

The Beerman Fan Club

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<https://github.com/CSC415-2022-Fall/csc415-filesystem-thebeermanfanclub>

File System Writeup

Description of File System:

Our file system can be broken down into three main components. The first component would be our Volume Control block, the second component would be our free space management, and our third component would be our Directory Entry Structure. Our Volume Control Block is responsible for holding information about our file system. These are the variables we implemented into our Volume Control Block.

```
typedef struct VCB{
    uint64_t size_of_block;           //size of a individual block
    uint64_t number_of_blocks;        //counts the number of blocks
    uint64_t blocks_available;        //holds blocks available
    uint64_t bitmap_starting_index;   //where the bitmap starts
    uint64_t bitmap_size_bytes;       // Size of bitmap in bytes
    uint64_t bitmap_size_blocks;      // Size of bitmap in blocks

    uint64_t root_starting_index;     // LBA where root starts
    uint64_t root_size;               // Size of root in blocks

    uint64_t signature;               //used to check if own the volume
} VCB;
```

Our Volume Control Block has a limited amount of space, 10MB. We manage this space by formatting free-space management. There were multiple ways to track free space, but we used

bitwise operations to keep track of our free space. Our bitmap is set up to help keep track of free space used by using bitwise operators flipping bit signs based on whether they are considered free or not.

Issues:

1. Setting up a meeting at first was difficult since we have our different schedules. We held our meetings every day for hours and worked together. We made progress each time we visited. If any one of our team members ran into a problem doing their own task, we ensured we all helped each other. We communicated most of the time through discord.
2. We had a lot of confusion about how to start the project. Later on when we started doing the project we had to figure out how to initialize our free space. It took some time and attempts to figure out how to do it. We resolved it by bouncing ideas with each other and trying them out to see if they worked.
3. ParsePath was a huge hurdle, as it was an incredibly important function for the system. A lot of smaller issues came up around functions wanting certain information, and so we constantly modified it to accommodate.

Detail of Driver Program:

- MFS.C
 - fs_mkdir
 - Creates a directory at the given path. May resize the parent directory to accommodate. It will also give the new directory the name at the end of the path.
 - fs_rmdir
 - Removes the directory at the given path. Checks to make sure the directory is empty before removal, by counting the number of DEs inside with the numberOfFilesInDir function. If that comes out to 2, we know

the directory is empty (includes only '.' and '..'), so we free its blocks and set its name to null, so that other DEs can be placed in that slot.

- fs_opendir

- Open Directory takes a pathname as a parameter and validates whether or not the pathname given is a valid path. If it's a valid path, it will be parsed, and the parsed information will be held in parsed_data, which is a type parsed data C structure.

```
DE* directoryPtr = malloc(d_reclen*vcb->size_of_block);
LBaread(directoryPtr, d_reclen, directoryStartLocation);
```

The function then created a directory entry pointer (DE *) and memory allocates the appropriate size of the directory by multiplying its block length with the block size found in the VCB. This pointer is used to read the parent directory needed. After the function LBAWrites into the pointer a file descriptor pointer is initialized and memory allocated the size of the C structure fdDir.

```
fdPtr->directoryStartLocation = directoryPtr->location;
fdPtr->d_reclen = directoryPtr->size;
fdPtr->dirEntryPosition = 0;
fdPtr->ii = malloc(sizeof(struct fs_diriteminfo));
if(fdPtr->ii == NULL){
    printf("Error: Failed to allocate memory\n");

    return NULL;
}
```

The function then populates the directory file descriptor with information about the directory and finishes by freeing all the pointers used and returning the directory file descriptor.

