

PennOS Team24

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Signals:

We are handling three signals, SIGINT, SIGCONT and SIGTSTP in this assignment. When a SIGINT is received, if the shell is running, prompt again, otherwise it terminates the current running process. When a SIGCONT is received by a certain stopped process, resume the process. When a SIGTSTP is received, if the shell is running, prompt again, otherwise it stops the current running process.

Additional Logging Events:

- DQ_READY_SCHD: removed a process from the ready queue.
- EQ_READY_TOUT: added a process to the ready queue.

Shell Built-in Functions

Built-in user programs

```
cat file ...
sleep seconds
busy
echo string ...
ls
touch file ...
mv src dest
cp src dest
rm file ...
chmod mode file
ps
kill -signal_name pid
zombify
orphanify
```

Built-in job control functions

```
nice priority cmd
nice_pid priority pid
man
bg job_id
fg job_id
jobs
logout
```


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Chapter 1

PennOS (23sp-pennOS-group-24)

1.0.1 Authors

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1.0.2 Source Files

```
bin/                # Compiled binaries
|   | pennFAT
|   | pennOS
src/                # Source code
|   | kernel/
|   | PennFAT/
doc/                # Documentation files
|   [Companion Document]
log/                # PennOS logs
|   log.txt
README.md
```

1.0.3 Extra Credit Answers

- [If you completed any extra credit, include your answers here]

1.0.4 Compilation Instructions

- Compile by running (make sure you are in the root directory)
`make`
- Run the PennOS
`./bin/pennOS`
- Or the PennFAT
`./bin/pennFAT`

1.0.5 Overview of Work Accomplished

All requirements of regular credit have been accomplished. We did not implement any feature of extra credit.

1.0.6 Description of Code and Code Layout

[Provide a detailed description of the code, including any algorithms or data structures used. Explain the layout of the code, including the purpose of each file and how they interact with each other.]

1.0.7 General Comments

[Include any general comments or observations about your code, including any challenges that you faced while working on the project. This can help us better understand your thought process and approach to the project.]

Chapter 2

Class Index

2.1 Class List

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

DirectoryEntry	The structure of the directory entry as stored in the filesystem is as follows:	7
FATConfig	The LSB(rightmost under little endian) of the first entry of the FAT specifies the block size with the mapping as below: {LSB : size in bytes} = {0:256; 1:512; 2:1024; 3:2048; 4:4096} The MSB(leftmost under little endian) of the first entry of the FAT specifies the number of blocks that FAT region occupies. The MSB should be ranged from 1-32 (numbers outside of this range will be considered an error). FAT region size = block size * FAT region block number FAT entry number = FAT region size / FAT entry size (2-byte in FAT16) Data region size = block size * (FAT entry number - 1)	8
FdNode	There are three open mode supported by PennFAT: F_WRITE, F_READ and F_APPEND. According to ed #953, each file can only be read/write exclusively which means only one instance can open() a file at a time. Under F_APPEND mode, the fileOffset will be set to the end of the file initially and it can only be increased. Under F_WRITE/F_APPEND mode, if the fileOffset is set to the position beyond the file size, the file system will occupy the space for the gap. As a result, the size of the file will increase, however, the gap space may contain uninitialized contents. Under F_READ mode, if the fileOffset is set to the position beyond the file size, f_read() will read nothing	8
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Chapter 3

File Index

3.1 File List

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

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Chapter 4

Class Documentation

4.1 DirectoryEntry Struct Reference

The structure of the directory entry as stored in the filesystem is as follows:

```
#include <FAT.h>
```

Public Attributes

- char **name** [MAX_FILE_NAME_LENGTH]
- uint32_t **size**
- uint16_t **firstBlock**
- uint8_t **type**
- uint8_t **perm**
- time_t **mtime**
- char **reserved** [RESERVED_BYTES]

4.1.1 Detailed Description

The structure of the directory entry as stored in the filesystem is as follows:

- char name[32]: null-terminated file name name[0] also serves as a special marker: – 0: end of directory – 1: deleted entry; the file is also deleted – 2: deleted entry; the file is still being used
- uint32_t size: number of bytes in file
- uint16_t firstBlock: the first block number of the file (undefined if size is zero) The block index of data region starts from 1. If the firstBlock is 0, it means that this is an empty file which has not occupied any data region block.
- uint8_t type: the type of the file, which will be one of the following: – 0: unknown – 1: a regular file – 2: a directory file – 4: a symbolic link
- uint8_t perm: file permissions, which will be one of the following: – 0: none – 2: write only – 4: read only – 5: read and executable (shell scripts) – 6: read and write – 7: read, write, and executable
- time_t mtime: creation/modification time as returned by time(2) in Linux

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

- src/PennFAT/[FAT.h](#)

4.2 FATConfig Struct Reference

The LSB(rightmost under little endian) of the first entry of the FAT specifies the block size with the mapping as below: {LSB : size in bytes} = {0:256; 1:512; 2:1024; 3:2048; 4:4096} The MSB(leftmost under little endian) of the first entry of the FAT specifies the number of blocks that FAT region occupies. The MSB should be ranged from 1-32 (numbers outside of this range will be considered an error). FAT region size = block size * FAT region block number
 FAT entry number = FAT region size / FAT entry size (2-byte in FAT16) Data region size = block size * (FAT entry number - 1)

```
#include <FAT.h>
```

Public Attributes

- char **name** [MAX_FILE_NAME_LENGTH]
- uint16_t **LSB**
- uint16_t **MSB**
- int **blockSize**
- int **FATRegionBlockNum**
- int **FATRegionSize**
- int **FATEntryNum**
- int **dataRegionSize**
- int **FATSizeInMemory**

4.2.1 Detailed Description

The LSB(rightmost under little endian) of the first entry of the FAT specifies the block size with the mapping as below: {LSB : size in bytes} = {0:256; 1:512; 2:1024; 3:2048; 4:4096} The MSB(leftmost under little endian) of the first entry of the FAT specifies the number of blocks that FAT region occupies. The MSB should be ranged from 1-32 (numbers outside of this range will be considered an error). FAT region size = block size * FAT region block number
 FAT entry number = FAT region size / FAT entry size (2-byte in FAT16) Data region size = block size * (FAT entry number - 1)

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

- src/PennFAT/[FAT.h](#)

4.3 FdNode Struct Reference

There are three open mode supported by PennFAT: F_WRITE, F_READ and F_APPEND. According to ed #953, each file can only be read/write exclusively which means only one instance can open() a file at a time. Under F_APPEND mode, the fileOffset will be set to the end of the file initially and it can only be increased. Under F_READ/F_WRITE/F_APPEND mode, if the fileOffset is set to the position beyond the file size, the file system will occupy the space for the gap. As a result, the size of the file will increase, however, the gap space may contain uninitialized contents. Under F_READ mode, if the fileOffset is set to the position beyond the file size, [f_read\(\)](#) will read nothing.

```
#include <fd-table.h>
```

Public Attributes

- int **openMode**
- int **directoryEntryOffset**
- int **fileOffset**
- struct [FdNode](#) * **prev**
- struct [FdNode](#) * **next**

4.3.1 Detailed Description

There are three open mode supported by PennFAT: F_WRITE, F_READ and F_APPEND. According to ed #953, each file can only be read/write exclusively which means only one instance can open() a file at a time. Under F_APPEND mode, the fileOffset will be set to the end of the file initially and it can only be increased. Under F_WRITE/F_APPEND mode, if the fileOffset is set to the position beyond the file size, the file system will occupy the space for the gap. As a result, the size of the file will increase, however, the gap space may contain uninitialized contents. Under F_READ mode, if the fileOffset is set to the position beyond the file size, [f_read\(\)](#) will read nothing.

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

- [src/PennFAT/fd-table.h](#)

4.4 FdTable Struct Reference

The file descriptor table is a linked list of [FdNode](#).

```
#include <fd-table.h>
```

Public Attributes

- [FdNode](#) * **head**
- [FdNode](#) * **tail**

4.4.1 Detailed Description

The file descriptor table is a linked list of [FdNode](#).

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

- [src/PennFAT/fd-table.h](#)

4.5 Job Struct Reference

Public Attributes

- struct [parsed_command](#) * **cmd**
- pid_t **pid**
- JobState **state**

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

- [src/kernel/utils.h](#)

4.6 JobList Struct Reference

Public Attributes

- [JobListNode](#) * **head**
- [JobListNode](#) * **tail**
- int **jobCount**

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

- src/kernel/utils.h

4.7 JobListNode Struct Reference

Public Attributes

- [Job](#) * **job**
- struct [JobListNode](#) * **prev**
- struct [JobListNode](#) * **next**
- int **jobId**

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

- src/kernel/utils.h

4.8 parsed_command Struct Reference

```
#include <parser.h>
```

Public Attributes

- bool **is_background**
- bool **is_file_append**
- const char * **stdin_file**
- const char * **stdout_file**
- size_t **num_commands**
- char ** **commands** []

4.8.1 Detailed Description

struct [parsed_command](#) stored all necessary information needed for penn-shell.

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

- src/kernel/parser.h

4.9 pcb Struct Reference

attributes of PCB

```
#include <utils.h>
```

Public Attributes

- `ucontext_t` **ucontext**
- `pid_t` **pid**
- `pid_t` **ppid**
parent pid
- `enum process_state` **prev_state**
- `enum process_state` **state**
state of the process
- `int` **priority**
priority of the process
- `FdNode * fds` [MAX_FILE_DESCRIPTOR]
keep track of open FDs
- `int` **ticks_left**
ticks left for sleep to be blocked
- `struct pcb_queue * children`
processes that have not completed yet
- `struct pcb_queue * zombies`
processes that are completed but the parent has not waited for it yet
- `char *` **pname**
name of the function
- `bool` **toWait**
true indicates the parent need to wait for this child

4.9.1 Detailed Description

attributes of PCB

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

- `src/kernel/utils.h`

4.10 pcb_node Struct Reference

node in the `pcb_queue`

```
#include <utils.h>
```

Public Attributes

- `pcb *` **pcb**
- `struct pcb_node *` **next**

4.10.1 Detailed Description

node in the [pcb_queue](#)

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

- [src/kernel/utils.h](#)

4.11 [pcb_queue](#) Struct Reference

A link list of pcb nodes.

```
#include <utils.h>
```

Public Attributes

- [pcb_node](#) * **head**
- [pcb_node](#) * **tail**

4.11.1 Detailed Description

A link list of pcb nodes.

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

- [src/kernel/utils.h](#)

4.12 [priority_queue](#) Struct Reference

the ready queue including three pcb queues of different priorities

```
#include <utils.h>
```

Public Attributes

- [pcb_queue](#) * **high**
priority -1
- [pcb_queue](#) * **mid**
priority 0
- [pcb_queue](#) * **low**
priority 1

4.12.1 Detailed Description

the ready queue including three pcb queues of different priorities

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

- [src/kernel/utils.h](#)

Chapter 5

File Documentation

5.1 src/kernel/behavior.c File Reference

```
#include "behavior.h"
```

Functions

- void `writePrompt` ()
Write the prompt to the screen.
- void `readUserInput` (char **line)
Read the user input.
- `LineType` `parseUserInput` (char *line)
Parse the user input.
- `LineType` `readAndParseUserInput` (char **line)
Read and parse the user input.
- int `parseLine` (char *line, struct `parsed_command` **cmd)
Parse the command line.
- `ProgramType` `parseProgramType` (struct `parsed_command` *cmd)
Execute the command line.
- int `executeLine` (struct `parsed_command` *cmd, int priority)
Execute the command line.
- pid_t `executeProgram` (`ProgramType` programType, char **argv, int fd_in, int fd_out)
Execute the user program.
- void `executeScript` (char *argv[])
Execute the user script.

5.1.1 Detailed Description

Author

Shuo Sun (sunshuo@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.1.2 Function Documentation

5.1.2.1 executeLine()

```
int executeLine (
    struct parsed_command * cmd,
    int priority )
```

Execute the command line.

Parameters

<i>cmd</i>	
<i>priority</i>	

Returns

int

5.1.2.2 executeProgram()

```
pid_t executeProgram (
    ProgramType programType,
    char ** argv,
    int fd_in,
    int fd_out )
```

Execute the user program.

Parameters

<i>programType</i>	
<i>argv</i>	
<i>fd_in</i>	
<i>fd_out</i>	

Returns

pid_t

5.1.2.3 executeScript()

```
void executeScript (
    char * argv[] )
```

Execute the user script.

Parameters

<i>argv</i>	
-------------	--

5.1.2.4 parseLine()

```
int parseLine (
    char * line,
    struct parsed_command ** cmd )
```

Parse the command line.

Parameters

<i>line</i>	
<i>cmd</i>	

Returns

int

5.1.2.5 parseProgramType()

```
ProgramType parseProgramType (
    struct parsed_command * cmd )
```

Execute the command line.

Parameters

<i>cmd</i>	
------------	--

Returns

ProgramType

5.1.2.6 parseUserInput()

```
LineType parseUserInput (
    char * line )
```

Parse the user input.

Parameters

<i>line</i>	
-------------	--

Returns

LineType

5.1.2.7 readAndParseUserInput()

```
LineType readAndParseUserInput (
    char ** line )
```

Read and parse the user input.

Parameters

<i>line</i>	
-------------	--

Returns

LineType

5.1.2.8 readUserInput()

```
void readUserInput (
    char ** line )
```

Read the user input.

Parameters

<i>line</i>	
-------------	--

5.1.2.9 writePrompt()

```
void writePrompt ( )
```

Write the prompt to the screen.

5.2 src/kernel/behavior.h File Reference

```
#include "job.h"
#include "../PennFAT/interface.h"
#include "programs.h"
```

Macros

- #define **S_MAX_BUFFER_SIZE** 4096
- #define **PROMPT** "pennOS> "

Enumerations

- enum [LineType](#) { **S_EXIT_SHELL**, **S_EMPTY_LINE**, **S_EXECUTE_COMMAND** }
The type of the command line.
- enum [ProgramType](#) {
 CAT, **SLEEP**, **BUSY**, **ECHO**,
 LS, **TOUCH**, **MV**, **CP**,
 RM, **CHMOD**, **PS**, **ZOMBIFY**,
 ORPHANIFY, **HANG**, **NOHANG**, **RECUR**,
 TEST, **UNKNOWN** }
The type of the user program.

Functions

- void [writePrompt](#) ()
Write the prompt to the screen.
- void [readUserInput](#) (char **line)
Read the user input.
- [LineType](#) [parseUserInput](#) (char *line)
Parse the user input.
- [LineType](#) [readAndParseUserInput](#) (char **line)
Read and parse the user input.
- int [parseLine](#) (char *line, struct [parsed_command](#) **cmd)

- Parse the command line.*
 - `ProgramType` `parseProgramType` (struct `parsed_command` *cmd)
- Execute the command line.*
 - int `executeLine` (struct `parsed_command` *cmd, int priority)
- Execute the command line.*
 - pid_t `executeProgram` (`ProgramType` programType, char **argv, int fd_in, int fd_out)
- Execute the user program.*
 - void `executeScript` (char *argv[])
- Execute the user script.*

Variables

- `JobList` `_jobList`

5.2.1 Detailed Description

Author

Shuo Sun (sunshuo@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.2.2 Enumeration Type Documentation

5.2.2.1 LineType

enum `LineType`

The type of the command line.

5.2.2.2 ProgramType

enum `ProgramType`

The type of the user program.

5.2.3 Function Documentation

5.2.3.1 executeLine()

```
int executeLine (
    struct parsed_command * cmd,
    int priority )
```

Execute the command line.

Parameters

<i>cmd</i>	
<i>priority</i>	

Returns

int

5.2.3.2 executeProgram()

```
pid_t executeProgram (
    ProgramType programType,
    char ** argv,
    int fd_in,
    int fd_out )
```

Execute the user program.

Parameters

<i>programType</i>	
<i>argv</i>	
<i>fd_in</i>	
<i>fd_out</i>	

Returns

pid_t

5.2.3.3 executeScript()

```
void executeScript (
    char * argv[] )
```


Execute the user script.

Parameters

<i>argv</i>	
-------------	--

5.2.3.4 parseLine()

```
int parseLine (
    char * line,
    struct parsed_command ** cmd )
```

Parse the command line.

Parameters

<i>line</i>	
<i>cmd</i>	

Returns

int

5.2.3.5 parseProgramType()

```
ProgramType parseProgramType (
    struct parsed_command * cmd )
```

Execute the command line.

Parameters

<i>cmd</i>	
------------	--

Returns

ProgramType

5.2.3.6 parseUserInput()

```
LineType parseUserInput (
    char * line )
```

Parse the user input.

Parameters

<i>line</i>	
-------------	--

Returns

LineType

5.2.3.7 readAndParseUserInput()

```
LineType readAndParseUserInput (
    char ** line )
```

Read and parse the user input.

