

# MacaroniOS

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# Chapter 1

## Macaroni Penguins

CS450: Operating Systems Structure

Fall 2025

See the repo at <https://github.com/WVU-CS450/MacaroniPenguins>.

### 1.1 GETTING STARTED

Install WSL if you need to:

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

Clone this repo into a linux environment (WSL, Ubuntu, etc):

```
git clone https://github.com/WVU-CS450/MacaroniPenguins.git
```

Prep your linux environment by running the following commands:

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

Then run `make` and `./mpx.sh`.

For more information, either run the `help` command inside of MacaroniOS, or consult the [doc/USER↔GUIDE.pdf](#).

### 1.2 CONTRIBUTING

After making changes, running `version` will show that your working directory is 'dirty'. This simply means that you have uncommitted changes.

Ensure you have checked out the correct branch and pulled its latest changes. Stage/add the relevant files before committing them.

Now you can run `make clean` and `make` again, run `./mpx.sh`, and finally run `version` to see your latest commit hash and showing that your working directory is 'clean'.

When you're done, add your contributions to [dev/CONTRIBUTIONS.docx](#) and save it as [doc/↔CONTRIBUTIONS.pdf](#).

## 1.3 DOXYGEN

Install doxygen and dependancies:

```
sudo apt update
sudo apt install -y doxygen texlive-full texlive-latex-base texlive-latex-extra
```

Create the configuration file (convention is a Doxyfile):

```
doxygen -g Doxyfile
```

Edit the file to your liking, reference the [doxygen manual](#) if needed, then run doxygen:

```
doxygen
```

When releasing a new version of MacaroniOS, remember to change the `PROJECT_NUMER` (to R1, R2, etc) and `OUTPUT_DIRECTORY` (from `dev/doxygen` to `doc`). Also remember to change `user/version.c`.

Then `cd` into the generated latex directory and run:

```
make pdf
```

In the same directory, a `refman.pdf` is generated. Save this file as [doc/PROGRAMMER-GUIDE.pdf](#).



## Chapter 2

# Data Structure Index

### 2.1 Data Structures

Here are the data structures with brief descriptions:

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<a href="#">rtc_time_t</a>	.....	<a href="#">7</a>



## Chapter 3

# File Index

### 3.1 File List

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

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include/ctype.h	A subset of standard C library functions . . . . .	10
include/exit.h	Header file for the exit command used in the command handler. Exits the terminal when called and confirmed by the user . . . . .	11
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include/memory.h	MPX-specific dynamic memory functions . . . . .	15
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## Chapter 4

# Data Structure Documentation

### 4.1 rtc\_date\_t Struct Reference

#### Data Fields

- uint8\_t **day**
- uint8\_t **month**
- uint8\_t **year**

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

- [include/clock.h](#)

### 4.2 rtc\_time\_t Struct Reference

#### Data Fields

- uint8\_t **second**
- uint8\_t **minute**
- uint8\_t **hour**

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

- [include/clock.h](#)



# Chapter 5

## File Documentation

### 5.1 include/clock.h File Reference

Header file for the clock functions. get/set TIME get/set DATE.

```
#include <string.h>
#include <sys_req.h>
#include <stdint.h>
#include <mpx/interrupts.h>
#include <mpx/io.h>
```

Include dependency graph for clock.h:

### 5.2 clock.h

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

```
00001 #ifndef CLOCK_H
00002 #define CLOCK_H
00003
00004 #include <string.h>
00005 #include <sys_req.h>
00006 #include <stdint.h>
00007 #include <mpx/interrupts.h>
00008 #include <mpx/io.h>
00009
00017 // Time structure
00018 typedef struct {
00019     uint8_t second;
00020     uint8_t minute;
00021     uint8_t hour;
00022 } rtc_time_t;
00023
00024 // Date structure
00025 typedef struct {
00026     uint8_t day;
00027     uint8_t month;
00028     uint8_t year;    // Last two digits of the year
00029 } rtc_date_t;
00030
00031 void get_time(rtc_time_t *time);
00032 void set_time(const rtc_time_t *time);
00033
00034 void get_date(rtc_date_t *date);
00035 void set_date(const rtc_date_t *date);
00036
00037 void print_clock(const rtc_time_t *time, const rtc_date_t *date);
00038
00039 void clock_command(void);
00040
00041 #endif
```

## 5.3 include/comhand.h File Reference

Command handler interface for the OS. Reads from the polling input and executes commands.