- fs_readdir

- The read directory takes in a directory file descriptor (fdPtr) and then validates if the given path is a directory using fs_isDir. If it is a valid path, the path is parsed using the passed path, and the information is stored in a parsedData C structure.

```

for(int i = dirp->dirEntryPosition; i < ((directory->size*vcb->size_of_block)/(sizeof(DE))); i++){
    // Check all but empty dirs
    if(strcmp(directory[i].name, "\0") != 0){
        strncpy(dirp->ii->d_name, directory[i].name, MAX_DE_NAME);
        dirp->ii->fileType = directory[i].is_directory; //have something to tell you file type
        dirp->dirEntryPosition = i + 1;
        foundItem = 1;
        break;
    }
}

```

The next step for the function is to iterate from the entry position through each directory entry in the parent directory. When the directory entry has a non-null directory entry name, it will store the directory entry name, directory entry type, and directory entry position in the directory. If no entry is found, it will return NULL, but if an entry is found, it will return a pointer to the directory item information C structure.

- fs_closedir

```

int fs_closedir(fdDir *dirp){
    free(dirp->ii);
    free(dirp);

    return 1;
};

```

- The closed directory function frees all the memory allocated in the open directory function. More specifically, the directory pointer and the item information pointer. Both of these pointers are used throughout the open life of the file.

- fs_getcwd

```

char * fs_getcwd(char *pathname, size_t size){
    strncpy(pathname, current_working_dir, size);

    return pathname;
};

```

- Getting the current working directory takes a character pointer buffer and the size of the pathname. The function then copies the current working directory character array to the buffer without going over the given size. The variable `current_working_dir` is a global variable found in the `mfs.h` file that holds the current working directory of the file. Used by the `pwd` command.

```
Prompt > pwd
/
Prompt >
```

- fs_setcwd

- Set current working directory is a function utilized by the change directory (CD) command. The function takes a pathname as an argument and then parses the path using the parsePath function. The parse path function acts in a way to not only store information on the pathname we're parsing, but also validates whether that pathname is valid.

```
if(data->testDirectoryStatus == 2){
    printf("Error: Not a directory\n");
    ret_val = -1;
}
else if(data->testDirectoryStatus == 0){
    printf("Error: Invalid path\n");
    ret_val = -1;
}
```

parsePath returns a directory status that indicates whether the given path is not a directory or not a valid path. The next step after making sure the path is valid and is a directory is to create a new pathname.

```
// Get CWD
char* cwd = malloc(MAX_PATH_LENGTH);
if(cwd == NULL){
    printf("Error: Failed to allocate memory\n");
    return -1;
}
fs_getcwd(cwd, MAX_PATH_LENGTH);

// Add cwd to path, then tack on the relative path after it
// Redundancy for clarity. Imagine starting at 0 and rebuilding
strncpy(current_working_dir, cwd, MAX_PATH_LENGTH);
strncpy(current_working_dir+strlen(cwd), pathname, MAX_PATH_LENGTH-strlen(cwd));
```

The function allocates memory to a char pointer and gets the current working directory that the command is being called in. The function then concatenates the current working directory and the directory it wants to access. If the pathname is absolute pathname it will call formatPath then concatenate the directory it wants to access to the new pathname, also removing inconvenient tokens (such as '.' or '/' that would bloat the path). The return is whether the function was successful or not.

```
Prompt > pwd
/
Prompt > cd Dir
Prompt > pwd
/Dir/
Prompt >
```

- fs_isFile
 - This function is responsible for checking to see if the filename passed into the function is actually a file. How do we check this? Within our parseData structure, we have a variable which keeps track of whether a file is a file, a directory, or an invalid path. This variable is called int testDirectoryStatus. This is done within parse path as we loop through a directory buffer we have, we check our current_element in the buffer and the next_element within the buffer. If our next_element is null, and not a directory known in our buffer, this would be a file. If it's the last element of the and not a directory, we have a file so we assign our testDirectoryStatus to 2, which is our indication that it's a file. Within fs_isFile we check if the filename passed in is actually a file using our testDirectoryStatus variable we utilized within our parsePath function to help us determine if it's a file or not. We lastly return a int based value to tell our shell whether the file was a file or not, via the values 1 (a file) or 0 (not a file).
- fs_isDir
 - This function is responsible for testing whether the pathname passed into the function is a directory or not. We again use our testDirectoryStatus variable we utilized within our parsePath function to help determine whether the pathname passed is a directory or not. We create a parseData pointer called isDirData that's assigned to our parsePath function, which passes in the pathname from the fs_isDir parameters. We do this to access the testDirectoryStatus information from our parseData structure that we populate and store information within our parsePath. If it's a directory (checked in parsePath) the testDirectoryStatus will be assigned to 1. So within fs_isDir we simply check if the pathname passed

testDirectoryStatus is equal to 1, if so it's a directory. Once we obtain this information we then return 1 if we have a valid directory, or we will return 0 if we do not have a valid directory.