Parameters

<i>line</i>	
-------------	--

Returns

LineType

5.2.3.8 readUserInput()

```
void readUserInput (
    char ** line )
```

Read the user input.

Parameters

<i>line</i>	
-------------	--

5.2.3.9 writePrompt()

```
void writePrompt ( )
```

Write the prompt to the screen.

5.3 behavior.h

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

```

00001
00011 #ifndef BEHAVIOR_H
00012 #define BEHAVIOR_H
00013
00014 #define S_MAX_BUFFER_SIZE 4096
00015 #define PROMPT "pennOS> "
00016
00017 #include "job.h"
00018 #include "../PennFAT/interface.h"
00019 #include "programs.h"
00024 typedef enum {
00025     S_EXIT_SHELL,
00026     S_EMPTY_LINE,
00027     S_EXECUTE_COMMAND
00028 } LineType;
00033 typedef enum {
00034     CAT,
00035     SLEEP,
00036     BUSY,
00037     ECHO,
00038     LS,
00039     TOUCH,
00040     MV,
00041     CP,
00042     RM,
00043     CHMOD,
00044     PS,
00045     ZOMBIFY,
00046     ORPHANIFY,
00047     HANG,
00048     NOHANG,
00049     RECUR,
00050     TEST,
00051     UNKNOWN
00052 } ProgramType;
00053
00054 extern JobList _jobList; // store all background job
00055
00056 /* Utility function for writing PROMPT */
00061 void writePrompt();
00062
00063 /* Read and parse utilities */
00069 void readUserInput(char **line);
00076 LineType parseUserInput(char *line);
00083 LineType readAndParseUserInput(char **line);
00091 int parseLine(char *line, struct parsed_command **cmd);
00092
00093
00094 /* Execute a user program */
00101 ProgramType parseProgramType(struct parsed_command *cmd);
00109 int executeLine(struct parsed_command *cmd, int priority);
00119 pid_t executeProgram(ProgramType programType, char **argv, int fd_in, int fd_out);
00125 void executeScript(char *argv[]);
00126
00127
00128
00129 #endif

```

5.4 global.h

```

00001 #ifndef GLOBAL_H
00002 #define GLOBAL_H
00003
00004 #include "utils.h"
00005
00006 #define HIGH -1
00007 #define MID 0
00008 #define LOW 1
00009
00010 #define SUCCESS 0
00011 #define FAILURE -1
00012
00013 // according to https://chromium.googlesource.com/chromiumos/docs/+master/constants/signals.md
00014 #define S_SIGSTOP 19
00015 #define S_SIGCONT 18
00016 #define S_SIGTERM 15
00017
00018 #endif

```

5.5 global2.h

```

00001 #ifndef GLOBAL2_H
00002 #define GLOBAL2_H
00003
00007 typedef enum process_state {
00008     RUNNING,
00009     READY,
00010     BLOCKED,
00011     STOPPED,
00012     ZOMBIED,
00013     ORPHANED,
00014     TERMINATED,    // terminated by signal
00015     EXITED,        // terminated normally
00016 } process_state;
00017
00018 #endif

```

5.6 src/kernel/job.c File Reference

```
#include "job.h"
```

Functions

- void [printCommandLine](#) (struct [parsed_command](#) *cmd)
The state of the job.
- void [writeJobStatePrompt](#) (JobState state)
Write the job state and prompt to the screen.
- void [writeJobState](#) (Job *job)
Write the job state to the screen.
- void [writeNewline](#) ()
Write the a new line to the screen.
- void [printJobList](#) (JobList *jobList)
Print the job list.
- CommandType [parseBuiltinCommandType](#) (struct [parsed_command](#) *cmd)
Parse the built-in command type.
- void [killBuidinCommand](#) (struct [parsed_command](#) *cmd)
Built-in command: kill.
- CommandType [executeBuiltinCommand](#) (struct [parsed_command](#) *cmd)
Execute the built-in command.
- void [jobsBuidinCommand](#) ()
Built-in command: jobs.
- void [bgBuidinCommand](#) (struct [parsed_command](#) *cmd)
Built-in command: bg.
- void [fgBuidinCommand](#) (struct [parsed_command](#) *cmd)
Built-in command: fg.
- void [nicePidBuidinCommand](#) (struct [parsed_command](#) *cmd)
Built-in command: nice.
- void [manBuidinCommand](#) ()
Built-in command: man.
- Job * [createJob](#) (struct [parsed_command](#) *cmd, pid_t pid, JobState state)
Create a Job object.
- void [initJobList](#) (JobList *jobList)
Initialize the job list.

- void `appendJobList` (`JobList` *jobList, `Job` *job)
Append a job to the job list.
- `Job` * `findJobList` (`JobList` *jobList, pid_t pid)
Find a job in the job list.
- `Job` * `updateJobList` (`JobList` *jobList, pid_t pid, `JobState` state)
Update the state of a job in the job list.
- int `removeJobList` (`JobList` *jobList, pid_t pid)
Remove a job from the job list.
- `Job` * `findJobListByJobId` (`JobList` *jobList, int jobId)
Find a job in the job list by job id.
- `Job` * `updateJobListByJobId` (`JobList` *jobList, int jobId, `JobState` state)
Update the state of a job in the job list by job id.
- int `removeJobListByJobId` (`JobList` *jobList, int jobId)
Remove a job from the job list by job id.
- int `removeJobListWithoutFreeCmd` (`JobList` *jobList, pid_t pid)
Remove a job from the job list without free the cmd.
- `Job` * `popJobList` (`JobList` *jobList, pid_t pid)
Pop a job from the job list.
- void `clearJobList` (`JobList` *jobList)
Clear the job list.
- void `pollBackgroundProcesses` ()
Poll the background processes.
- `Job` * `findTheCurrentJob` (`JobList` *jobList)
Find the current job.

5.6.1 Detailed Description

Author

Shuo Sun (sunshuo@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.6.2 Function Documentation

5.6.2.1 `appendJobList()`

```
void appendJobList (
    JobList * jobList,
    Job * job )
```

Append a job to the job list.

Parameters

<i>jobList</i>	
<i>job</i>	

5.6.2.2 bgBuildinCommand()

```
void bgBuildinCommand (
    struct parsed_command * cmd )
```

Built-in command: bg.

Parameters

<i>cmd</i>	
------------	--

5.6.2.3 clearJobList()

```
void clearJobList (
    JobList * jobList )
```

Clear the job list.

Parameters

<i>jobList</i>	
----------------	--

5.6.2.4 createJob()

```
Job * createJob (
    struct parsed_command * cmd,
    pid_t pid,
    JobState state )
```

Create a *Job* object.

Parameters

<i>cmd</i>	
<i>pid</i>	
<i>state</i>	

Returns

Job*

5.6.2.5 executeBuiltinCommand()

```
CommandType executeBuiltinCommand (
    struct parsed_command * cmd )
```

Execute the built-in command.

Parameters

<i>cmd</i>	
------------	--

Returns

CommandType

5.6.2.6 fgBuildinCommand()

```
void fgBuildinCommand (
    struct parsed_command * cmd )
```

Built-in command: fg.

Parameters

<i>cmd</i>	
------------	--

5.6.2.7 findJobList()

```
Job * findJobList (
    JobList * jobList,
    pid_t pid )
```

Find a job in the job list.

Parameters

<i>jobList</i>	
<i>pid</i>	

Returns

Job*

5.6.2.8 findJobListByJobId()

```
Job * findJobListByJobId (
    JobList * jobList,
    int jobId )
```

Find a job in the job list by job id.

Parameters

<i>jobList</i>	
<i>jobId</i>	

Returns

Job*

5.6.2.9 findTheCurrentJob()

```
Job * findTheCurrentJob (
    JobList * jobList )
```

Find the current job.

Parameters

<i>jobList</i>	
----------------	--

Returns

Job*

5.6.2.10 initJobList()

```
void initJobList (
    JobList * jobList )
```

Initialize the job list.

Parameters

<i>jobList</i>	
----------------	--

5.6.2.11 jobsBuildinCommand()

```
void jobsBuildinCommand ( )
```

Built-in command: jobs.

5.6.2.12 killBuildinCommand()

```
void killBuildinCommand (
    struct parsed\_command * cmd )
```

Built-in command: kill.

Parameters

<i>cmd</i>	
------------	--

5.6.2.13 manBuildinCommand()

```
void manBuildinCommand ( )
```

Built-in command: man.

5.6.2.14 nicePidBuildinCommand()

```
void nicePidBuildinCommand (
    struct parsed\_command * cmd )
```

Built-in command: nice.

Parameters

<i>cmd</i>	
------------	--

5.6.2.15 parseBuiltinCommandType()

```
CommandType parseBuiltinCommandType (
    struct parsed_command * cmd )
```

Parse the built-in command type.

Parameters

<i>cmd</i>	
------------	--

Returns

CommandType

5.6.2.16 pollBackgroundProcesses()

```
void pollBackgroundProcesses ( )
```

Poll the background processes.

5.6.2.17 popJobList()

```
Job * popJobList (
    JobList * jobList,
    pid_t pid )
```

Pop a job from the job list.

Parameters

<i>jobList</i>	
<i>pid</i>	

Returns

Job*

5.6.2.18 printCommandLine()

```
void printCommandLine (
    struct parsed_command * cmd )
```

The state of the job.

Parameters

<i>cmd</i>	
------------	--

5.6.2.19 printJobList()

```
void printJobList (
    JobList * jobList )
```

Print the job list.

Parameters

<i>jobList</i>	
----------------	--

5.6.2.20 removeJobList()

```
int removeJobList (
    JobList * jobList,
    pid_t pid )
```

Remove a job from the job list.

Parameters

<i>jobList</i>	
<i>pid</i>	

Returns

int

5.6.2.21 removeJobListByJobId()

```
int removeJobListByJobId (
    JobList * jobList,
    int jobId )
```

Remove a job from the job list by job id.

Parameters

<i>jobList</i>	
<i>jobId</i>	

Returns

int

5.6.2.22 removeJobListWithoutFreeCmd()

```
int removeJobListWithoutFreeCmd (  
    JobList * jobList,  
    pid_t pid )
```

Remove a job from the job list without free the cmd.

Parameters

<i>jobList</i>	
<i>pid</i>	

Returns

int

5.6.2.23 updateJobList()

```
Job * updateJobList (  
    JobList * jobList,  
    pid_t pid,  
    JobState state )
```

Update the state of a job in the job list.

Parameters

<i>jobList</i>	
<i>pid</i>	
<i>state</i>	

Returns

Job*

5.6.2.24 updateJobListByJobId()

```
Job * updateJobListByJobId (
    JobList * jobList,
    int jobId,
    JobState state )
```

Update the state of a job in the job list by job id.

Parameters

<i>jobList</i>	
<i>jobId</i>	
<i>state</i>	

Returns

Job*

5.6.2.25 writeJobState()

```
void writeJobState (
    Job * job )
```

Write the job state to the screen.

Parameters

<i>job</i>	
------------	--

5.6.2.26 writeJobStatePrompt()

```
void writeJobStatePrompt (
    JobState state )
```

Write the job state and prompt to the screen.

Parameters

<i>state</i>	
--------------	--

5.6.2.27 writeNewline()

```
void writeNewline ( )
```

Write the a new line to the screen.

5.7 src/kernel/job.h File Reference

```
#include "user.h"
#include "utils.h"
#include "parser.h"
#include "unistd.h"
#include "../PennFAT/interface.h"
#include "programs.h"
```

Functions

- void [printCommandLine](#) (struct [parsed_command](#) *cmd)
The state of the job.
- void [writeJobStatePrompt](#) (JobState state)
Write the job state and prompt to the screen.
- void [writeJobState](#) (Job *job)
Write the job state to the screen.
- void [writeNewline](#) ()
Write the a new line to the screen.
- Job * [createJob](#) (struct [parsed_command](#) *cmd, pid_t pid, JobState state)
Create a Job object.
- void [initJobList](#) (JobList *jobList)
Initialize the job list.
- void [appendJobList](#) (JobList *jobList, Job *job)
Append a job to the job list.
- Job * [findJobList](#) (JobList *jobList, pid_t pid)
Find a job in the job list.
- Job * [updateJobList](#) (JobList *jobList, pid_t pid, JobState state)
Update the state of a job in the job list.
- int [removeJobList](#) (JobList *jobList, pid_t pid)
Remove a job from the job list.
- Job * [findJobListByJobId](#) (JobList *jobList, int jobId)
Find a job in the job list by job id.
- Job * [updateJobListByJobId](#) (JobList *jobList, int jobId, JobState state)
Update the state of a job in the job list by job id.
- int [removeJobListByJobId](#) (JobList *jobList, int jobId)
Remove a job from the job list by job id.
- int [removeJobListWithoutFreeCmd](#) (JobList *jobList, pid_t pid)
Remove a job from the job list without free the cmd.
- Job * [popJobList](#) (JobList *jobList, pid_t pid)
Pop a job from the job list.
- Job * [findTheCurrentJob](#) (JobList *jobList)

- Find the current job.*
- void `printJobList` (`JobList *jobList`)
Print the job list.
- CommandType `parseBuiltinCommandType` (struct `parsed_command *cmd`)
Parse the built-in command type.
- CommandType `executeBuiltinCommand` (struct `parsed_command *cmd`)
Execute the built-in command.
- void `clearJobList` (`JobList *jobList`)
Clear the job list.
- void `pollBackgroundProcesses` ()
Poll the background processes.
- void `bgBuildinCommand` (struct `parsed_command *cmd`)
Built-in command: bg.
- void `fgBuildinCommand` (struct `parsed_command *cmd`)
Built-in command: fg.
- void `jobsBuildinCommand` ()
Built-in command: jobs.
- void `nicePidBuildinCommand` (struct `parsed_command *cmd`)
Built-in command: nice.
- void `killBuildinCommand` (struct `parsed_command *cmd`)
Built-in command: kill.
- void `manBuildinCommand` ()
Built-in command: man.

Variables

- `JobList _jobList`
- `pid_t fgPid`

5.7.1 Detailed Description

Author

Shuo Sun (sunshuo@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.7.2 Function Documentation

5.7.2.1 appendJobList()

```
void appendJobList (
    JobList * jobList,
    Job * job )
```

Append a job to the job list.

Parameters

<i>jobList</i>	
<i>job</i>	

5.7.2.2 bgBuildinCommand()

```
void bgBuildinCommand (
    struct parsed_command * cmd )
```

Built-in command: bg.

Parameters

<i>cmd</i>	
------------	--

5.7.2.3 clearJobList()

```
void clearJobList (
    JobList * jobList )
```

Clear the job list.

Parameters

<i>jobList</i>	
----------------	--

5.7.2.4 createJob()

```
Job * createJob (
    struct parsed_command * cmd,
    pid_t pid,
    JobState state )
```

Create a [Job](#) object.

Parameters

<i>cmd</i>	
<i>pid</i>	
<i>state</i>	

Returns

Job*

5.7.2.5 executeBuiltinCommand()

```
CommandType executeBuiltinCommand (
    struct parsed_command * cmd )
```

Execute the built-in command.

Parameters

<i>cmd</i>	
------------	--

Returns

CommandType

5.7.2.6 fgBuildinCommand()

```
void fgBuildinCommand (
    struct parsed_command * cmd )
```

Built-in command: fg.

Parameters

<i>cmd</i>	
------------	--

5.7.2.7 findJobList()

```
Job * findJobList (
    JobList * jobList,
    pid_t pid )
```

Find a job in the job list.

Parameters

<i>jobList</i>	
<i>pid</i>	

Returns

Job*

5.7.2.8 findJobListByJobId()

```
Job * findJobListByJobId (
    JobList * jobList,
    int jobId )
```

Find a job in the job list by job id.

Parameters

<i>jobList</i>	
<i>jobId</i>	

Returns

Job*

5.7.2.9 findTheCurrentJob()

```
Job * findTheCurrentJob (
    JobList * jobList )
```

Find the current job.

Parameters

<i>jobList</i>	
----------------	--

Returns

Job*

5.7.2.10 initJobList()

```
void initJobList (
    JobList * jobList )
```

Initialize the job list.

Parameters

<i>jobList</i>	
----------------	--

5.7.2.11 jobsBuildinCommand()

```
void jobsBuildinCommand ( )
```

Built-in command: jobs.

5.7.2.12 killBuildinCommand()

```
void killBuildinCommand (
    struct parsed_command * cmd )
```

Built-in command: kill.

Parameters

<i>cmd</i>	
------------	--

5.7.2.13 manBuildinCommand()

```
void manBuildinCommand ( )
```

Built-in command: man.

5.7.2.14 nicePidBuildinCommand()

```
void nicePidBuildinCommand (
    struct parsed_command * cmd )
```

Built-in command: nice.