### Functions

- void **com\_startup** (void)  
*Prints a welcome message and penguin ASCII art to the terminal.*
- void **trim\_Input** (char \*str)  
*Trim function to remove \n and \r from the string.*
- void **comhand** (void)  
*Enters a loop and waits for the user to input commands.*

### 5.3.1 Detailed Description

Command handler interface for the OS. Reads from the polling input and executes commands.

### 5.3.2 Function Documentation

#### 5.3.2.1 trim\_Input()

```
void trim_Input (
    char * str )
```

Trim function to remove \n and \r from the string.

#### Parameters

<i>str</i>	string variable to trim
------------	-------------------------

## 5.4 comhand.h

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

```
00001 #ifndef COMHAND_H
00002 #define COMHAND_H
00003
00013 void com_startup(void);
00014
00019 void trim_Input(char *str);
00020
00024 void comhand(void);
00025
00026 #endif
```

## 5.5 include/ctype.h File Reference

A subset of standard C library functions.



## Functions

- int [isspace](#) (int c)

### 5.5.1 Detailed Description

A subset of standard C library functions.

### 5.5.2 Function Documentation

#### 5.5.2.1 isspace()

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

Determine if a character is whitespace.

#### Parameters

c	Character to check
---	--------------------

#### Returns

Non-zero if space, 0 if not space

## 5.6 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  
00016 #endif
```

## 5.7 include/exit.h File Reference

Header file for the exit command used in the command handler. Exits the terminal when called and confirmed by the user.

## Functions

- void [exit\\_help](#) (void)
- int [exit\\_command](#) (const char \*args)

*Begins the shutdown process when the user types 'exit' in the terminal. Confirmation by typing 'Y' or 'n' is then required to completely exit.*

### 5.7.1 Detailed Description

Header file for the exit command used in the command handler. Exits the terminal when called and confirmed by the user.

Author

Caleb Edwards

### 5.7.2 Function Documentation

#### 5.7.2.1 `exit_command()`

```
int exit_command (
    const char * args )
```

Begins the shutdown process when the user types 'exit' in the terminal. Confirmation by typing 'Y' or 'n' is then required to completely exit.

Parameters

<i>arg_counter</i>	Counts the number of arguments input.
<i>arg_vector</i>	Stores the arguments.

Returns

int return 1 to confirm exit and 0 to return to terminal.

## 5.8 `exit.h`

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

```
00001 #ifndef EXIT_H
00002 #define EXIT_H
00010 void exit_help(void);
00011
00020 int exit_command(const char *args);
00021
00022 #endif
```

## 5.9 `include/help.h` File Reference

Header for the help command used in command handler. Used to list the commands available to the user.

Functions

- void **help\_message** (void)
- void **help\_command** (const char \*args)

*Prints all commands available into the terminal when the user types 'help' in the input.*

## 5.9.1 Detailed Description

Header for the help command used in command handler. Used to list the commands available to the user.

### Author

Caleb Edwards

## 5.10 help.h

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

```
00001 #ifndef HELP_H
00002 #define HELP_H
00010 void help_message(void);
00011
00016 void help_command(const char *args);
00017
00018 #endif
```

## 5.11 include/itoa.h File Reference

Declaration for interger-to-ASCII conversion.

### Functions

- void [itoa](#) (int num, char \*buffer)  
*Converts an integer to a C-string.*

### 5.11.1 Detailed Description

Declaration for interger-to-ASCII conversion.

### 5.11.2 Function Documentation

#### 5.11.2.1 itoa()