- fs_move
 - Moves a given DE to a given directory. This is done by wiping that entry from the old parent, setting info in the new parent, and changing the given DE's '..' data to reflect the new parent. May resize if moving the DE would cause the target directory to overflow.
- fs_delete
 - This function is responsible for deleting a file given its filename. Before we start, we have to create a parseData pointer called deleteFileData and assign it to our parsePath function, with the filename passed inside it from our fs_delete parameter. This allows us to access information we need about the file based on its given parent. There's a few things we need to know before we delete a given file. The first thing we want to know is where exactly this file is, this is why we have a variable called filePosition, as it will give us the directoryElement that the file is in. We then would want to create a DE pointer, in this instance we call it tempCheck, and allocate it by the vcb size of blocks times the files directory pointer that has the directory record length variable. We are doing this because we want to read our directory first given the files directory record length and its starting location before we make changes to delete the file from the directory it's within. Once we LBaread, we then can set that given file at its current position to null. That is why we made the filePosition variable earlier, and this is how we properly assign the given file to null within the directory.

```
char* name2 = "\\0";  
strncpy(tempCheck[filePosition].name, name2, 256);
```

- Once we assign that file to null given the current position is in, we free the blocks that the given file was allocating. We have a MarkBlocksFree function made that takes in a starting position and the size amount we

want to free. This is why we pass in the filePosition as the start parameter and the filePositions given size using tempCheck[filePosition].size as the size parameter for the function. This is how we mark the blocks that the given file was occupying as free. Now that we marked the blocks free, we LBAwrite back the directory the file was in but without the file being present. Upon a successful delete call, we return 0.

```
Prompt > ls
Dir
File
Prompt > rm File
Prompt > ls
Dir
Prompt > 
```

- parsePath

- This function is a very critical function to the entire project. This function is called a vast amount of functions and is responsible for holding our directory entries, being able to identify the given entries status of file or directory, and determine whether a path to a given directory is relative or absolute. If the path starts with /, we know it's absolute and can read it to our buffer immediately.

```
if(pathname[0] == '/'){
    LBAread(dirBuffer, vcb->root_size, vcb->root_starting_index);
}
```

- But if the path was relative, we want to construct an absolute version of the path. This is done by running our parse on the current working directory, and then working from there.


```

parseData* relativeData = parsePath(fs_getcwd(pathBuffer, MAX_PATH_LENGTH));

LBAread(dirBuffer, relativeData->dirPointer->d_reclen,
relativeData->dirPointer->directoryStartLocation);

free(relativeData->dirPointer);
free(relativeData);
relativeData = NULL;

```

- Once we do this we want to copy our pathname into our path buffer. We can then establish the directories, specifically their current_element and their next_element.
 - When we're done, we return a struct containing various info on the directory. This information varies depending on the result of that path parse. We indicate what sort of data we have by setting one value, the testDirectoryStatus, to 0 if the path was invalid, 1 if the path pointed to a directory, and 2 if the path pointed to a file. Depending on what the path pointed to, information may be filled in for the directory size and location, as well as some other info, like its position in the parent. Some information is only filled in for certain statuses.
- fs_stat
- the stat function takes in a pathname and buffer as a parameter and is used for the LS command in fshell.c file meant to display all files and their statistics.

```

parseData* parsed_data = parsePath(path);

DE* directory = malloc(parsed_data->dirPointer->d_reclen * vcb->size_of_block);
LBAread(directory, parsed_data->dirPointer->d_reclen, parsed_data->dirPointer->directoryStartLocation);