Parameters

<i>cmd</i>	
------------	--

5.7.2.15 parseBuiltinCommandType()

```
CommandType parseBuiltinCommandType (
    struct parsed_command * cmd )
```

Parse the built-in command type.

Parameters

<i>cmd</i>	
------------	--

Returns

CommandType

5.7.2.16 pollBackgroundProcesses()

```
void pollBackgroundProcesses ( )
```

Poll the background processes.

5.7.2.17 popJobList()

```
Job * popJobList (
    JobList * jobList,
    pid_t pid )
```

Pop a job from the job list.

Parameters

<i>jobList</i>	
<i>pid</i>	

Returns

Job*

5.7.2.18 printCommandLine()

```
void printCommandLine (
    struct parsed_command * cmd )
```

The state of the job.

Parameters

<i>cmd</i>	
------------	--

5.7.2.19 printJobList()

```
void printJobList (
    JobList * jobList )
```

Print the job list.

Parameters

<i>jobList</i>	
----------------	--

5.7.2.20 removeJobList()

```
int removeJobList (
    JobList * jobList,
    pid_t pid )
```

Remove a job from the job list.

Parameters

<i>jobList</i>	
<i>pid</i>	

Returns

int

5.7.2.21 removeJobListByJobId()

```
int removeJobListByJobId (  
    JobList * jobList,  
    int jobId )
```

Remove a job from the job list by job id.

Parameters

<i>jobList</i>	
<i>jobId</i>	

Returns

int

5.7.2.22 removeJobListWithoutFreeCmd()

```
int removeJobListWithoutFreeCmd (  
    JobList * jobList,  
    pid_t pid )
```

Remove a job from the job list without free the cmd.

Parameters

<i>jobList</i>	
<i>pid</i>	

Returns

int

5.7.2.23 updateJobList()

```
Job * updateJobList (  
    JobList * jobList,
```

```
pid_t pid,  
JobState state )
```

Update the state of a job in the job list.

Parameters

<i>jobList</i>	
<i>pid</i>	
<i>state</i>	

Returns

Job*

5.7.2.24 updateJobListByJobId()

```
Job * updateJobListByJobId (
    JobList * jobList,
    int jobId,
    JobState state )
```

Update the state of a job in the job list by job id.

Parameters

<i>jobList</i>	
<i>jobId</i>	
<i>state</i>	

Returns

Job*

5.7.2.25 writeJobState()

```
void writeJobState (
    Job * job )
```

Write the job state to the screen.

Parameters

<i>job</i>	
------------	--

5.7.2.26 writeJobStatePrompt()

```
void writeJobStatePrompt (
    JobState state )
```

Write the job state and prompt to the screen.

Parameters

<i>state</i>	
--------------	--

5.7.2.27 writeNewline()

```
void writeNewline ( )
```

Write the a new line to the screen.

5.8 job.h

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

```
00001
00011 #ifndef JOB_H
00012 #define JOB_H
00013
00014 #include "user.h"
00015 #include "utils.h"
00016 #include "parser.h"
00017 #include "unistd.h"
00018 #include "../PennFAT/interface.h"
00019 #include "programs.h"
00020
00021 extern JobList _jobList; // store all background job
00022 extern pid_t fgPid; // running foreground process
00023
00024 /* Utility functions for writing job state */
00030 void printCommandLine(struct parsed_command *cmd);
00036 void writeJobStatePrompt(JobState state);
00042 void writeJobState(Job *job);
00047 void writeNewline();
00048
00049 /* Utility functions for job and job list */
00058 Job *createJob(struct parsed_command *cmd, pid_t pid, JobState state);
00064 void initJobList(JobList *jobList);
00071 void appendJobList(JobList *jobList, Job *job);
00079 Job *findJobList(JobList *jobList, pid_t pid);
00088 Job *updateJobList(JobList *jobList, pid_t pid, JobState state);
00096 int removeJobList(JobList *jobList, pid_t pid);
00097
00105 Job *findJobListByJobId(JobList *jobList, int jobId);
00114 Job *updateJobListByJobId(JobList *jobList, int jobId, JobState state);
00122 int removeJobListByJobId(JobList *jobList, int jobId);
00130 int removeJobListWithoutFreeCmd(JobList *jobList, pid_t pid);
00138 Job *popJobList(JobList *jobList, pid_t pid);
00145 Job *findTheCurrentJob(JobList *jobList);
00146
00152 void printJobList(JobList *jobList);
00153
00154 /* Built-in commands */
00161 CommandType parseBuiltinCommandType(struct parsed_command *cmd);
00168 CommandType executeBuiltinCommand(struct parsed_command *cmd);
00169
00170
00176 void clearJobList(JobList *jobList);
00181 void pollBackgroundProcesses();
00182
```

```

00188 void bgBuildinCommand(struct parsed_command *cmd);
00194 void fgBuildinCommand(struct parsed_command *cmd);
00199 void jobsBuildinCommand();
00205 void nicePidBuildinCommand(struct parsed_command *cmd);
00211 void killBuildinCommand(struct parsed_command *cmd);
00216 void manBuildinCommand();
00217
00218
00219 #endif

```

5.9 kernel.h

```

00001 #ifndef KERNEL_H
00002 #define KERNEL_H
00003
00004 #include <string.h>
00005 #include <unistd.h>
00006 #include <signal.h>
00007 #include "utils.h"
00008 #include "global.h"
00009 #include "job.h"
00010 #include "log.h"
00011
00012 extern ucontext_t scheduler_context;
00013 extern pid_t lastPID;
00014 extern priority_queue* ready_queue;
00015 extern bool stopped_by_timer;
00016 extern pcb_queue* exited_queue;
00017 extern pcb_queue* stopped_queue;
00018
00019 extern JobList _jobList;
00020 extern pid_t fgPid;
00021
00029 pcb *k_process_create(pcb * parent);
00030
00038 int k_process_kill(pcb *process, int signal);
00039
00047 int k_process_cleanup(pcb *process);
00048
00054 int kernel_init();
00055
00060 void kernel_deconstruct();
00061
00068 int block_process(pid_t pid);
00069
00076 int process_unblock(pid_t pid);
00077
00084 int clean_orphan(pcb * process);
00085
00086 #endif

```

5.10 log.h

```

00001 #ifndef LOG_H
00002 #define LOG_H
00003
00004 #include <stdio.h>
00005 #include "global.h"
00006 #include "utils.h"
00007
00008 extern int tick_tracker;
00009
00014 int log_init(const char *filename);
00015
00022 void log_event(pcb* pcb, char* action);
00023
00030 void log_pnice(pcb* pcb, int new);
00031
00036 void log_cleanup();
00037
00038 #endif

```

5.11 parser.h

```

00001 /* Penn-Shell Parser

```

```

00002     hanbangw, 21fa    */
00003
00004 #pragma once
00005
00006 #include <stddef.h>
00007 #include <stdbool.h>
00008
00009 /* Here defines all possible parser errors */
00010 // parser encountered an unexpected file input token '<'
00011 #define UNEXPECTED_FILE_INPUT 1
00012
00013 // parser encountered an unexpected file output token '>'
00014 #define UNEXPECTED_FILE_OUTPUT 2
00015
00016 // parser encountered an unexpected pipeline token '|'
00017 #define UNEXPECTED_PIPELINE 3
00018
00019 // parser encountered an unexpected ampersand token '&'
00020 #define UNEXPECTED_AMPERSAND 4
00021
00022 // parser didn't find input filename following '<'
00023 #define EXPECT_INPUT_FILENAME 5
00024
00025 // parser didn't find output filename following '>' or '»'
00026 #define EXPECT_OUTPUT_FILENAME 6
00027
00028 // parser didn't find any commands or arguments where it expects one
00029 #define EXPECT_COMMANDS 7
00030
00031 struct parsed_command {
00032     // indicates the command shall be executed in background
00033     // (ends with an ampersand '&')
00034     bool is_background;
00035
00036     // indicates if the stdout_file shall be opened in append mode
00037     // ignore this value when stdout_file is NULL
00038     bool is_file_append;
00039
00040     // filename for redirecting input from
00041     const char *stdin_file;
00042
00043     // filename for redirecting output to
00044     const char *stdout_file;
00045
00046     // number of commands (pipeline stages)
00047     size_t num_commands;
00048
00049     // an array to a list of arguments
00050     // size of 'commands' is 'num_commands'
00051     char **commands[];
00052 };
00053
00054 int parse_command(const char *cmd_line, struct parsed_command **result);
00055
00056 /* This is a debugging function used for outputting a parsed command line. */
00057 void print_parsed_command(const struct parsed_command *cmd);

```

5.12 src/kernel/perrno.h File Reference

Error codes and messages in PennOS.

```

#include "stdio.h"
#include "errno.h"

```

Macros

- #define **P_SUCCESS** 0
error codes in PennOS
- #define **P_NO_SUCH_PROCESS** -1
- #define **P_NO_SUCH_FILE** -2
- #define **P_FAIL_TO_INITIALIZE_QUEUE** -3

- `#define P_SHOULD_NOT_KILL_SHELL -4`
- `#define P_NODE_IS_NULL -5`
- `#define P_PARENT_IS_NULL -6`
- `#define P_PROCESS_IS_NULL -7`
- `#define P_PROCESS_NOT_IN_READY_QUEUE -8`
- `#define P_PROCESS_NOT_IN_STOPPED_QUEUE -9`
- `#define P_FAIL_TO_CLEANUP -10`

Functions

- void `p_set_errno` (int `errnum`)
set `p_error` to specified error number
- void `p_perror` (const char *`error_msg`)
log error message and set error number
- void `p_reset_errno` ()
reset the error number to 0

5.12.1 Detailed Description

Error codes and messages in PennOS.

5.12.2 Function Documentation

5.12.2.1 `p_perror()`

```
void p_perror (
    const char * error_msg )
```

log error message and set error number

Parameters

<i>msg</i>	error message that user wants to display
------------	--

5.12.2.2 `p_set_errno()`

```
void p_set_errno (
    int errnum )
```

set `p_error` to specified error number

Parameters

<code>err_num</code>	error number
----------------------	--------------

5.13 perrno.h

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

```

00001 #ifndef PERRNO_H
00002 #define PERRNO_H
00003
00004 #include "stdio.h"
00005 #include "errno.h"
00006
00016 #define P_SUCCESS 0
00017 #define P_NO_SUCH_PROCESS -1
00018 #define P_NO_SUCH_FILE -2
00019 #define P_FAIL_TO_INITIALIZE_QUEUE -3
00020 #define P_SHOULD_NOT_KILL_SHELL -4
00021 #define P_NODE_IS_NULL -5
00022 #define P_PARENT_IS_NULL -6
00023 #define P_PROCESS_IS_NULL -7
00024 #define P_PROCESS_NOT_IN_READY_QUEUE -8
00025 #define P_PROCESS_NOT_IN_STOPPED_QUEUE -9
00026 #define P_FAIL_TO_CLEANUP -10
00027
00032 void p_set_errno(int errnum);
00033
00038 void p_perror(const char* error_msg);
00039
00043 void p_reset_errno();
00044
00045 #endif

```

5.14 src/kernel/programs.c File Reference

```
#include "programs.h"
```

Functions

- int **argc** (char *argv[])
- void **s_cat** (char *argv[])
Shell cat command.
- void **s_sleep** (char *argv[])
Shell sleep command.
- void **s_busy** (char *argv[])
Shell busy command.
- void **s_echo** (char *argv[])
Shell echo command.
- void **s_ls** (char *argv[])
Shell ls command.
- void **s_touch** (char *argv[])
Shell touch command.
- void **s_mv** (char *argv[])
Shell mv command.
- void **s_cp** (char *argv[])

- Shell cp command.*
- void `s_rm` (char *argv[])
Shell rm command.
- void `s_chmod` (char *argv[])
Shell chmod command.
- void `s_ps` (char *argv[])
Shell ps command.
- void `s_kill` (char *argv[])
Shell kill command.
- void `zombie_child` ()
- void `orphan_child` ()
- void `s_zombify` (char *argv[])
Shell zombify command.
- void `s_orphanify` (char *argv[])
Shell orphanify command.
- void `s_hang` (char *argv[])
Shell hang command.
- void `s_nohang` (char *argv[])
Shell nohang command.
- void `s_recur` (char *argv[])
Shell recur command.
- void `s_test` (char *argv[])
Our shell test command.

5.14.1 Detailed Description

Author

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Version

0.1

Date

2023-04-16

Copyright

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5.14.2 Function Documentation

5.14.2.1 s_busy()

```
void s_busy (  
    char * argv[] )
```

Shell busy command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.2 s_cat()

```
void s_cat (
    char * argv[] )
```

Shell cat command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.3 s_chmod()

```
void s_chmod (
    char * argv[] )
```

Shell chmod command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.4 s_cp()

```
void s_cp (
    char * argv[] )
```

Shell cp command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.5 s_echo()

```
void s_echo (
    char * argv[] )
```

Shell echo command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.6 s_hang()

```
void s_hang (
    char * argv[] )
```

Shell hang command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.7 s_kill()

```
void s_kill (
    char * argv[] )
```

Shell kill command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.8 s_ls()

```
void s_ls (
    char * argv[] )
```

Shell ls command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.9 s_mv()

```
void s_mv (
    char * argv[] )
```

Shell mv command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.10 s_nohang()

```
void s_nohang (
    char * argv[] )
```

Shell nohang command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.11 s_orphanify()

```
void s_orphanify (
    char * argv[] )
```

Shell orphanify command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.12 s_ps()

```
void s_ps (
    char * argv[] )
```

Shell ps command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.13 s_recur()

```
void s_recur (
    char * argv[] )
```

Shell recur command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.14 s_rm()

```
void s_rm (
    char * argv[] )
```

Shell rm command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.15 s_sleep()

```
void s_sleep (
    char * argv[] )
```

Shell sleep command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.16 s_test()

```
void s_test (
    char * argv[] )
```

Our shell test command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.17 s_touch()

```
void s_touch (
    char * argv[] )
```

Shell touch command.

Parameters

<i>argv</i>	
-------------	--

5.14.2.18 s_zombify()

```
void s_zombify (
    char * argv[] )
```

Shell zombify command.

Parameters

<i>argv</i>	
-------------	--

5.15 src/kernel/programs.h File Reference

```
#include "behavior.h"
```

```
#include "stress.h"
#include "../PennFAT/pennFAT.h"
```

Macros

- #define **READ_BUFFER_SIZE** 4096

Functions

- void **s_cat** (char *argv[])
Shell cat command.
- void **s_sleep** (char *argv[])
Shell sleep command.
- void **s_busy** (char *argv[])
Shell busy command.
- void **s_echo** (char *argv[])
Shell echo command.
- void **s_ls** (char *argv[])
Shell ls command.
- void **s_touch** (char *argv[])
Shell touch command.
- void **s_mv** (char *argv[])
Shell mv command.
- void **s_cp** (char *argv[])
Shell cp command.
- void **s_rm** (char *argv[])
Shell rm command.
- void **s_chmod** (char *argv[])
Shell chmod command.
- void **s_ps** (char *argv[])
Shell ps command.
- void **s_kill** (char *argv[])
Shell kill command.
- void **s_zombify** (char *argv[])
Shell zombify command.
- void **s_orphanify** (char *argv[])
Shell orphanify command.
- void **s_hang** (char *argv[])
Shell hang command.
- void **s_nohang** (char *argv[])
Shell nohang command.
- void **s_recur** (char *argv[])
Shell recur command.
- void **s_test** (char *argv[])
Our shell test command.

5.15.1 Detailed Description

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Version

0.1

Date

2023-04-16

Copyright

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5.15.2 Function Documentation

5.15.2.1 `s_busy()`

```
void s_busy (
    char * argv[] )
```

Shell busy command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.2 `s_cat()`

```
void s_cat (
    char * argv[] )
```

Shell cat command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.3 s_chmod()

```
void s_chmod (
    char * argv[] )
```

Shell chmod command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.4 s_cp()

```
void s_cp (
    char * argv[] )
```

Shell cp command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.5 s_echo()

```
void s_echo (
    char * argv[] )
```

Shell echo command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.6 s_hang()

```
void s_hang (
    char * argv[] )
```

Shell hang command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.7 s_kill()

```
void s_kill (
    char * argv[] )
```

Shell kill command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.8 s_ls()

```
void s_ls (
    char * argv[] )
```

Shell ls command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.9 s_mv()

```
void s_mv (
    char * argv[] )
```

Shell mv command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.10 s_nohang()

```
void s_nohang (
    char * argv[] )
```

Shell nohang command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.11 s_orphanify()

```
void s_orphanify (
    char * argv[] )
```

Shell orphanify command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.12 s_ps()

```
void s_ps (
    char * argv[] )
```

Shell ps command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.13 s_recur()

```
void s_recur (
    char * argv[] )
```

Shell recur command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.14 s_rm()

```
void s_rm (
    char * argv[] )
```

Shell rm command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.15 s_sleep()

```
void s_sleep (
    char * argv[] )
```

Shell sleep command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.16 s_test()

```
void s_test (
    char * argv[] )
```

Our shell test command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.17 s_touch()

```
void s_touch (
    char * argv[] )
```

Shell touch command.