```
void itoa (
    int num,
    char * buffer )
```

Converts an integer to a C-string.

#### Parameters

<i>num</i>	The integer to convert.
<i>buffer</i>	Pointer to an array to store the string.

## 5.12 itoa.h

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

```
00001 #ifndef ITOA_H
00002 #define ITOA_H
00003
00015 void itoa(int num, char* buffer);
00016
00017 #endif
```

## 5.13 include/itoBCD.h File Reference

Function that converts an integer into a string that is representative of the binary coded decimal format of the input integer.

### Functions

- void [itoBCD](#) (int num, char \*buffer)

### 5.13.1 Detailed Description

Function that converts an integer into a string that is representative of the binary coded decimal format of the input integer.

### 5.13.2 Function Documentation

#### 5.13.2.1 itoBCD()

```
void itoBCD (
    int num,
    char * buffer )
```

Convert an integer to an Binary Coded Decimal

#### Parameters

<i>int</i>	Integer being converted into a Binary Coded Decimal
<i>s</i>	A buffer to hold the created string

## 5.14 itoBCD.h

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

```
00001 #ifndef ITOBCD_H
00002 #define ITOBCD_H
00003
00017 void itoBCD(int num, char* buffer);
00018
00019 #endif
```

## 5.15 include/memory.h File Reference

MPX-specific dynamic memory functions.

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

Include dependency graph for memory.h:

### Functions

- void \* [sys\\_alloc\\_mem](#) (size\_t size)
- int [sys\\_free\\_mem](#) (void \*ptr)
- void [sys\\_set\\_heap\\_functions](#) (void \*(\*alloc\_fn)(size\_t), int(\*free\_fn)(void \*))

### 5.15.1 Detailed Description

MPX-specific dynamic memory functions.

### 5.15.2 Function Documentation

#### 5.15.2.1 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

#### 5.15.2.2 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

**5.15.2.3 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

**5.16 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
```

**5.17 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
```

**5.18 include/mpx/gdt.h File Reference**

Kernel functions to initialize the Global Descriptor Table.

**Functions**

- void [gdt\\_init](#) (void)

### 5.18.1 Detailed Description

Kernel functions to initialize the Global Descriptor Table.

### 5.18.2 Function Documentation

#### 5.18.2.1 gdt\_init()

```
void gdt_init (
    void )
```

Creates and installs the Global Descriptor Table.

## 5.19 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
```

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

Kernel functions related to software and hardware interrupts.

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

### Macros

- `#define cli() __asm__ volatile ("cli")`
- `#define sti() __asm__ volatile ("sti")`

### Functions

- void `irq_init` (void)
- void `pic_init` (void)
- void `idt_init` (void)
- void `idt_install` (int vector, void(\*handler)(void \*))

### 5.20.1 Detailed Description

Kernel functions related to software and hardware interrupts.

## 5.20.2 Macro Definition Documentation

### 5.20.2.1 cli

```
#define cli( ) __asm__ volatile ("cli")
```

Disable interrupts

### 5.20.2.2 sti

```
#define sti( ) __asm__ volatile ("sti")
```

Enable interrupts

## 5.20.3 Function Documentation

### 5.20.3.1 idt\_init()

```
void idt_init (  
    void )
```

Creates and installs the Interrupt Descriptor Table.

### 5.20.3.2 idt\_install()

```
void idt_install (  
    int vector,  
    void(*) (void *) handler )
```

Installs an interrupt handler

### 5.20.3.3 irq\_init()

```
void irq_init (  
    void )
```

Installs the initial interrupt handlers for the first 32 IRQ lines. Most do a panic for now.

### 5.20.3.4 pic\_init()

```
void pic_init (  
    void )
```

Initializes the programmable interrupt controllers and performs the necessary remapping of IRQs. Leaves interrupts turned off.