```

Functions begin by parsing and checking if the pathname is valid and if it is we will use the parsed information to read a directory into a directory entry variable.

```

if(parsed_data->testDirectoryStatus == 2){
    buf->st_blocks = directory[parsed_data->directoryElement].size;
    buf->st_size = directory[parsed_data->directoryElement].size_bytes;
    buf->st_createtime = directory[parsed_data->directoryElement].creation_time;
    buf->st_modtime = directory[parsed_data->directoryElement].last_modified;
}

```

The function then checks if it's a file and if it is it will store the file information into the buffer passed through the parameter. This function will return 1 if everything is correct.

- formatPath

- Takes a pathname and returns a buffer containing a formatted version of that path.
- Mostly, it removes ‘.’ and ‘..’, and reconstructs the path to instead use whatever directories those refer to.
- This is used to fix paths to remove bloat on paths, which saves space and increases clarity on the CWD. It also adds a / at the end of the path, to help in adding the CWD in front of relative paths for parsePath’s sake.
- Debug text:

```
Path /A/B/C/./C/././B/E/F/./G was converted to /A/B/E/G/  
Prompt > 
```

- countPathTokens

- The count path tokens function helps formatPath. It takes in a pathname as a parameter and counts the number of tokens in the path.

```
char* token = strtok(pathCopy, "/");  
  
while(token != NULL){  
    numTokens++;  
  
    token = strtok(NULL, "/");  
}
```

The tokens are counted using the strtok function which takes the path it to tokenize and a delimiter. Since we are working with paths the only delimiter would be “/”. Once each token is counted the return of this function will be the count of the tokens.

- B_IO.C

- b_open

- This function is responsible for opening our filename passed via our parameter. We test whether the file that's passed in as actually a file using our parseData struct variable, “testDirectoryStatus.” This status is validated and assigned within our parsePath function described earlier. Again, we initially test to see if what we are opening is actually a file, if it's not a file, then we return an error as there is nothing to open and assign a valid file descriptor. Additionally, if the filename passed to the parameters doesn't exist within our directory, we can also additionally add it. If our path was valid up until the final token, we have a valid path we can create a file at. Additionally, we also have to make sure that if the

file doesn't exist and they want to create it, the flag must be triggered, so we also have this condition to test that.

```
if(((flags | O_CREAT) != flags)){
    printf("Error: File does not exist: No create permission\n");
    if(fdData->dirPointer != NULL){
        free(fdData->dirPointer);
    }
}
```

- We additionally have a createFile function that attempts to create a file given the conditions pass. Within this createFile we attempt to create a file with parent and data specified by the input parseData structure information we have. Within this function, we check for a file that isn't a directory: that it is created with just enough space for our given '.' and '..'. That way, it has info on itself and its parent. We also note that size_bytes reflects the content size so that it will ignore the size from '.' and '..'. Once we pass all the conditions of open, we can then assign the given file a file descriptor. Open is also responsible for setting up our writing and reading for our file. This is why we assign the element of a file within our parent. We then create a pointer to the parent directory. Malloc enough space to fit the file within our buffer, then read our given element into our buffer. With this given file descriptor and writing and read setup, we can get the file's information saved. After everything is complete, we then free our mallocs and return our file descriptor-as that's what the open's return value is.
- b_read
 - This function is responsible for reading data from a file to a given buffer.
 - It first checks whether or not the given fd is invalid, or if the given fd does not have flags that allow reading.
 - After calculating an offset from our file buffer, we copy over to the given buffer as many bytes as they asked for.
- b_write
 - This function is responsible for writing data to a given file descriptor. This function takes our given file descriptor, the information being written, and the actual given count of the information and writes it. We do have

to take into account the EOF condition, bytes being written an account of the block updating. The first thing we do is check our initial condition of if our file descriptor being passed is valid, if it's not, we can't do much so we return -1. We also have to check whether our write flags are checked to be able to write. We do so as shown below.

```
//Flag check for write call
int flag = fcbArray[fd].flagPassed;
if(!(flag & O_WRONLY == flag) && !(flag & O_RDWR) == flag)){
    printf("\nb_write ERROR: NO WRITE FLAG PASSED.\n");
    return -1;
}
```