Parameters

<i>argv</i>	
-------------	--

5.15.2.18 s_zombify()

```
void s_zombify (
    char * argv[] )
```

Shell zombify command.

Parameters

<i>argv</i>	
-------------	--

5.16 programs.h

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

```
00001
00011 #ifndef PROGRAMS_H
00012 #define PROGRAMS_H
00013
00014 #include "behavior.h"
00015 #include "stress.h"
00016 #include "../PennFAT/pennFAT.h"
00017
00018 #define READ_BUFFER_SIZE 4096
00019
00020 /* Known user programs */
00026 void s_cat(char *argv[]);
00032 void s_sleep(char *argv[]);
00038 void s_busy(char *argv[]);
00044 void s_echo(char *argv[]);
00050 void s_ls(char *argv[]);
00056 void s_touch(char *argv[]);
00062 void s_mv(char *argv[]);
00068 void s_cp(char *argv[]);
00074 void s_rm(char *argv[]);
00080 void s_chmod(char *argv[]);
00086 void s_ps(char *argv[]);
00092 void s_kill(char *argv[]);
00098 void s_zombify(char *argv[]);
00104 void s_orphanify(char *argv[]);
00110 void s_hang(char *argv[]);
00116 void s_nohang(char *argv[]);
00122 void s_recur(char *argv[]);
00128 void s_test(char *argv[]);
00129
00130 #endif
```

5.17 scheduler.h

```

00001 #ifndef SCHEDULER_H
00002 #define SCHEDULER_H
00003
00004 #include <signal.h>      // sigaction, sigemptyset, sigfillset, signal
00005 #include <stdbool.h>
00006 #include <stdio.h>
00007 #include <stdlib.h>
00008 #include <sys/time.h>    // setitimer
00009 #include <ucontext.h>    // getcontext, makecontext, setcontext, swapcontext
00010 #include <valgrind/valgrind.h>
00011
00012 #include "utils.h"
00013 #include "global.h"
00014 #include "kernel.h"
00015 #include "log.h"
00016
00017 extern pcb* active_process;
00018 extern priority_queue* ready_queue;
00019 extern ucontext_t main_context;
00020 extern ucontext_t scheduler_context;
00021 extern ucontext_t* p_active_context;
00022 extern bool stopped_by_timer;
00023 extern pcb_queue* exited_queue;
00024 extern pcb_queue* stopped_queue;
00025 extern int tick_tracker;
00026
00027 #define TICK 100000      // 1 tick = 0.1s
00028
00034 int set_alarm_handler();
00035
00040 void alarm_handler();
00041
00047 int set_timer();
00048
00054 pcb* next_process();
00055
00062 pcb_node* get_node_by_pid_all_queues(pid_t pid);
00063
00068 void scheduler();
00069
00074 void idle_func();
00075
00081 int scheduler_init();
00082
00088 int idle_process_init();    // initialize the idle process
00089
00096 int haveChildrenToWait(pcb *process);
00097
00102 void deconstruct_idle();
00103
00104 #endif

```

5.18 src/kernel/shell.c File Reference

```

#include "shell.h"
#include "scheduler.h"

```

Functions

- void [shell_process](#) ()
The main function of shell.
- bool [isBuildinCommand](#) (struct [parsed_command](#) *cmd)
Check if the command is a buildin command.
- bool [isKnownProgram](#) (struct [parsed_command](#) *cmd)
Check if the command is a known program.
- int [shell_init](#) (int argc, const char **argv)
Initialize the shell.

Variables

- `JobList_jobList`
- `pid_t fgPid = 1`

5.18.1 Detailed Description

Author

Shuo Sun (sunshuo@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.18.2 Function Documentation

5.18.2.1 `isBuildinCommand()`

```
bool isBuildinCommand (
    struct parsed_command * cmd )
```

Check if the command is a buildin command.

Parameters

<code>cmd</code>	
------------------	--

Returns

true
false

5.18.2.2 isKnownProgram()

```
bool isKnownProgram (
    struct parsed\_command * cmd )
```

Check if the command is a known program.

Parameters

<i>cmd</i>	
------------	--

Returns

true

false

5.18.2.3 shell_init()

```
int shell_init (
    int argc,
    const char ** argv )
```

Initialize the shell.

Parameters

<i>argc</i>	
<i>argv</i>	

Returns

int

5.18.2.4 shell_process()

```
void shell_process ( )
```

The main function of shell.

5.19 src/kernel/shell.h File Reference

```
#include "utils.h"
#include "job.h"
#include "user.h"
#include "behavior.h"
#include "log.h"
#include "../PennFAT/filesys.h"
#include "../PennFAT/interface.h"
```

Functions

- void [shell_process](#) ()
The main function of shell.
- int [shell_init](#) (int argc, const char **argv)
Initialize the shell.
- bool [isBuildinCommand](#) (struct [parsed_command](#) *cmd)
Check if the command is a buildin command.
- bool [isKnownProgram](#) (struct [parsed_command](#) *cmd)
Check if the command is a known program.

5.19.1 Detailed Description

Author

Shuo Sun (sunshuo@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

Copyright (c) 2023

5.19.2 Function Documentation

5.19.2.1 isBuildinCommand()

```
bool isBuildinCommand (
    struct parsed\_command * cmd )
```

Check if the command is a buildin command.

Parameters

<i>cmd</i>	
------------	--

Returns

true
false

5.19.2.2 isKnownProgram()

```
bool isKnownProgram (
    struct parsed\_command * cmd )
```

Check if the command is a known program.

Parameters

<i>cmd</i>	
------------	--

Returns

true
false

5.19.2.3 shell_init()

```
int shell_init (
    int argc,
    const char ** argv )
```

Initialize the shell.

Parameters

<i>argc</i>	
<i>argv</i>	

Returns

int

5.19.2.4 shell_process()

```
void shell_process ( )
```

The main function of shell.

5.20 shell.h

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

```
00001
00011 #ifndef SHELL_H
00012 #define SHELL_H
00013
00014 #include "utils.h"
00015 #include "job.h"
00016 #include "user.h"
00017 #include "behavior.h"
00018 #include "log.h"
00019 #include "../PennFAT/filesys.h"
00020 #include "../PennFAT/interface.h"
00021
00026 void shell_process();
00034 int shell_init(int argc, const char **argv);
00042 bool isBuildinCommand(struct parsed_command *cmd);
00050 bool isKnownProgram(struct parsed_command *cmd);
00051
00052
00053 #endif
```

5.21 stress.h

```
00001 #ifndef STRESS_H
00002 #define STRESS_H
00003
00004 void hang(void);
00005 void nohang(void);
00006 void recur(void);
00007
00008 #endif
```

5.22 src/kernel/user.h File Reference

user level functions

```
#include "kernel.h"
#include "utils.h"
#include "global.h"
#include "job.h"
#include "log.h"
```


Functions

- void [writePrompt](#) ()
Write the prompt to the screen.
- void [deconstruct_idle](#) ()
deconstruct the idle process
- bool **W_WIFEXITED** (int status)
- bool **W_WIFSTOPPED** (int status)
- bool **W_WIFSIGNALED** (int status)
- void **signal_handler** (int signal)
- int **register_signals** ()
- pid_t [p_spawn](#) (void(*func)(), char *argv[], int fd0, int fd1)
forks a new thread that retains most of the attributes of the parent thread (see [k_process_create](#)).
- pid_t **wait_for_one** (pid_t pid, int *wstatus)
- pid_t **wait_for_anyone** (int *wstatus)
- pid_t [p_waitpid](#) (pid_t pid, int *wstatus, bool nohang)
sets the calling thread as blocked (if nohang is false) until a child of the calling thread changes state
- [pcb_node](#) * [get_node_by_pid_all_alive_queues](#) (pid_t pid)
Get the node by pid all alive queues object.
- int [p_kill](#) (pid_t pid, int sig)
sends the signal sig to the thread referenced by pid.
- int [p_exit](#) (void)
exits the current thread unconditionally
- int [p_nice](#) (pid_t pid, int priority)
sets the priority of the thread pid to priority
- void [p_sleep](#) (unsigned int ticks)
sleeps the current thread for ticks of the system clock
- void [deconstruct_shell](#) ()
deconstructs the shell

Variables

- [priority_queue](#) * **ready_queue**
- [pcb](#) * **active_process**
- ucontext_t **scheduler_context**
- int **tick_tracker**
- ucontext_t * **p_active_context**
- ucontext_t **main_context**
- [JobList](#) **_jobList**
- pid_t **fgPid**

5.22.1 Detailed Description

user level functions

5.22.2 Function Documentation

5.22.2.1 deconstruct_idle()

```
void deconstruct_idle ( )
```

deconstruct the idle process

5.22.2.2 deconstruct_shell()

```
void deconstruct_shell ( )
```

deconstructs the shell

5.22.2.3 get_node_by_pid_all_alive_queues()

```
pcb_node * get_node_by_pid_all_alive_queues (
    pid_t pid )
```

Get the node by pid all alive queues object.

Parameters

<i>pid</i>	
------------	--

Returns

pcb_node*

5.22.2.4 p_exit()

```
int p_exit (
    void )
```

exits the current thread unconditionally

Returns

int

5.22.2.5 p_kill()

```
int p_kill (
    pid_t pid,
    int sig )
```

sends the signal sig to the thread referenced by pid.

Parameters

<i>pid</i>	pid of the thread to send the signal to
<i>sig</i>	signal to be sent

Returns

returns 0 on success, or -1 on error.

5.22.2.6 p_nice()

```
int p_nice (
    pid_t pid,
    int priority )
```

sets the priority of the thread pid to priority

Parameters

<i>pid</i>	
<i>priority</i>	

Returns

int

5.22.2.7 p_sleep()

```
void p_sleep (
    unsigned int ticks )
```

sleeps the current thread for ticks of the system clock

Parameters

<i>ticks</i>	
--------------	--

5.22.2.8 p_spawn()

```
pid_t p_spawn (
    void(*)() func,
```

```
char * argv[],  
int fd0,  
int fd1 )
```

forks a new thread that retains most of the attributes of the parent thread (see `k_process_create`).

Parameters

<i>func</i>	the function to be executed by the new thread
<i>argv</i>	the arguments to be passed to the function
<i>fd0</i>	the file descriptor to be used as stdin for the new thread
<i>fd1</i>	the file descriptor to be used as stdout for the new thread

Returns

the pid of the new thread on success, or -1 on error

5.22.2.9 p_waitpid()

```
pid_t p_waitpid (  
    pid_t pid,  
    int * wstatus,  
    bool nohang )
```

sets the calling thread as blocked (if `nohang` is false) until a child of the calling thread changes state

Parameters

<i>pid</i>	pid of the child thread to wait for
<i>wstatus</i>	status of the child thread
<i>nohang</i>	whether to block the calling thread or not

Returns

`pid_t`

5.22.2.10 writePrompt()

```
void writePrompt ( )
```

Write the prompt to the screen.

5.23 user.h

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

```

00001 #include "kernel.h"
00002 #include "utils.h"
00003 #include "global.h"
00004 #include "job.h"
00005 #include "log.h"
00006
00012 extern priority_queue* ready_queue;
00013 extern pcb* active_process;
00014 extern ucontext_t scheduler_context;
00015 extern int tick_tracker;
00016 extern ucontext_t* p_active_context;
00017 extern ucontext_t main_context;
00018
00019 extern JobList _jobList;
00020 extern pid_t fgPid;
00021
00022 extern void writePrompt();
00023 extern void deconstruct_idle();
00024
00025 bool W_WIFEXITED(int status);
00026 bool W_WIFSTOPPED(int status);
00027 bool W_WIFSIGNALED(int status);
00028
00029 void signal_handler(int signal);
00030
00031 int register_signals();
00032
00041 pid_t p_spawn(void (*func)(), char *argv[], int fd0, int fd1);
00042
00043 // helper functions for waitpid
00044 pid_t wait_for_one(pid_t pid, int *wstatus);
00045 pid_t wait_for_anyone(int *wstatus);
00046
00054 pid_t p_waitpid(pid_t pid, int *wstatus, bool nohang);
00055
00061 pcb_node* get_node_by_pid_all_alive_queues(pid_t pid);
00062
00069 int p_kill(pid_t pid, int sig);
00070
00076 int p_exit(void);
00077
00085 int p_nice(pid_t pid, int priority);
00086
00092 void p_sleep(unsigned int ticks);
00093
00098 void deconstruct_shell();

```

5.24 src/PennFAT/utils.c File Reference

```
#include "utils.h"
```

5.24.1 Detailed Description

Author

Zhiyuan Liang (liangzhy@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.25 utils.h

```

00001 #ifndef UTILS_H
00002 #define UTILS_H
00003
00004 #include <signal.h> // sigaction, sigemptyset, sigfillset, signal
00005 #include <stdbool.h>
00006 #include <stdio.h>
00007 #include <string.h>
00008 #include <stdlib.h>
00009 #include <sys/time.h> // setitimer
00010 #include <ucontext.h> // getcontext, makecontext, setcontext, swapcontext
00011 #include <time.h>
00012 #include <valgrind/valgrind.h>
00013 #include "global2.h"
00014 #include "perrno.h"
00015 #include "../PennFAT/fd-table.h"
00016
00021 typedef struct pcb {
00022     ucontext_t ucontext;
00023     pid_t pid;
00024     pid_t ppid;
00025     enum process_state prev_state;
00026     enum process_state state;
00027     int priority;
00028     FdNode *fds[MAX_FILE_DESCRIPTOR];
00029     int ticks_left;
00030     struct pcb_queue* children;
00031     struct pcb_queue* zombies;
00032     char* pname;
00033     bool toWait;
00034 } pcb;
00035
00040 typedef struct pcb_node {
00041     pcb* pcb;
00042     struct pcb_node* next;
00043 } pcb_node;
00044
00049 typedef struct pcb_queue {
00050     pcb_node* head;
00051     pcb_node* tail;
00052 } pcb_queue;
00053
00058 typedef struct priority_queue {
00059     pcb_queue* high;
00060     pcb_queue* mid;
00061     pcb_queue* low;
00062 } priority_queue;
00063
00071 pcb* new_pcb(ucontext_t* ucontext, pid_t pid);
00072
00079 pcb_node* new_pcb_node(pcb* pcb);
00080
00086 pcb_queue* new_pcb_queue();
00087
00093 priority_queue* new_priority_queue();
00094
00102 bool is_empty(pcb_queue* queue);
00103
00111 bool is_priority_queue_empty(priority_queue* ready_queue);
00112
00120 pcb_queue* get_pcb_queue_by_priority(priority_queue* ready_queue, int priority);
00121
00128 void enqueue(pcb_queue* queue, pcb_node* node);
00129
00137 void enqueue_by_priority(priority_queue* ready_queue, int priority, pcb_node* node);
00138
00146 pcb_node* dequeue_by_pid(pcb_queue* queue, pid_t pid);
00147
00154 pcb_node* dequeue_front(pcb_queue* queue);
00155
00163 pcb_node* dequeue_front_by_priority(priority_queue* ready_queue, int priority);
00164
00172 pcb_node* get_node_by_pid(pcb_queue* queue, pid_t pid);
00173
00181 pcb_node* get_node_by_pid_from_priority_queue(priority_queue* ready_queue, pid_t pid);
00182
00188 void deconstruct_queue(pcb_queue* queue);
00189
00195 void deconstruct_priority_queue(priority_queue* ready_queue);
00196
00204 pcb_node* get_node_from_ready_queue(priority_queue* ready_queue, pid_t pid);
00205
00211 int pick_priority();
00212
00218 void set_stack(stack_t *stack);
00219