## 5.21 interrupts.h

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

```
00001 #ifndef MPX_INTERRUPTS_H
00002 #define MPX_INTERRUPTS_H
00003
00010 #define cli() __asm__ volatile ("cli")
00011
00013 #define sti() __asm__ volatile ("sti")
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
```

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

Kernel macros to read and write I/O ports.

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

### Macros

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

### 5.22.1 Detailed Description

Kernel macros to read and write I/O ports.

### 5.22.2 Macro Definition Documentation

#### 5.22.2.1 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

**5.22.2.2 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

**5.23 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 #pragma clang diagnostic ignored "-Wgnu-statement-expression"
00023 #define inb(port) ({ \
00024     unsigned char r; \
00025     __asm__ volatile ("inb %%dx, %%al" : "=a" (r) : "d" (port)); \
00026     r; \
00027 })
00028
00029 #endif
```

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

Common system functions and definitions.

```
#include <stdnoreturn.h>
Include dependency graph for panic.h:
```

**Functions**

- `noreturn __attribute__((no_caller_saved_registers)) void kpanic(const char *msg)`

**5.24.1 Detailed Description**

Common system functions and definitions.

## 5.24.2 Function Documentation

### 5.24.2.1 \_\_attribute\_\_((no\_caller\_saved\_registers))

```
noreturn __attribute__((no_caller_saved_registers)) void kpanic(const char *msg);
```

Kernel panic. Prints an error message and halts.

#### Parameters

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

## 5.25 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
```

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

Kernel functions and constants for handling serial I/O.

```
#include <stddef.h>
#include <mpx/device.h>
Include dependency graph for serial.h:
```

### Functions

- int [serial\\_init](#) (device dev)
- int [serial\\_out](#) (device dev, const char \*buffer, size\_t len)
- int [serial\\_poll](#) (device dev, char \*buffer, size\_t len)

### 5.26.1 Detailed Description

Kernel functions and constants for handling serial I/O.

## 5.26.2 Function Documentation

### 5.26.2.1 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

**5.26.2.2 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

**5.26.2.3 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

## 5.27 serial.h

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

```

00001 #ifndef MPX_SERIAL_H
00002 #define MPX_SERIAL_H
00003
00004 #include <stddef.h>
00005 #include <mpx/device.h>
00006
00017 int serial_init(device dev);
00018
00026 int serial_out(device dev, const char *buffer, size_t len);
00027
00035 int serial_poll(device dev, char *buffer, size_t len);
00036
00037 #endif

```

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

Kernel functions for virtual memory and primitive allocation.

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

Include dependency graph for vm.h:

## Functions

- void \* [kmalloc](#) (size\_t size, int align, void \*\*phys\_addr)
- void [vm\\_init](#) (void)

### 5.28.1 Detailed Description

Kernel functions for virtual memory and primitive allocation.

### 5.28.2 Function Documentation

#### 5.28.2.1 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

**5.28.2.2 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.

**5.29 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 *kmallocc(size_t size, int align, void **phys_addr);
00020
00026 void vm_init(void);
00027
00028 #endif
```

**5.30 include/processes.h File Reference**

Provided system process and user processes for testing.

**Functions**

- void [proc1](#) (void)
- void [proc2](#) (void)
- void [proc3](#) (void)
- void [proc4](#) (void)
- void [proc5](#) (void)
- void [sys\\_idle\\_process](#) (void)

**5.30.1 Detailed Description**

Provided system process and user processes for testing.

**5.30.2 Function Documentation****5.30.2.1 proc1()**

```
void proc1 (
    void )
```

A test process that prints a message then yields, exiting after 1 iteration.

**5.30.2.2 proc2()**

```
void proc2 (
    void )
```

A test process that prints a message then yields, exiting after 2 iterations.

**5.30.2.3 proc3()**

```
void proc3 (
    void )
```

A test process that prints a message then yields, exiting after 3 iterations.

**5.30.2.4 proc4()**

```
void proc4 (
    void )
```

A test process that prints a message then yields, exiting after 4 iterations.

**5.30.2.5 proc5()**

```
void proc5 (
    void )
```

A test process that prints a message then yields, exiting after 5 iterations.

**5.30.2.6 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.

**5.31 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 #endif
```

## 5.32 include/stdlib.h File Reference

A subset of standard C library functions.