- If the flag to write is not set, we return -1. If the write condition is triggered we are good to set up our writing. We create a b_fcb pointer file that references the given file descriptor from our fcbArray. We additionally have a condition that ensures we only reset once per trunc flag call. As shown below.

```
if(flag | O_TRUNC == flag && fcbArray[fd].truncUsed == 0){
    fcbArray[fd].size_bytes = 0;
    fcbArray[fd].individualFilePosition = 0;
    fcbArray[fd].truncUsed = 1;
}
```

- We have the variables byteWroteCount, which keeps track of the total bytes written. We also have an available variable that will help us calculate bytes left in the file, this is important because if the user wants to write more than we have available, we have to be able to expand! The available variable we have has to take into account our '..' and '.', this is why we have this code written below. We essentially treat our file as always offset by the size of the first two DEs.

```
available-= (sizeof(DE)*2);
available-= file->individualFilePosition;
```

- If we are writing more than we have available, we need to expand the file. We calculate how much we need to expand it by below. Once we do so, we can reset our file buffer to the new expanded size. We also need to make sure to write these changes to the file and its parent. This is done, shown with the code below.

```
if(available < count){
    int extraBytes = count - available;
    int extraBlocks = extraBytes / vcb->size_of_block;

    if(extraBytes % vcb->size_of_block != 0){
        extraBlocks++;
    }

    DE* d = (DE*)file->buf;
    DE* newFile = addNBlocksToDE(d, extraBlocks);

    // Reset file buffer to new size
    file->buf = malloc(newFile->size * vcb->size_of_block);

    LBAwrite(newFile, newFile->size, newFile->location);
    LBAread(file->buf, newFile->size, newFile->location);

    file->directoryStartLocation = newFile->location;
    file->d_reclen = newFile->size;
    file->size_bytes = newFile->size_bytes;
    file->bufLen = newFile->size;

    free(newFile);
}
```

- After this given action, we recalculate our available bytes after our resize. Now we can loop through our bytesWroteCount variable, if it's less than our given count passed in, we have two conditions to check. If our bytesWroteCount + our chunk size is greater than our count. If this is the case we assign our bytesWritten variable to the chunk size. Otherwise, we have an else condition that calculates byteWritten being equal to our count - BytesWroteCount. After we check these two space conditions we want to copy our user data to our buffer. Do this by the code given below.

Note again the offset by two DE sizes.

```
memcpy(file->buf + (sizeof(DE)*2) + file->individualFilePosition,
        buffer, count);
```

- We then update our bytesWrittenCount to the count, we do this because we are taking care of that given count from the parameter that we used inside our memcpy. Second to last of the write function, we save what we wrote and update our parent with the new file information that was written. We do so by the code given below.

```
DE* saveFile = (DE*)file->buf;
saveFile->size_bytes = saveFile->size_bytes+count;;
saveFile->size = file->d_reclen;
time_t time_mod = time(0);
saveFile->last_modified = time_mod;

// Update parent with new info of file
DE* parent = malloc(saveFile[1].size * vcb->size_of_block);
LBRead(parent, saveFile[1].size, saveFile[1].location);
parent[file->positionInParent].size_bytes = saveFile->size_bytes;
parent[file->positionInParent].size = saveFile->size;
parent[file->positionInParent].location = saveFile->location;
parent[file->positionInParent].last_modified = time_mod;
LBWrite(parent, parent->size, parent->location);
LBWrite(saveFile, file->d_reclen, file->directoryStartLocation);
```