```

```

00230 int makeContext(ucontext_t *ucp, void (*func)(), int argc, ucontext_t *next_context, char *argv[]);
00231
00238 int printQueue(pcb_queue *queue);
00239
00240 typedef enum {
00241     JOB_RUNNING,
00242     JOB_STOPPED,
00243     JOB_FINISHED,
00244     JOB_TERMINATED
00245 } JobState;
00246
00247
00248 typedef enum {
00249     NICE, // Syntax: nice priority command [args]
00250     NICE_PID, // Syntax: nice_pid priority pid
00251     MAN, // Syntax: man
00252     BG, // Syntax: bg [job_id]
00253     FG, // Syntax: fg [job_id]
00254     JOBS, // Syntax: jobs
00255     LOGOUT, // Syntax: logout
00256     KILL,
00257     OTHERS // non-builtin command
00258 } CommandType;
00259
00260 typedef struct Job {
00261     struct parsed_command *cmd;
00262     pid_t pid;
00263     JobState state;
00264 } Job;
00265
00266 typedef struct JobListNode {
00267     Job *job;
00268     struct JobListNode *prev;
00269     struct JobListNode *next;
00270     int jobId;
00271 } JobListNode;
00272
00273 typedef struct JobList {
00274     JobListNode *head;
00275     JobListNode *tail;
00276     int jobCount;
00277 } JobList;
00278
00279 pcb_queue* sortQueue(pcb_queue* queue);
00280
00281 pcb_queue* merge_two_queues(pcb_queue* queue1, pcb_queue* queue2);
00282
00283 extern priority_queue* ready_queue;
00284 extern pcb_queue* exited_queue;
00285 extern pcb_queue* stopped_queue;
00286
00287 extern pcb_node* get_node_by_pid_all_queues(pid_t pid);
00288
00289 #endif

```

5.26 src/PennFAT/utils.h File Reference

```

#include <stdlib.h>
#include <inttypes.h>
#include <time.h>
#include <string.h>
#include <stdbool.h>
#include <math.h>
#include <unistd.h>
#include <fcntl.h>
#include <sys/mman.h>
#include <stdio.h>

```

Macros

- `#define FS_SUCCESS 0`
- `#define FS_FAILURE -1`
- `#define FS_NOT_FOUND -1`

5.26.1 Detailed Description

Author

Zhiyuan Liang (liangzhy@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.27 utils.h

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

```
00001
00011 #ifndef FS_UTILS_H
00012 #define FS_UTILS_H
00013
00014 #include <stdlib.h>
00015 #include <inttypes.h>
00016 #include <time.h>
00017 #include <string.h>
00018 #include <stdbool.h>
00019 #include <math.h>
00020 #include <unistd.h>
00021 #include <fcntl.h>
00022 #include <sys/mman.h>
00023
00024 #include <stdio.h>
00025
00026 // #define FS_DEBUG_INFO 1
00027
00028 #define FS_SUCCESS 0
00029 #define FS_FAILURE -1
00030 #define FS_NOT_FOUND -1
00031
00032 #endif
00033
```

5.28 src/PennFAT/FAT.c File Reference

```
#include "FAT.h"
```


Functions

- [FATConfig](#) * [createFATConfig](#) (const char *name, uint16_t LSB, uint16_t MSB)
Create a [FATConfig](#) object.
- uint16_t * [createFAT16InMemory](#) ([FATConfig](#) *config)
Create a FAT16 object in memory.
- int [createFATOnDisk](#) ([FATConfig](#) *config)
Create a FAT16 object on disk.
- int [findEmptyFAT16Entry](#) ([FATConfig](#) *config, uint16_t *FAT16)
Return the index of next empty FAT entry.
- [DirectoryEntry](#) * [createDirectoryEntry](#) (const char *name, uint32_t size, uint16_t firstBlock, uint8_t type, uint8_t perm)
Create a Directory Entry object.
- int [createFileDirectoryOnDisk](#) ([FATConfig](#) *config, uint16_t *FAT16, const char *fileName, uint8_t fileType, uint8_t filePerm)
Create a File Directory On Disk object.
- int [findFileDirectory](#) ([FATConfig](#) *config, uint16_t *FAT16, const char *fileName)
Return the offset of the file directory entry in data region.
- int [readDirectoryEntry](#) ([FATConfig](#) *config, int offset, [DirectoryEntry](#) *dir)
Read the directory entry from FAT and set it to dir.
- int [writeFileDirectory](#) ([FATConfig](#) *config, int offset, [DirectoryEntry](#) *dir)
Write the directory entry to the offset.
- int [deleteFileDirectory](#) ([FATConfig](#) *config, uint16_t *FAT16, int offset)
Delete the file directory entry.
- int [deleteFileDirectoryByName](#) ([FATConfig](#) *config, uint16_t *FAT16, const char *fileName)
Delete the file directory entry by file name.
- bool [isDirectoryEntryToDelete](#) ([FATConfig](#) *config, int directoryEntryOffset)
Judge whether the directory entry is to be deleted.
- int [readFAT](#) ([FATConfig](#) *config, uint16_t *FAT16, int startBlock, int startBlockOffset, int size, char *buffer)
Read the file data from FAT and set it to buffer.
- int [writeFAT](#) ([FATConfig](#) *config, uint16_t *FAT16, int startBlock, int startBlockOffset, int size, const char *buffer)
Write the buffer to FAT.
- int [traceFileEnd](#) ([FATConfig](#) *config, uint16_t *FAT16, const char *fileName)
Return the offset of the file end.
- int [traceBytesFromBeginning](#) ([FATConfig](#) *config, uint16_t *FAT16, int directoryEntryOffset, int fileOffset)
Return the byte number from the file beginning to the file offset.
- int [traceBytesToEnd](#) ([FATConfig](#) *config, uint16_t *FAT16, int directoryEntryOffset, int fileOffset)
Return the byte number from the file offset to the file end.
- int [traceOffset](#) ([FATConfig](#) *config, uint16_t *FAT16, int directoryEntryOffset, int fileOffset, int n)
Return the offset of the n bytes after the given file offset.

5.28.1 Detailed Description

Author

Zhiyuan Liang (liangzhy@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.28.2 Function Documentation

5.28.2.1 createDirectoryEntry()

```
DirectoryEntry * createDirectoryEntry (
    const char * name,
    uint32_t size,
    uint16_t firstBlock,
    uint8_t type,
    uint8_t perm )
```

Create a Directory Entry object.

Parameters

<i>name</i>	
<i>size</i>	
<i>firstBlock</i>	
<i>type</i>	
<i>perm</i>	

Returns

DirectoryEntry*

5.28.2.2 createFAT16InMemory()

```
uint16_t * createFAT16InMemory (
    FATConfig * config )
```

Create a FAT16 object in memory.

Parameters

<i>config</i>	
---------------	--

Returns

uint16_t*

5.28.2.3 createFATConfig()

```
FATConfig * createFATConfig (
    const char * name,
    uint16_t LSB,
    uint16_t MSB )
```

Create a [FATConfig](#) object.

Parameters

<i>name</i>	
<i>LSB</i>	
<i>MSB</i>	

Returns

FATConfig*

5.28.2.4 createFATOnDisk()

```
int createFATOnDisk (
    FATConfig * config )
```

Create a FAT16 object on disk.

Parameters

<i>config</i>	
---------------	--

Returns

int

5.28.2.5 createFileDirectoryOnDisk()

```
int createFileDirectoryOnDisk (
    FATConfig * config,
```

```
uint16_t * FAT16,  
const char * fileName,  
uint8_t fileType,  
uint8_t filePerm )
```

Create a File Directory On Disk object.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>fileName</i>	
<i>fileType</i>	
<i>filePerm</i>	

Returns

int

5.28.2.6 deleteFileDirectory()

```
int deleteFileDirectory (  
    FATConfig * config,  
    uint16_t * FAT16,  
    int directoryEntryOffset )
```

Delete the file directory entry.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>directoryEntryOffset</i>	

Returns

int

5.28.2.7 deleteFileDirectoryByName()

```
int deleteFileDirectoryByName (  
    FATConfig * config,  
    uint16_t * FAT16,  
    const char * fileName )
```

Delete the file directory entry by file name.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>fileName</i>	

Returns

int

5.28.2.8 findEmptyFAT16Entry()

```
int findEmptyFAT16Entry (
    FATConfig * config,
    uint16_t * FAT16 )
```

Return the index of next empty FAT entry.

Parameters

<i>config</i>	
<i>FAT16</i>	

Returns

int

5.28.2.9 findFileDirectory()

```
int findFileDirectory (
    FATConfig * config,
    uint16_t * FAT16,
    const char * fileName )
```

Return the offset of the file directory entry in data region.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>fileName</i>	

Returns

int

5.28.2.10 isDirectoryEntryToDelete()

```
bool isDirectoryEntryToDelete (
    FATConfig * config,
    int offset )
```

Judge whether the directory entry is to be deleted.

Parameters

<i>config</i>	
<i>offset</i>	

Returns

true

false

5.28.2.11 readDirectoryEntry()

```
int readDirectoryEntry (
    FATConfig * config,
    int offset,
    DirectoryEntry * dir )
```

Read the directory entry from FAT and set it to dir.

Parameters

<i>config</i>	
<i>offset</i>	
<i>dir</i>	

Returns

int

5.28.2.12 readFAT()

```
int readFAT (
    FATConfig * config,
    uint16_t * FAT16,
    int startBlock,
    int startBlockOffset,
    int size,
    char * buffer )
```

Read the file data from FAT and set it to buffer.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>startBlock</i>	
<i>startBlockOffset</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.28.2.13 traceBytesFromBeginning()

```
int traceBytesFromBeginning (
    FATConfig * config,
    uint16_t * FAT16,
    int directoryEntryOffset,
    int fileOffset )
```

Return the byte number from the file beginning to the file offset.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>directoryEntryOffset</i>	
<i>fileOffset</i>	

Returns

int

5.28.2.14 traceBytesToEnd()

```
int traceBytesToEnd (
    FATConfig * config,
    uint16_t * FAT16,
    int directoryEntryOffset,
    int fileOffset )
```

Return the byte number from the file offset to the file end.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>directoryEntryOffset</i>	
<i>fileOffset</i>	

Returns

int

5.28.2.15 traceFileEnd()

```
int traceFileEnd (
    FATConfig * config,
    uint16_t * FAT16,
    const char * fileName )
```

Return the offset of the file end.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>fileName</i>	

Returns

int

5.28.2.16 traceOffset()

```
int traceOffset (
    FATConfig * config,
    uint16_t * FAT16,
```



```

    int directoryEntryOffset,
    int fileOffset,
    int n )

```

Return the offset of the *n* bytes after the given file offset.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>directoryEntryOffset</i>	
<i>fileOffset</i>	
<i>n</i>	

Returns

int

5.28.2.17 writeFAT()

```

int writeFAT (
    FATConfig * config,
    uint16_t * FAT16,
    int startBlock,
    int startBlockOffset,
    int size,
    const char * buffer )

```

Write the buffer to FAT.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>startBlock</i>	
<i>startBlockOffset</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.28.2.18 writeFileDirectory()

```

int writeFileDirectory (
    FATConfig * config,

```

```
int offset,
DirectoryEntry * dir )
```

Write the directory entry to the offset.

Parameters

<i>config</i>	
<i>offset</i>	
<i>dir</i>	

Returns

int

5.29 src/PennFAT/FAT.h File Reference

```
#include "utils.h"
```

Classes

- struct [FATConfig](#)

*The LSB(rightmost under little endian) of the first entry of the FAT specifies the block size with the mapping as below: {LSB : size in bytes} = {0:256; 1:512; 2:1024; 3:2048; 4:4096} The MSB(leftmost under little endian) of the first entry of the FAT specifies the number of blocks that FAT region occupies. The MSB should be ranged from 1-32 (numbers outside of this range will be considered an error). FAT region size = block size * FAT region block number FAT entry number = FAT region size / FAT entry size (2-byte in FAT16) Data region size = block size * (FAT entry number - 1)*

- struct [DirectoryEntry](#)

The structure of the directory entry as stored in the filesystem is as follows:

Macros

- #define **MIN_BLOCK_SIZE** 256
- #define **MAX_FAT_BLOCK_NUM** 32
- #define **MAX_BLOCK_SCALE** 4
- #define **FAT_ENTRY_SIZE** 2
- #define **EMPTY_FAT_ENTRY** 0x0000
- #define **NO_SUCC_FAT_ENTRY** 0xFFFF
- #define **MAX_FILE_NAME_LENGTH** 32
- #define **DIRECTORY_ENTRY_SIZE** 64
- #define **NO_FIRST_BLOCK** 0x0000
- #define **DIRECTORY_END** "0"
- #define **DELETED_DIRECTORY** "1"
- #define **DELETED_DIRECTORY_IN_USE** "2"
- #define **FILE_TYPE_UNKNOWN** 0
- #define **FILE_TYPE_REGULAR** 1
- #define **FILE_TYPE_DIRECTORY** 2
- #define **FILE_TYPE_SYMBOLIC_LINK** 4
- #define **FILE_PERM_NONE** 0
- #define **FILE_PERM_WRITE** 2
- #define **FILE_PERM_READ** 4
- #define **FILE_PERM_READ_EXEC** 5
- #define **FILE_PERM_READ_WRITE** 6
- #define **FILE_PERM_READ_WRITE_EXEC** 7
- #define **RESERVED_BYTES** 16

Typedefs

- typedef struct [FATConfig](#) **FATConfig**
*The LSB(rightmost under little endian) of the first entry of the FAT specifies the block size with the mapping as below: {LSB : size in bytes} = {0:256; 1:512; 2:1024; 3:2048; 4:4096} The MSB(leftmost under little endian) of the first entry of the FAT specifies the number of blocks that FAT region occupies. The MSB should be ranged from 1-32 (numbers outside of this range will be considered an error). FAT region size = block size * FAT region block number FAT entry number = FAT region size / FAT entry size (2-byte in FAT16) Data region size = block size * (FAT entry number - 1)*
- typedef struct [DirectoryEntry](#) **DirectoryEntry**
The structure of the directory entry as stored in the filesystem is as follows:

Functions

- [FATConfig](#) * [createFATConfig](#) (const char *name, uint16_t LSB, uint16_t MSB)
Create a [FATConfig](#) object.
- uint16_t * [createFAT16InMemory](#) ([FATConfig](#) *config)
Create a FAT16 object in memory.
- int [createFATOnDisk](#) ([FATConfig](#) *config)
Create a FAT16 object on disk.
- int [findEmptyFAT16Entry](#) ([FATConfig](#) *config, uint16_t *FAT16)
Return the index of next empty FAT entry.
- [DirectoryEntry](#) * [createDirectoryEntry](#) (const char *name, uint32_t size, uint16_t firstBlock, uint8_t type, uint8_t perm)
Create a Directory Entry object.
- int [createFileDirectoryOnDisk](#) ([FATConfig](#) *config, uint16_t *FAT16, const char *fileName, uint8_t fileType, uint8_t filePerm)
Create a File Directory On Disk object.
- int [findFileDirectory](#) ([FATConfig](#) *config, uint16_t *FAT16, const char *fileName)
Return the offset of the file directory entry in data region.
- int [readDirectoryEntry](#) ([FATConfig](#) *config, int offset, [DirectoryEntry](#) *dir)
Read the directory entry from FAT and set it to dir.
- int [writeFileDirectory](#) ([FATConfig](#) *config, int offset, [DirectoryEntry](#) *dir)
Write the directory entry to the offset.
- int [deleteFileDirectory](#) ([FATConfig](#) *config, uint16_t *FAT16, int directoryEntryOffset)
Delete the file directory entry.
- int [deleteFileDirectoryByName](#) ([FATConfig](#) *config, uint16_t *FAT16, const char *fileName)
Delete the file directory entry by file name.
- bool [isDirectoryEntryToDelete](#) ([FATConfig](#) *config, int offset)
Judge whether the directory entry is to be deleted.
- int [readFAT](#) ([FATConfig](#) *config, uint16_t *FAT16, int startBlock, int startBlockOffset, int size, char *buffer)
Read the file data from FAT and set it to buffer.
- int [writeFAT](#) ([FATConfig](#) *config, uint16_t *FAT16, int startBlock, int startBlockOffset, int size, const char *buffer)
Write the buffer to FAT.
- int [traceFileEnd](#) ([FATConfig](#) *config, uint16_t *FAT16, const char *fileName)
Return the offset of the file end.
- int [traceBytesFromBeginning](#) ([FATConfig](#) *config, uint16_t *FAT16, int directoryEntryOffset, int fileOffset)
Return the byte number from the file beginning to the file offset.
- int [traceBytesToEnd](#) ([FATConfig](#) *config, uint16_t *FAT16, int directoryEntryOffset, int fileOffset)
Return the byte number from the file offset to the file end.
- int [traceOffset](#) ([FATConfig](#) *config, uint16_t *FAT16, int directoryEntryOffset, int fileOffset, int n)
Return the offset of the n bytes after the given file offset.

