced from one of two locations. They're listed in the order they're checked.

1. The DCB queues. If a process is loaded from there, it means that its IO operation was finished.
2. The PCB queue. If no such PCB is done in the DCBs, a PCB is polled from the PCB queue. If no PCB is available, NULL returns. In either case, the PCB is prepared for running by removing it from wherever it is in the PCB queue and set to a 'RUNNING' state.

#### Returns

the next PCB to load, or NULL if no such PCB exists.

#### 6.58.2.2 `next_pcb()`

```
struct context * next_pcb (
    struct pcb * next_pcb,
    struct context * current_context,
    enum pcb_exec_state next_state )
```

Want to check if next PCB is blocked, unblocked, IDLE, NULL, etc.

**Parameters**

<i>next_pcb</i>	the next PCB to load.
<i>current_context</i>	the current context.
<i>next_state</i>	the new state of the PCB.

**Returns**

Pointer to the next context struct

**Author**

Zachary Ebert

**6.58.2.3 sys\_call()**

```
struct context * sys_call (
    op_code action,
    struct context * ctx )
```

The main system call function, implementing the IDLE and EXIT system requests.

**Parameters**

<i>action</i>	the action to perform.
<i>ctx</i>	the current PCB context.

**Returns**

a pointer to the next context to load.

**Author**

Andrew Bowie, Zachary Ebert, Kolby Eisenhauer