### Functions

- int [atoi](#) (const char \*s)

### 5.32.1 Detailed Description

A subset of standard C library functions.

### 5.32.2 Function Documentation

#### 5.32.2.1 atoi()

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

Convert an ASCII string to an integer

#### Parameters

s	A NUL-terminated string
---	-------------------------

#### Returns

The value of the string converted to an integer

## 5.33 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
00016 #endif
```

## 5.34 include/string.h File Reference

A subset of standard C library functions.

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

Include dependency graph for string.h: This graph shows which files directly or indirectly include this file:



## Functions

- void \* [memcpy](#) (void \*restrict dst, const void \*restrict src, size\_t n)
- void \* [memset](#) (void \*address, int c, size\_t n)
- int [strcmp](#) (const char \*s1, const char \*s2)
- int [strncmp](#) (const char \*s1, const char \*s2, unsigned int n)
- size\_t [strlen](#) (const char \*s)
- char \* [strtok](#) (char \*restrict s1, const char \*restrict s2)

### 5.34.1 Detailed Description

A subset of standard C library functions.

### 5.34.2 Function Documentation

#### 5.34.2.1 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

#### 5.34.2.2 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

**5.34.2.3 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

**5.34.2.4 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)

**5.34.2.5 strtok()**

```
char * strtok (
    char *restrict s1,
    const char *restrict s2 )
```

Split string into tokens TODO

## 5.35 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
00018 void* memcpy(void * restrict dst, const void * restrict src, size_t n);
00019
00027 void* memset(void *address, int c, size_t n);
00028
00035 int strcmp(const char *s1, const char *s2);
00036
00037 int strncmp(const char *s1, const char *s2, unsigned int n);
00038
00044 size_t strlen(const char *s);
00045
00050 char* strtok(char * restrict s1, const char * restrict s2);
00051
00052 #endif
```

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

System request function and constants.

#include <mpx/device.h>

Include dependency graph for sys\_req.h: This graph shows which files directly or indirectly include this file:

### 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,...)

### 5.36.1 Detailed Description

System request function and constants.

### 5.36.2 Function Documentation

#### 5.36.2.1 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

**5.37 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

```

**5.38 include/version.h File Reference**

Displays the current version of MacaroniOS.

**Macros**

- `#define GIT_DATE "unknown"`
- `#define GIT_HASH "unknown"`
- `#define GIT_DIRTY "unknown"`

**Functions**

- void **version\_help** (void)  
*Prints help information related to the version command.*
- void **version\_latest** (void)  
*Displays the latest version.*
- void **version\_history** (void)  
*Displays the past and present versions.*
- void **version\_command** (const char \*args)  
*Main handler for the version command.*

### 5.38.1 Detailed Description

Displays the current version of MacaroniOS.

### 5.38.2 Function Documentation

#### 5.38.2.1 version\_command()

```
void version_command (
    const char * args )
```

Main handler for the version command.

Parameters

<i>args</i>	The argument string passed after 'version'
-------------	--

## 5.39 version.h

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

```
00001 #ifndef VERSION_H
00002 #define VERSION_H
00003
00004 #ifndef GIT_DATE
00005 #define GIT_DATE "unknown"
00006 #endif
00007
00008 #ifndef GIT_HASH
00009 #define GIT_HASH "unknown"
00010 #endif
00011
00012 #ifndef GIT_DIRTY
00013 #define GIT_DIRTY "unknown"
00014 #endif
00015
00025 void version_help(void);
00026
00030 void version_latest(void);
00031
00035 void version_history(void);
00036
00041 void version_command(const char *args);
00042
00043 #endif
```



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