5.29.1 Detailed Description

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Version

0.1

Date

2023-04-16

Copyright

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5.29.2 Typedef Documentation

5.29.2.1 DirectoryEntry

```
typedef struct DirectoryEntry DirectoryEntry
```

The structure of the directory entry as stored in the filesystem is as follows:

- char name[32]: null-terminated file name name[0] also serves as a special marker: – 0: end of directory – 1: deleted entry; the file is also deleted – 2: deleted entry; the file is still being used
- uint32_t size: number of bytes in file
- uint16_t firstBlock: the first block number of the file (undefined if size is zero) The block index of data region starts from 1. If the firstBlock is 0, it means that this is an empty file which has not occupied any data region block.
- uint8_t type: the type of the file, which will be one of the following: – 0: unknown – 1: a regular file – 2: a directory file – 4: a symbolic link
- uint8_t perm: file permissions, which will be one of the following: – 0: none – 2: write only – 4: read only – 5: read and executable (shell scripts) – 6: read and write – 7: read, write, and executable
- time_t mtime: creation/modification time as returned by time(2) in Linux

5.29.3 Function Documentation

5.29.3.1 createDirectoryEntry()

```
DirectoryEntry * createDirectoryEntry (  
    const char * name,  
    uint32_t size,  
    uint16_t firstBlock,  
    uint8_t type,  
    uint8_t perm )
```

Create a Directory Entry object.

Parameters

<i>name</i>	
<i>size</i>	
<i>firstBlock</i>	
<i>type</i>	
<i>perm</i>	

Returns

DirectoryEntry*

5.29.3.2 createFAT16InMemory()

```
uint16_t * createFAT16InMemory (
    FATConfig * config )
```

Create a FAT16 object in memory.

Parameters

<i>config</i>	
---------------	--

Returns

uint16_t*

5.29.3.3 createFATConfig()

```
FATConfig * createFATConfig (
    const char * name,
    uint16_t LSB,
    uint16_t MSB )
```

Create a [FATConfig](#) object.

Parameters

<i>name</i>	
<i>LSB</i>	
<i>MSB</i>	

Returns

FATConfig*

5.29.3.4 createFATOnDisk()

```
int createFATOnDisk (
    FATConfig * config )
```

Create a FAT16 object on disk.

Parameters

<i>config</i>	
---------------	--

Returns

int

5.29.3.5 createFileDirectoryOnDisk()

```
int createFileDirectoryOnDisk (
    FATConfig * config,
    uint16_t * FAT16,
    const char * fileName,
    uint8_t fileType,
    uint8_t filePerm )
```

Create a File Directory On Disk object.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>fileName</i>	
<i>fileType</i>	
<i>filePerm</i>	

Returns

int

5.29.3.6 deleteFileDirectory()

```
int deleteFileDirectory (
    FATConfig * config,
    uint16_t * FAT16,
    int directoryEntryOffset )
```

Delete the file directory entry.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>directoryEntryOffset</i>	

Returns

int

5.29.3.7 deleteFileDirectoryByName()

```
int deleteFileDirectoryByName (
    FATConfig * config,
    uint16_t * FAT16,
    const char * fileName )
```

Delete the file directory entry by file name.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>fileName</i>	

Returns

int

5.29.3.8 findEmptyFAT16Entry()

```
int findEmptyFAT16Entry (
    FATConfig * config,
    uint16_t * FAT16 )
```

Return the index of next empty FAT entry.

Parameters

<i>config</i>	
<i>FAT16</i>	

Returns

int

5.29.3.9 findFileDirectory()

```
int findFileDirectory (
    FATConfig * config,
    uint16_t * FAT16,
    const char * fileName )
```

Return the offset of the file directory entry in data region.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>fileName</i>	

Returns

int

5.29.3.10 isDirectoryEntryToDelete()

```
bool isDirectoryEntryToDelete (
    FATConfig * config,
    int offset )
```

Judge whether the directory entry is to be deleted.

Parameters

<i>config</i>	
<i>offset</i>	

Returns

true
false

5.29.3.11 readDirectoryEntry()

```
int readDirectoryEntry (
    FATConfig * config,
    int offset,
    DirectoryEntry * dir )
```

Read the directory entry from FAT and set it to dir.

Parameters

<i>config</i>	
<i>offset</i>	
<i>dir</i>	

Returns

int

5.29.3.12 readFAT()

```
int readFAT (
    FATConfig * config,
    uint16_t * FAT16,
    int startBlock,
    int startBlockOffset,
    int size,
    char * buffer )
```

Read the file data from FAT and set it to buffer.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>startBlock</i>	
<i>startBlockOffset</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.29.3.13 traceBytesFromBeginning()

```
int traceBytesFromBeginning (
    FATConfig * config,
    uint16_t * FAT16,
    int directoryEntryOffset,
    int fileOffset )
```

Return the byte number from the file beginning to the file offset.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>directoryEntryOffset</i>	
<i>fileOffset</i>	

Returns

int

5.29.3.14 traceBytesToEnd()

```
int traceBytesToEnd (
    FATConfig * config,
    uint16_t * FAT16,
    int directoryEntryOffset,
    int fileOffset )
```

Return the byte number from the file offset to the file end.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>directoryEntryOffset</i>	
<i>fileOffset</i>	

Returns

int

5.29.3.15 traceFileEnd()

```
int traceFileEnd (
    FATConfig * config,
    uint16_t * FAT16,
    const char * fileName )
```

Return the offset of the file end.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>fileName</i>	

Returns

int

5.29.3.16 traceOffset()

```
int traceOffset (
    FATConfig * config,
    uint16_t * FAT16,
    int directoryEntryOffset,
    int fileOffset,
    int n )
```

Return the offset of the n bytes after the given file offset.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>directoryEntryOffset</i>	
<i>fileOffset</i>	
<i>n</i>	

Returns

int

5.29.3.17 writeFAT()

```
int writeFAT (
    FATConfig * config,
```

```
uint16_t * FAT16,
int startBlock,
int startBlockOffset,
int size,
const char * buffer )
```

Write the buffer to FAT.

Parameters

<i>config</i>	
<i>FAT16</i>	
<i>startBlock</i>	
<i>startBlockOffset</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.29.3.18 writeFileDirectory()

```
int writeFileDirectory (
    FATConfig * config,
    int offset,
    DirectoryEntry * dir )
```

Write the directory entry to the offset.

Parameters

<i>config</i>	
<i>offset</i>	
<i>dir</i>	

Returns

int

5.30 FAT.h

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

```
00001
00011 #ifndef FAT_H
00012 #define FAT_H
00013
00014 #include "utils.h"
00015
00016 /* PennFAT is based on FAT16 */
```

```

00017 #define MIN_BLOCK_SIZE 256
00018 #define MAX_FAT_BLOCK_NUM 32
00019 #define MAX_BLOCK_SCALE 4
00020
00021 #define FAT_ENTRY_SIZE 2
00022 #define EMPTY_FAT_ENTRY 0x0000
00023 #define NO_SUCC_FAT_ENTRY 0xFFFF
00024
00025 #define MAX_FILE_NAME_LENGTH 32
00026
00036 typedef struct FATConfig {
00037     char name[MAX_FILE_NAME_LENGTH];
00038
00039     uint16_t LSB;
00040     uint16_t MSB;
00041
00042     int blockSize;
00043     int FATRegionBlockNum;
00044     int FATRegionSize;
00045     int FATEntryNum;
00046     int dataRegionSize;
00047
00048     /*
00049     The FAT region will be mapped to the memory through mmap().
00050     The size of the mapping area must be a multiple of the memory page size.
00051     */
00052     int FATSizeInMemory;
00053 } FATConfig;
00054
00055 /* PennFAT has a 64-byte fixed directory entry size (32 + 4 + 2 + 1 + 1 + 8 + 16 = 64 bytes)*/
00056 #define DIRECTORY_ENTRY_SIZE 64
00057
00058 #define NO_FIRST_BLOCK 0x0000
00059
00060 #define DIRECTORY_END "0"
00061 #define DELETED_DIRECTORY "1"
00062 /*
00063 Process A and Process B opened the same file.
00064 Process A unlinked the file but Process B was still using the file.
00065 The file should be deleted after Process B closes the file.
00066 */
00067 #define DELETED_DIRECTORY_IN_USE "2"
00068
00069 #define FILE_TYPE_UNKNOWN 0
00070 #define FILE_TYPE_REGULAR 1
00071 #define FILE_TYPE_DIRECTORY 2
00072 #define FILE_TYPE_SYMBOLIC_LINK 4
00073
00074 #define FILE_PERM_NONE 0 // 000
00075 #define FILE_PERM_WRITE 2 // 010
00076 #define FILE_PERM_READ 4 // 100
00077 #define FILE_PERM_READ_EXEC 5 // 101
00078 #define FILE_PERM_READ_WRITE 6 // 110
00079 #define FILE_PERM_READ_WRITE_EXEC 7 // 111
00080
00081 #define RESERVED_BYTES 16
00082
00107 typedef struct DirectoryEntry {
00108     char name[MAX_FILE_NAME_LENGTH]; // 32-byte
00109     uint32_t size; // 4-byte
00110     uint16_t firstBlock; // 2-byte
00111     uint8_t type; // 1-byte
00112     uint8_t perm; // 1-byte
00113     time_t mtime; // 8-byte
00114     char reserved[RESERVED_BYTES]; // 16-byte reserved space for extension
00115 } DirectoryEntry;
00124 FATConfig *createFATConfig(const char *name, uint16_t LSB, uint16_t MSB);
00131 uint16_t *createFAT16InMemory(FATConfig *config);
00138 int createFATOnDisk(FATConfig *config);
00139
00140 /* ##### TODO: Thread Safety ##### */
00141
00149 int findEmptyFAT16Entry(FATConfig *config, uint16_t *FAT16);
00160 DirectoryEntry *createDirectoryEntry(const char *name, uint32_t size, uint16_t firstBlock, uint8_t
type, uint8_t perm);
00171 int createFileDirectoryOnDisk(FATConfig *config, uint16_t *FAT16, const char *fileName, uint8_t
fileType, uint8_t filePerm);
00180 int findFileDirectory(FATConfig *config, uint16_t *FAT16, const char *fileName);
00189 int readDirectoryEntry(FATConfig *config, int offset, DirectoryEntry *dir);
00198 int writeFileDirectory(FATConfig *config, int offset, DirectoryEntry *dir);
00207 int deleteFileDirectory(FATConfig *config, uint16_t *FAT16, int directoryEntryOffset);
00216 int deleteFileDirectoryByName(FATConfig *config, uint16_t *FAT16, const char *fileName);
00225 bool isDirectoryEntryToDelete(FATConfig *config, int offset);
00237 int readFAT(FATConfig *config, uint16_t *FAT16, int startBlock, int startBlockOffset, int size, char
*buffer);
00249 int writeFAT(FATConfig *config, uint16_t *FAT16, int startBlock, int startBlockOffset, int size, const
char *buffer);

```

```

00258 int traceFileEnd(FATConfig *config, uint16_t *FAT16, const char *fileName);
00268 int traceBytesFromBeginning(FATConfig *config, uint16_t *FAT16, int directoryEntryOffset, int
    fileOffset);
00278 int traceBytesToEnd(FATConfig *config, uint16_t *FAT16, int directoryEntryOffset, int fileOffset);
00289 int traceOffset(FATConfig *config, uint16_t *FAT16, int directoryEntryOffset, int fileOffset, int n);
00290
00291 #endif

```

5.31 src/PennFAT/fd-table.c File Reference

```
#include "fd-table.h"
```

Functions

- `FdNode * createFdNode` (int openMode, int directoryEntryOffset, int fileOffset)
Create a Fd Node object.
- int `initFdTable` (FdTable *fdTable)
Initialize the file descriptor table.
- int `clearFdTable` (FdTable *fdTable)
Clear the file descriptor table.
- int `appendFdTable` (FdTable *fdTable, FdNode *newNode)
Append a new FdNode to the file descriptor table.
- int `removeFdNode` (FdNode *fdNode)
Remove a FdNode from the file descriptor table.
- bool `isFileBeingUsed` (FdTable *fdTable, int directoryEntryOffset)
Check if the file is being used by any file descriptor.
- bool `isFileBeingWritten` (FdTable *fdTable, int directoryEntryOffset)
Check if the file is being written by any file descriptor.
- int `findAvailableFd` (FdNode **fds)
Find the first available file descriptor.

5.31.1 Detailed Description

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Version

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Date

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Copyright

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5.31.2 Function Documentation

5.31.2.1 appendFdTable()

```
int appendFdTable (
    FdTable * fdTable,
    FdNode * newNode )
```

Append a new [FdNode](#) to the file descriptor table.

Parameters

<i>fdTable</i>	
<i>newNode</i>	

Returns

int

5.31.2.2 clearFdTable()

```
int clearFdTable (
    FdTable * fdTable )
```

Clear the file descriptor table.

Parameters

<i>fdTable</i>	
----------------	--

Returns

int

5.31.2.3 createFdNode()

```
FdNode * createFdNode (
    int openMode,
    int directoryEntryOffset,
    int fileOffset )
```

Create a Fd Node object.

Parameters

<i>openMode</i>	
<i>directoryEntryOffset</i>	
<i>fileOffset</i>	

Returns

FdNode*

5.31.2.4 findAvailableFd()

```
int findAvailableFd (
    FdNode ** fds )
```

Find the first available file descriptor.

Parameters

<i>fds</i>	
------------	--

Returns

int

5.31.2.5 initFdTable()

```
int initFdTable (
    FdTable * fdTable )
```

Initialize the file descriptor table.

Parameters

<i>fdTable</i>	
----------------	--

Returns

int

5.31.2.6 isFileBeingUsed()

```
bool isFileBeingUsed (
    FdTable * fdTable,
    int directoryEntryOffset )
```

Check if the file is being used by any file descriptor.

Parameters

<i>fdTable</i>	
<i>directoryEntryOffset</i>	

Returns

true
false

5.31.2.7 isFileBeingWritten()

```
bool isFileBeingWritten (
    FdTable * fdTable,
    int directoryEntryOffset )
```

Check if the file is being written by any file descriptor.

Parameters

<i>fdTable</i>	
<i>directoryEntryOffset</i>	

Returns

true
false

5.31.2.8 removeFdNode()

```
int removeFdNode (
    FdNode * fdNode )
```

Remove a [FdNode](#) from the file descriptor table.

Parameters

<code>fdNode</code>	
---------------------	--

Returns

`int`

5.32 src/PennFAT/fd-table.h File Reference

```
#include "utils.h"
#include "FAT.h"
```

Classes

- struct [FdNode](#)

There are three open mode supported by PennFAT: `F_WRITE`, `F_READ` and `F_APPEND`. According to ed #953, each file can only be read/write exclusivly which means only one instance can `open()` a file at a time. Under `F_APPEND` mode, the `fileOffset` will be set to the end of the file initially and it can only be increased. Under `F_WRITE/F_APPEND` mode, if the `fileOffset` is set to the position beyond the file size, the file system will occupy the space for the gap. As a result, the size of the file will increase, however, the gap space may contain uninitialized contents. Under `F_READ` mode, if the `fileOffset` is set to the position beyond the file size, `f_read()` will read nothing.

- struct [FdTable](#)

The file descriptor table is a linked list of [FdNode](#).

Macros

- `#define MAX_FILE_DESCRIPTOR 8`
- `#define F_STDIN_FD 0`
- `#define F_STDOUT_FD 1`
- `#define F_ERROR 2`
- `#define F_MIN_FD 3`
- `#define F_WRITE 0`
- `#define F_READ 1`
- `#define F_APPEND 2`

Typedefs

- typedef struct [FdNode](#) **FdNode**

There are three open mode supported by PennFAT: `F_WRITE`, `F_READ` and `F_APPEND`. According to ed #953, each file can only be read/write exclusivly which means only one instance can `open()` a file at a time. Under `F_APPEND` mode, the `fileOffset` will be set to the end of the file initially and it can only be increased. Under `F_WRITE/F_APPEND` mode, if the `fileOffset` is set to the position beyond the file size, the file system will occupy the space for the gap. As a result, the size of the file will increase, however, the gap space may contain uninitialized contents. Under `F_READ` mode, if the `fileOffset` is set to the position beyond the file size, `f_read()` will read nothing.

- typedef struct [FdTable](#) **FdTable**

The file descriptor table is a linked list of [FdNode](#).

Functions

- `FdNode * createFdNode` (int openMode, int directoryEntryOffset, int fileOffset)
Create a Fd Node object.
- int `initFdTable` (FdTable *fdTable)
Initialize the file descriptor table.
- int `clearFdTable` (FdTable *fdTable)
Clear the file descriptor table.
- int `appendFdTable` (FdTable *fdTable, FdNode *newNode)
Append a new FdNode to the file descriptor table.
- int `removeFdNode` (FdNode *fdNode)
Remove a FdNode from the file descriptor table.
- bool `isFileBeingUsed` (FdTable *fdTable, int directoryEntryOffset)
Check if the file is being used by any file descriptor.
- bool `isFileBeingWritten` (FdTable *fdTable, int directoryEntryOffset)
Check if the file is being written by any file descriptor.
- int `findAvailableFd` (FdNode **fds)
Find the first available file descriptor.

Variables

- `FATConfig * fs_FATConfig`
- `uint16_t * fs_FAT16InMemory`

5.32.1 Detailed Description

Author

Zhiyuan Liang (liangzhy@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.32.2 Typedef Documentation

5.32.2.1 FdTable

```
typedef struct FdTable FdTable
```

The file descriptor table is a linked list of [FdNode](#).

5.32.3 Function Documentation

5.32.3.1 appendFdTable()

```
int appendFdTable (  
    FdTable * fdTable,  
    FdNode * newNode )
```

Append a new [FdNode](#) to the file descriptor table.

Parameters

<i>fdTable</i>	
<i>newNode</i>	

Returns

int

5.32.3.2 clearFdTable()

```
int clearFdTable (  
    FdTable * fdTable )
```

Clear the file descriptor table.

Parameters

<i>fdTable</i>	
----------------	--

Returns

int

5.32.3.3 createFdNode()

```
FdNode * createFdNode (
    int openMode,
    int directoryEntryOffset,
    int fileOffset )
```

Create a Fd Node object.

Parameters

<i>openMode</i>	
<i>directoryEntryOffset</i>	
<i>fileOffset</i>	

Returns

FdNode*

5.32.3.4 findAvailableFd()

```
int findAvailableFd (
    FdNode ** fds )
```

Find the first available file descriptor.

Parameters

<i>fds</i>	
------------	--

Returns

int

5.32.3.5 initFdTable()

```
int initFdTable (
    FdTable * fdTable )
```

Initialize the file descriptor table.

Parameters

<i>fdTable</i>	
----------------	--

Returns

int

5.32.3.6 isFileBeingUsed()

```
bool isFileBeingUsed (
    FdTable * fdTable,
    int directoryEntryOffset )
```

Check if the file is being used by any file descriptor.

Parameters

<i>fdTable</i>	
<i>directoryEntryOffset</i>	

Returns

true

false

5.32.3.7 isFileBeingWritten()

```
bool isFileBeingWritten (
    FdTable * fdTable,
    int directoryEntryOffset )
```

Check if the file is being written by any file descriptor.

Parameters

<i>fdTable</i>	
<i>directoryEntryOffset</i>	

Returns

true

false

5.32.3.8 removeFdNode()

```
int removeFdNode (
    FdNode * fdNode )
```

Remove a [FdNode](#) from the file descriptor table.

Parameters

<i>fdNode</i>	
---------------	--

Returns

int

5.33 fd-table.h

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

```

00001
00011 #ifndef FD_TABLE_H
00012 #define FD_TABLE_H
00013
00014 #include "utils.h"
00015 #include "FAT.h"
00016
00017 extern FATConfig *fs_FATConfig;
00018 extern uint16_t *fs_FAT16InMemory;
00019
00020 #define MAX_FILE_DESCRIPTOR 8
00021
00022 /* file descriptor 0,1,2 were reserved */
00023 #define F_STDIN_FD 0
00024 #define F_STDOUT_FD 1
00025 #define F_ERROR 2
00026 #define F_MIN_FD 3
00027
00028 #define F_WRITE 0
00029 #define F_READ 1
00030 #define F_APPEND 2
00031
00032 /* We use linked list to implement the file descriptor table. */
00033
00034
00043 typedef struct FdNode {
00044     int openMode;
00045     int directoryEntryOffset; // directory entry location
00046     /* If a file is an empty file, the fileOffset will be set to 0. */
00047     int fileOffset;
00048
00049     struct FdNode* prev;
00050     struct FdNode* next;
00051 } FdNode;
00052
00057 typedef struct FdTable {
00058     FdNode *head;
00059     FdNode *tail;
00060 } FdTable;
00061
00070 FdNode *createFdNode(int openMode, int directoryEntryOffset, int fileOffset);
00077 int initFdTable(FdTable *fdTable);
00084 int clearFdTable(FdTable *fdTable);
00092 int appendFdTable(FdTable *fdTable, FdNode *newNode);
00099 int removeFdNode(FdNode *fdNode);
00108 bool isFileBeingUsed(FdTable *fdTable, int directoryEntryOffset);
00117 bool isFileBeingWritten(FdTable *fdTable, int directoryEntryOffset);
00124 int findAvailableFd(FdNode **fds);
00125
00126 #endif

```

5.34 src/PennFAT/filesys.c File Reference

```
#include "filesys.h"
```

Functions

- bool `isFileSystemMounted` ()
Check if the file system is mounted.
- bool `isValidFileName` (const char *fileName)
Check if the file name is valid.
- int `fs_mkfs` (const char *fsName, uint16_t blockSizeConfig, uint16_t FATRegionBlockNum)
Create a file system. Return 0 if success.
- int `fs_mount` (const char *fsName)
Mount the file system. Return 0 if success.
- int `fs_unmount` ()
Unmount the file system. Return 0 if success.
- int `fs_touch` (const char *fileName)
Creates the file if it does not exist, otherwise update its timestamp. Return the offset of the file directory entry.
- int `fs_rm` (const char *fileName)
Remove the file from FAT. Return 0 if success.
- int `fs_mv` (const char *src, const char *dst)
Rename src to dst. If dst exists, remove it from FAT. Return 0 if success.
- int `fs_cp` (const char *src, const char *dst)
Duplicate src to dst. If dst exists, replace it. Return 0 if success.
- int `fs_readFAT` (int startBlock, int startBlockOffset, int size, char *buffer)
Encapsulation of `readFAT()`. Return 0 if success.
- int `fs_writeFAT` (int startBlock, int startBlockOffset, int size, const char *buffer)
Encapsulation of `writeFAT()`. Return 0 if success.
- int `fs_chmod` (char *fileName, uint8_t perm)
Change the permission of the file. Return 0 if success.

Variables

- `FATConfig * fs_FATConfig` = NULL
- `uint16_t * fs_FAT16InMemory` = NULL
- `FdTable fs_fdTable`

5.34.1 Detailed Description

Author

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Version

0.1

Date

2023-04-16

Copyright

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5.34.2 Function Documentation

5.34.2.1 fs_chmod()

```
int fs_chmod (
    char * fileName,
    uint8_t perm )
```

Change the permission of the file. Return 0 if success.

Parameters

<i>fileName</i>	
<i>perm</i>	

Returns

int

5.34.2.2 fs_cp()

```
int fs_cp (
    const char * src,
    const char * dst )
```

Duplicate src to dst. If dst exists, replace it. Return 0 if success.

Parameters

<i>src</i>	
<i>dst</i>	

Returns

int

5.34.2.3 fs_mkfs()

```
int fs_mkfs (
    const char * fsName,
    uint16_t blockSizeConfig,
    uint16_t FATRegionBlockNum )
```

Create a file system. Return 0 if success.

Parameters

<i>fsName</i>	
<i>blockSizeConfig</i>	
<i>FATRegionBlockNum</i>	

Returns

int

5.34.2.4 fs_mount()

```
int fs_mount (
    const char * fsName )
```

Mount the file system. Return 0 if success.

Parameters

<i>fsName</i>	
---------------	--

Returns

int

5.34.2.5 fs_mv()

```
int fs_mv (
    const char * src,
    const char * dst )
```

Rename src to dst. If dst exists, remove it from FAT. Return 0 if success.

Parameters

<i>src</i>	
<i>dst</i>	

Returns

int

5.34.2.6 fs_readFAT()

```
int fs_readFAT (
    int startBlock,
    int startBlockOffset,
    int size,
    char * buffer )
```

Encapsulation of [readFAT\(\)](#). Return 0 if success.

Parameters

<i>startBlock</i>	
<i>startBlockOffset</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.34.2.7 fs_rm()

```
int fs_rm (
    const char * fileName )
```

Remove the file from FAT. Return 0 if success.

Parameters

<i>fileName</i>	
-----------------	--

Returns

int

5.34.2.8 fs_touch()

```
int fs_touch (
    const char * fileName )
```

Creates the file if it does not exist, otherwise update its timestamp. Return the offset of the file directory entry.

Parameters

<i>fileName</i>	
-----------------	--

Returns

int

5.34.2.9 fs_unmount()

```
int fs_unmount ( )
```

Unmount the file system. Return 0 if success.

Returns

int

5.34.2.10 fs_writeFAT()

```
int fs_writeFAT (
    int startBlock,
    int startBlockOffset,
    int size,
    const char * buffer )
```

Encapsulation of [writeFAT\(\)](#). Return 0 if success.

Parameters

<i>startBlock</i>	
<i>startBlockOffset</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.34.2.11 isFileSystemMounted()

```
bool isFileSystemMounted ( )
```

Check if the file system is mounted.

Returns

true

false

5.34.2.12 isValidFileName()

```
bool isValidFileName (
    const char * fileName )
```

Check if the file name is valid.

Parameters

<code>fileName</code>	
-----------------------	--

Returns

true
false

5.35 src/PennFAT/filesys.h File Reference

```
#include "utils.h"
#include "FAT.h"
#include "fd-table.h"
```

Functions

- bool [isFileSystemMounted](#) ()
Check if the file system is mounted.
- bool [isValidFileName](#) (const char *fileName)
Check if the file name is valid.
- int [fs_mkfs](#) (const char *fsName, uint16_t blockSizeConfig, uint16_t FATRegionBlockNum)
Create a file system. Return 0 if success.
- int [fs_mount](#) (const char *fsName)
Mount the file system. Return 0 if success.
- int [fs_unmount](#) ()
Unmount the file system. Return 0 if success.
- int [fs_touch](#) (const char *fileName)
Creates the file if it does not exist, otherwise update its timestamp. Return the offset of the file directory entry.
- int [fs_rm](#) (const char *fileName)
Remove the file from FAT. Return 0 if success.
- int [fs_mv](#) (const char *src, const char *dst)
Rename src to dst. If dst exists, remove it from FAT. Return 0 if success.
- int [fs_cp](#) (const char *src, const char *dst)
Duplicate src to dst. If dst exists, replace it. Return 0 if success.
- int [fs_readFAT](#) (int startBlock, int startBlockOffset, int size, char *buffer)
Encapsulation of [readFAT\(\)](#). Return 0 if success.
- int [fs_writeFAT](#) (int startBlock, int startBlockOffset, int size, const char *buffer)
Encapsulation of [writeFAT\(\)](#). Return 0 if success.
- int [fs_chmod](#) (char *fileName, uint8_t perm)
Change the permission of the file. Return 0 if success.

5.35.1 Detailed Description

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Version

0.1

Date

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Copyright

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5.35.2 Function Documentation

5.35.2.1 fs_chmod()

```
int fs_chmod (
    char * fileName,
    uint8_t perm )
```

Change the permission of the file. Return 0 if success.

Parameters

<i>fileName</i>	
<i>perm</i>	

Returns

int

5.35.2.2 fs_cp()

```
int fs_cp (
    const char * src,
    const char * dst )
```

Duplicate src to dst. If dst exists, replace it. Return 0 if success.

Parameters

<i>src</i>	
<i>dst</i>	

Returns

int

5.35.2.3 fs_mkfs()

```
int fs_mkfs (
    const char * fsName,
    uint16_t blockSizeConfig,
    uint16_t FATRegionBlockNum )
```

Create a file system. Return 0 if success.

Parameters

<i>fsName</i>	
<i>blockSizeConfig</i>	
<i>FATRegionBlockNum</i>	

Returns

int

5.35.2.4 fs_mount()

```
int fs_mount (
    const char * fsName )
```

Mount the file system. Return 0 if success.

Parameters

<i>fsName</i>	
---------------	--

Returns

int

5.35.2.5 fs_mv()

```
int fs_mv (
    const char * src,
    const char * dst )
```

Rename *src* to *dst*. If *dst* exists, remove it from FAT. Return 0 if success.

Parameters

<i>src</i>	
<i>dst</i>	

Returns

int

5.35.2.6 fs_readFAT()

```
int fs_readFAT (
    int startBlock,
    int startBlockOffset,
    int size,
    char * buffer )
```

Encapsulation of [readFAT\(\)](#). Return 0 if success.

Parameters

<i>startBlock</i>	
<i>startBlockOffset</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.35.2.7 fs_rm()

```
int fs_rm (
    const char * fileName )
```

Remove the file from FAT. Return 0 if success.

Parameters

<i>fileName</i>	
-----------------	--

Returns

int

5.35.2.8 fs_touch()

```
int fs_touch (
    const char * fileName )
```

Creates the file if it does not exist, otherwise update its timestamp. Return the offset of the file directory entry.

Parameters

<i>fileName</i>	
-----------------	--

Returns

int

5.35.2.9 fs_unmount()

```
int fs_unmount ( )
```

Unmount the file system. Return 0 if success.

Returns

int

5.35.2.10 fs_writeFAT()

```
int fs_writeFAT (
    int startBlock,
    int startBlockOffset,
    int size,
    const char * buffer )
```

Encapsulation of [writeFAT\(\)](#). Return 0 if success.

Parameters

<i>startBlock</i>	
<i>startBlockOffset</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.35.2.11 `isFileSystemMounted()`

```
bool isFileSystemMounted ( )
```

Check if the file system is mounted.

Returns

true

false

5.35.2.12 `isValidFileName()`

```
bool isValidFileName (
    const char * fileName )
```

Check if the file name is valid.

Parameters

<i>fileName</i>	
-----------------	--

Returns

true

false

5.36 `filesystem.h`

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

```
00001
00011 #ifndef FILESYS_H
```

```

00012 #define FILESYS_H
00013
00014 #include "utils.h"
00015 #include "FAT.h"
00016 #include "fd-table.h"
00017
00024 bool isFileSystemMounted();
00032 bool isValidFileName(const char *fileName);
00033
00042 int fs_mkfs(const char *fsName, uint16_t blockSizeConfig, uint16_t FATRegionBlockNum);
00049 int fs_mount(const char *fsName);
00055 int fs_unmount();
00062 int fs_touch(const char *fileName);
00069 int fs_rm(const char *fileName);
00077 int fs_mv(const char *src, const char *dst);
00085 int fs_cp(const char *src, const char *dst);
00095 int fs_readFAT(int startBlock, int startBlockOffset, int size, char *buffer);
00096
00106 int fs_writeFAT(int startBlock, int startBlockOffset, int size, const char *buffer);
00114 int fs_chmod(char *fileName, uint8_t perm);
00115
00116
00117 #endif

```

5.37 src/PennFAT/interface.c File Reference

```

#include "interface.h"
#include "filesys.h"

```

Functions

- int [f_open](#) (const char *fname, int mode)
Open a file with the given mode.
- int [f_close](#) (int fd)
Close a file.
- int [f_read](#) (int fd, int n, char *buf)
Read n bytes from the file.
- int [f_write](#) (int fd, const char *str, int n)
Write n bytes to the file.
- int [f_lseek](#) (int fd, int offset, int whence)
Seek to a position in the file.
- int [f_unlink](#) (const char *fname)
Unlink a file.
- int [f_ls](#) (const char *filename)
List all files in the current directory.
- bool [f_find](#) (const char *filename)
Check if a file exists.
- bool [f_isExecutable](#) (const char *filename)
Check if a file is executable.

Variables

- [FATConfig](#) * [fs_FATConfig](#)
- uint16_t * [fs_FAT16InMemory](#)
- [FdTable](#) [fs_fdTable](#)
- [pcb](#) * [active_process](#)

5.37.1 Detailed Description

Author

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Version

0.1

Date

2023-04-16

Copyright

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5.37.2 Function Documentation

5.37.2.1 `f_close()`

```
int f_close (
    int fd )
```

Close a file.

Parameters

<i>fd</i>	
-----------	--

Returns

int

5.37.2.2 `f_find()`

```
bool f_find (
    const char * filename )
```

Check if a file exists.

Parameters

<i>filename</i>	
-----------------	--

Returns

true

false

5.37.2.3 f_isExecutable()

```
bool f_isExecutable (
    const char * filename )
```

Check if a file is executable.

Parameters

<i>filename</i>	
-----------------	--

Returns

true

false

5.37.2.4 f_ls()

```
int f_ls (
    const char * filename )
```

List all files in the current directory.

Parameters

<i>filename</i>	
-----------------	--

Returns

int

5.37.2.5 f_lseek()

```
int f_lseek (
    int fd,
    int offset,
    int whence )
```

Seek to a position in the file.

Parameters

<i>fd</i>	
<i>offset</i>	
<i>whence</i>	

Returns

int

5.37.2.6 f_open()

```
int f_open (
    const char * fname,
    int mode )
```

Open a file with the given mode.

Parameters

<i>fname</i>	
<i>mode</i>	

Returns

int

5.37.2.7 f_read()

```
int f_read (
    int fd,
    int n,
    char * buf )
```

Read n bytes from the file.

Parameters

<i>fd</i>	
<i>n</i>	
<i>buf</i>	

Returns

int

5.37.2.8 f_unlink()

```
int f_unlink (
    const char * fname )
```

Unlink a file.

Parameters

<i>fname</i>	
--------------	--

Returns

int

5.37.2.9 f_write()

```
int f_write (
    int fd,
    const char * str,
    int n )
```

Write *n* bytes to the file.

Parameters

<i>fd</i>	
<i>str</i>	
<i>n</i>	

Returns

int

5.38 src/PennFAT/interface.h File Reference

```
#include "../kernel/utils.h"
```

Macros

- `#define F_STDIN_FD 0`
- `#define F_STDOUT_FD 1`
- `#define F_ERROR 2`
- `#define F_WRITE 0`
- `#define F_READ 1`
- `#define F_APPEND 2`
- `#define F_SEEK_SET 0`
- `#define F_SEEK_CUR 1`
- `#define F_SEEK_END 2`
- `#define F_SUCCESS 0`
- `#define F_FAILURE -1`

Functions

- `int f_open` (const char *fname, int mode)
Open a file with the given mode.
- `int f_close` (int fd)
Close a file.
- `int f_read` (int fd, int n, char *buf)
Read n bytes from the file.
- `int f_write` (int fd, const char *str, int n)
Write n bytes to the file.
- `int f_lseek` (int fd, int offset, int whence)
Seek to a position in the file.
- `int f_unlink` (const char *fname)
Unlink a file.
- `int f_ls` (const char *filename)
List all files in the current directory.
- `bool f_find` (const char *filename)
Check if a file exists.
- `bool f_isExecutable` (const char *filename)
Check if a file is executable.

5.38.1 Detailed Description

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Version

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Date

2023-04-16

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5.38.2 Function Documentation

5.38.2.1 `f_close()`

```
int f_close (
    int fd )
```

Close a file.

Parameters

<i>fd</i>	
-----------	--

Returns

int

5.38.2.2 `f_find()`

```
bool f_find (
    const char * filename )
```

Check if a file exists.

Parameters

<i>filename</i>	
-----------------	--

Returns

true

false

5.38.2.3 `f_isExecutable()`

```
bool f_isExecutable (
    const char * filename )
```

Check if a file is executable.

Parameters

<i>filename</i>	
-----------------	--

Returns

true
false

5.38.2.4 f_ls()

```
int f_ls (
    const char * filename )
```

List all files in the current directory.

Parameters

<i>filename</i>	
-----------------	--

Returns

int

5.38.2.5 f_lseek()

```
int f_lseek (
    int fd,
    int offset,
    int whence )
```

Seek to a position in the file.

Parameters

<i>fd</i>	
<i>offset</i>	
<i>whence</i>	

Returns

int

5.38.2.6 `f_open()`

```
int f_open (
    const char * fname,
    int mode )
```

Open a file with the given mode.

Parameters

<i>fname</i>	
<i>mode</i>	

Returns

int

5.38.2.7 `f_read()`

```
int f_read (
    int fd,
    int n,
    char * buf )
```

Read *n* bytes from the file.

Parameters

<i>fd</i>	
<i>n</i>	
<i>buf</i>	

Returns

int

5.38.2.8 `f_unlink()`

```
int f_unlink (
    const char * fname )
```

Unlink a file.

Parameters

<i>fname</i>	
--------------	--

Returns

int

5.38.2.9 f_write()

```
int f_write (
    int fd,
    const char * str,
    int n )
```

Write n bytes to the file.

Parameters

<i>fd</i>	
<i>str</i>	
<i>n</i>	

Returns

int

5.39 interface.h

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

```
00001
00011 #ifndef FILESYS_INTERFACE_H
00012 #define FILESYS_INTERFACE_H
00013
00014 #define F_STDIN_FD 0
00015 #define F_STDOUT_FD 1
00016 #define F_ERROR 2
00017
00018 #define F_WRITE 0
00019 #define F_READ 1
00020 #define F_APPEND 2
00021
00022 #define F_SEEK_SET 0
00023 #define F_SEEK_CUR 1
00024 #define F_SEEK_END 2
00025
00026 #define F_SUCCESS 0
00027 #define F_FAILURE -1
00028
00029 #include "../kernel/utls.h"
00030
00038 int f_open(const char *fname, int mode);
00045 int f_close(int fd);
00054 int f_read(int fd, int n, char *buf);
00063 int f_write(int fd, const char *str, int n);
00072 int f_lseek(int fd, int offset, int whence);
00079 int f_unlink(const char *fname);
00086 int f_ls(const char *filename);
00094 bool f_find(const char *filename);
0102 bool f_isExecutable(const char *filename);
0103
0104 #endif
```

5.40 src/PennFAT/pennFAT.c File Reference

```
#include "pennFAT.h"
```

Functions

- bool [pf_isMounted](#) ()
Check if the PennFAT is mounted.
- int [pf_readFile](#) (const char *fileName, int size, char *buffer)
Read a file.
- int [pf_writeFile](#) (const char *fileName, int size, const char *buffer, [PF_WRITEMODE](#) mode)
Write a file.
- int [pf_mkfs](#) (const char *fsName, int BLOCKS_IN_FAT, int BLOCK_SIZE_CONFIG)
Make a PennFAT file system.
- int [pf_mount](#) (const char *fsName)
Mount a PennFAT file system.
- int [pf_umount](#) ()
Unmount a PennFAT file system.
- int [pf_touch](#) (const char *fileName)
Create a file.
- int [pf_rm](#) (const char *fileName)
Remove a file.
- int [pf_mv](#) (const char *src, const char *dst)
Rename a file.
- int [pf_ls](#) ()
List all files.
- int [pf_chmod](#) (const char *fileName, uint8_t perm)
Change the permission of a file.
- int [pf_catFiles](#) (char **fileNames, int fileNum, int *size, char *buffer)
Cat files.
- void [SIGINTHandler](#) (int sig)
Signal handler for SIGINT.
- char * [readInput](#) (char *inputBuffer)
Read input utility function.
- int [parseInput](#) (char *userInput, char **argsBuffer, int *argNum)
Parse input utility function.
- int **main** (int argc, char **argv)

5.40.1 Detailed Description

Author

Zhiyuan Liang (liangzhy@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.40.2 Function Documentation

5.40.2.1 parseInput()

```
int parseInput (
    char * userInput,
    char ** argsBuffer,
    int * argNum )
```

Parse input utility function.

Parameters

<i>userInput</i>	
<i>argsBuffer</i>	
<i>argNum</i>	

Returns

int

5.40.2.2 pf_catFiles()

```
int pf_catFiles (
    char ** fileNames,
    int fileNum,
    int * size,
    char * buffer )
```

Cat files.

Parameters

<i>fileNames</i>	
<i>fileNum</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.40.2.3 pf_chmod()

```
int pf_chmod (
    const char * fileName,
    uint8_t perm )
```

Change the permission of a file.

Parameters

<i>fileName</i>	
<i>perm</i>	

Returns

int

5.40.2.4 pf_isMounted()

```
bool pf_isMounted ( )
```

Check if the PennFAT is mounted.

Returns

true

false

5.40.2.5 pf_ls()

```
int pf_ls ( )
```

List all files.

Returns

int

5.40.2.6 pf_mkfs()

```
int pf_mkfs (
    const char * fsName,
    int BLOCKS_IN_FAT,
    int BLOCK_SIZE_CONFIG )
```

Make a PennFAT file system.

Parameters

<i>fsName</i>	
<i>BLOCKS_IN_FAT</i>	
<i>BLOCK_SIZE_CONFIG</i>	

Returns

int

5.40.2.7 pf_mount()

```
int pf_mount (
    const char * fsName )
```

Mount a PennFAT file system.

Parameters

<i>fsName</i>	
---------------	--

Returns

int

5.40.2.8 pf_mv()

```
int pf_mv (
    const char * src,
    const char * dst )
```

Rename a file.

Parameters

<i>src</i>	
<i>dst</i>	

Returns

int

5.40.2.9 pf_readFile()

```
int pf_readFile (
    const char * fileName,
    int size,
    char * buffer )
```

Read a file.

Parameters

<i>fileName</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.40.2.10 pf_rm()

```
int pf_rm (
    const char * fileName )
```

Remove a file.

Parameters

<i>fileName</i>	
-----------------	--

Returns

int

5.40.2.11 pf_touch()

```
int pf_touch (
    const char * fileName )
```

Create a file.

Parameters

<i>fileName</i>	
-----------------	--

Returns

int

5.40.2.12 pf_umount()

```
int pf_umount ( )
```

Unmount a PennFAT file system.

Returns

int

5.40.2.13 pf_writeFile()

```
int pf_writeFile (
    const char * fileName,
    int size,
    const char * buffer,
    PF_WRITEMODE mode )
```

Write a file.

Parameters

<i>fileName</i>	
<i>size</i>	
<i>buffer</i>	
<i>mode</i>	

Returns

int

5.40.2.14 readInput()

```
char * readInput (
    char * inputBuffer )
```

Read input utility function.

Parameters

<i>inputBuffer</i>	
--------------------	--

Returns

char*

5.40.2.15 SIGINTHandler()

```
void SIGINTHandler (
    int sig )
```

Signal handler for SIGINT.

Parameters

<i>sig</i>	
------------	--

5.41 src/PennFAT/pennFAT.h File Reference

```
#include "fileSYS.h"
#include "signal.h"
```

Macros

- #define **PF_MAX_BUFFER_SIZE** 32512
- #define **PF_MAX_FILE_NUM** 4
- #define **MAX_LINE_LENGTH** 4096
- #define **MAX_ARGS_NUM** 8
- #define **EXIT_SHREDDER** -1
- #define **EMPTY_LINE** 0
- #define **EXECUTE_COMMAND** 1

Enumerations

- enum **PF_WRITEMODE** { **PF_OVERWRITE** , **PF_APPEND** , **PF_STDOUT** }
PennFAT write mode.

Functions

- bool [pf_isMounted](#) ()
Check if the PennFAT is mounted.
- int [pf_readFile](#) (const char *fileName, int size, char *buffer)
Read a file.
- int [pf_writeFile](#) (const char *fileName, int size, const char *buffer, [PF_WRITEMODE](#) mode)
Write a file.
- int [pf_mkfs](#) (const char *fsName, int BLOCKS_IN_FAT, int BLOCK_SIZE_CONFIG)
Make a PennFAT file system.
- int [pf_mount](#) (const char *fsName)
Mount a PennFAT file system.
- int [pf_umount](#) ()
Unmount a PennFAT file system.
- int [pf_touch](#) (const char *fileName)
Create a file.
- int [pf_rm](#) (const char *fileName)
Remove a file.
- int [pf_mv](#) (const char *src, const char *dst)
Rename a file.
- int [pf_ls](#) ()
List all files.
- int [pf_chmod](#) (const char *fileName, uint8_t perm)
Change the permission of a file.
- int [pf_catFiles](#) (char **fileNames, int fileNum, int *size, char *buffer)
Cat files.
- void [SIGINTHandler](#) (int sig)
Signal handler for SIGINT.
- char * [readInput](#) (char *inputBuffer)
Read input utility function.
- int [parseInput](#) (char *userInput, char **argsBuffer, int *argNum)
Parse input utility function.

Variables

- [FATConfig](#) * [fs_FATConfig](#)
- uint16_t * [fs_FAT16InMemory](#)

5.41.1 Detailed Description

Author

Zhiyuan Liang (liangzhy@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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5.41.2 Enumeration Type Documentation

5.41.2.1 PF_WRITEMODE

enum [PF_WRITEMODE](#)

PennFAT write mode.

5.41.3 Function Documentation

5.41.3.1 parseInput()

```
int parseInput (
    char * userInput,
    char ** argsBuffer,
    int * argNum )
```

Parse input utility function.

Parameters

<i>userInput</i>	
<i>argsBuffer</i>	
<i>argNum</i>	

Returns

int

5.41.3.2 pf_catFiles()

```
int pf_catFiles (
    char ** fileNames,
    int fileNum,
    int * size,
    char * buffer )
```

Cat files.

Parameters

<i>fileNames</i>	
<i>fileNum</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.41.3.3 pf_chmod()

```
int pf_chmod (
    const char * fileName,
    uint8_t perm )
```

Change the permission of a file.

Parameters

<i>fileName</i>	
<i>perm</i>	

Returns

int

5.41.3.4 pf_isMounted()

```
bool pf_isMounted ( )
```

Check if the PennFAT is mounted.

Returns

true

false

5.41.3.5 pf_ls()

```
int pf_ls ( )
```

List all files.

Returns

int

5.41.3.6 pf_mkfs()

```
int pf_mkfs (
    const char * fsName,
    int BLOCKS_IN_FAT,
    int BLOCK_SIZE_CONFIG )
```

Make a PennFAT file system.

Parameters

<i>fsName</i>	
<i>BLOCKS_IN_FAT</i>	
<i>BLOCK_SIZE_CONFIG</i>	

Returns

int

5.41.3.7 pf_mount()

```
int pf_mount (
    const char * fsName )
```

Mount a PennFAT file system.

Parameters

<i>fsName</i>	
---------------	--

Returns

int

5.41.3.8 pf_mv()

```
int pf_mv (
    const char * src,
    const char * dst )
```

Rename a file.

Parameters

<i>src</i>	
<i>dst</i>	

Returns

int

5.41.3.9 pf_readFile()

```
int pf_readFile (
    const char * fileName,
    int size,
    char * buffer )
```

Read a file.

Parameters

<i>fileName</i>	
<i>size</i>	
<i>buffer</i>	

Returns

int

5.41.3.10 pf_rm()

```
int pf_rm (
    const char * fileName )
```

Remove a file.

Parameters

<i>fileName</i>	
-----------------	--

Returns

int

5.41.3.11 pf_touch()

```
int pf_touch (
    const char * fileName )
```

Create a file.

Parameters

<i>fileName</i>	
-----------------	--

Returns

int

5.41.3.12 pf_umount()

```
int pf_umount ( )
```

Unmount a PennFAT file system.

Returns

int

5.41.3.13 pf_writeFile()

```
int pf_writeFile (
    const char * fileName,
    int size,
    const char * buffer,
    PF_WRITEMODE mode )
```

Write a file.

Parameters

<i>fileName</i>	
<i>size</i>	
<i>buffer</i>	
<i>mode</i>	

Returns

int

5.41.3.14 readInput()

```
char * readInput (
    char * inputBuffer )
```

Read input utility function.

Parameters

<i>inputBuffer</i>	
--------------------	--

Returns

char*

5.41.3.15 SIGINTHandler()

```
void SIGINTHandler (
    int sig )
```

Signal handler for SIGINT.

Parameters

<i>sig</i>	
------------	--

5.42 pennFAT.h

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

```
00001
00011 #ifndef PENNFAT_H
00012 #define PENNFAT_H
00013
00014 #include "fileysys.h"
00015 #include "signal.h"
00016
00017 #define PF_MAX_BUFFER_SIZE 32512
00018 #define PF_MAX_FILE_NUM 4
00019
00020 extern FATConfig *fs_FATConfig;
00021 extern uint16_t *fs_FAT16InMemory;
00022
00027 typedef enum {
00028     PF_OVERWRITE,
00029     PF_APPEND,
```

```

00030     PF_STDOUT
00031 } PF_WRITEMODE;
00032
00039 bool pf_isMounted();
00048 int pf_readFile(const char *fileName, int size, char *buffer);
00058 int pf_writeFile(const char *fileName, int size, const char *buffer, PF_WRITEMODE mode);
00059 ;
00067 int pf_mkfs(const char *fsName, int BLOCKS_IN_FAT, int BLOCK_SIZE_CONFIG);
00074 int pf_mount(const char *fsName);
00080 int pf_umount();
00087 int pf_touch(const char *fileName);
00094 int pf_rm(const char *fileName);
00102 int pf_mv(const char *src, const char *dst);
00108 int pf_ls();
00116 int pf_chmod(const char *fileName, uint8_t perm);
00126 int pf_catFiles(char **fileNames, int fileNum, int *size, char *buffer);
00127
00128
00129 #define MAX_LINE_LENGTH 4096
00130 #define MAX_ARGS_NUM 8
00131
00132 #define EXIT_SHREDDER -1
00133 #define EMPTY_LINE 0
00134 #define EXECUTE_COMMAND 1
00140 void SIGINTHandler(int sig);
00147 char *readInput(char *inputBuffer);
00156 int parseInput(char *userInput, char **argsBuffer, int *argNum);
00157
00158 #endif

```

5.43 src/PennFAT/test-playground.c File Reference

```

#include "interface.h"
#include "pennFAT.h"

```

Functions

- int **main** (int argc, char **argv)

Variables

- `pcb` * **active_process**

5.43.1 Detailed Description

Author

Zhiyuan Liang (liangzhy@seas.upenn.edu)

Version

0.1

Date

2023-04-16

Copyright

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