- Lastly, like Linux would in their write function, in our b_write we will return the count of the bytes that we have written that the user passed in via the b_write parameters.
- b_seek
 - This function is responsible for repositioning the file offset given its file descriptor based on its byte offset count and given whence. First, we condition check to make sure our file descriptor passed is valid. After we checked that our given file descriptor passed is valid, we obtained the length of our file we are currently working with. We do this because we will be repositioning our position within our file given our whence choice. This leads me to the whence section. We have three whence conditions

that could be passed within our parameters: SEEK_SET, SEEK_CUR, and SEEK_END. SEEK_SET, whence starts the offset reposition from the beginning of the file. It's important to note that our fcbArray.individualFilePosition is simply the variable we use to keep track of where we are in the file. So with the SEEK_SET whence, we add the offset given from the start of the given file position. For SEEK_CUR, we reposition ourselves in the file from our current position, plus the offset passed in. This is why we set our individualFilePosition to += offset. When our whence is set to SEEK_END, we reposition ourselves in the file from the end of the file, plus our offset passed in. It's important also to note that b_seek allows the file offset to be set beyond the end of the file, but this does not change the size of the given file. This is why we have the given code below.

```
// Keep seek from sending file past EOF or before
if(fcbArray[fd].individualFilePosition < 0){
    fcbArray[fd].individualFilePosition = 0;
}
else if(fcbArray[fd].individualFilePosition > fcbArray[fd].size_bytes){
    fcbArray[fd].individualFilePosition = fcbArray[fd].size_bytes;
}
```

- Finally, the last step of b_seek is to return the filePosition of our given file we are in, so we return fcbArray[fd].individualFilePosition.
- b_close:
 - This function is responsible for closing a file. We do so by testing whether our given file buffer is not equal to null, if this is the case, we free that given file buffer. We then set that given file buffer we free'd to null. The file I'm referring to is a b_fcb pointer that references our fcbArray given the specific file descriptor. Upon a successful close, we shall return 1.
- directory_entry.c
 - DirectoryInit
 - Creates a directory and attaches it to a free spot in a given DE. If NULL is given instead of a DE pointer, it will adjust and init root.
 - Initializes fields of the new directory, and allocates enough space for 51 directory entries to fit inside of it.
 - findFileInDirectory
 - Returns the index of a given filename within a given DE.
 - findEmptyEntry

- Finds the first empty entry in a given DE and returns an integer index of that entry.
- `printFilesInDir`
 - this function takes a directory entry C structure pointer and iterates through each entry in the directory and prints names of all the files in the given directory excluding the empty ones.
- `printFilesInDirWithEmpty`
 - this function takes a directory entry C structure pointer and iterates through each entry in the directory and prints names of all the files in the given directory including the empty ones.
- `numberOfFilesInDir`
 - this function takes a directory entry C structure pointer and iterates through each entry in the directory and counts every non-null entry. the return of this function is the number of files.
- `resize`
 - Takes in a DE to resize, and calls `addNBlocksToDE` with twice the size of the given DE.
- `addNBlocksToDe`
 - Takes in a DE to resize, and a number of blocks to add to it. It returns a pointer to the new directory location, as we have to remalloc the DE to account for the new size. It also will update the parent with this child's new location and size, and it will free the blocks the DE used before the resize.
- `int_to_char`
 - The integer to character function takes in an integer as a parameter which is the number that will turn into a char.


```

char* int_to_char(int input){
    int hundreds = input / 100;
    input = input - 100*hundreds;
    int tens = input / 10;
    input = input - 10*tens;

    char* number = malloc(256);

    int index = 0;
    if(hundreds > 0){
        number[index] = hundreds+48;
        index++;
    }
    if(tens > 0){
        number[index] = tens+48;
        index++;
    }
    if(input > 0){
        number[index] = input+48;
        index++;
    }

    number[index] = 0;
}

```

■ This converts the integer by separating each digit and converting them into an array of characters. This function helps DirectoryInit functions to make the location readable, as giving it a name that isn't null lets us search for it, if we make a directory without an input name.

- appendDEtoDir
 - Attempts to add a given DE to an empty entry in a given directory, resizing if necessary.
- createFile
 - The create file function takes in data from a parse path. It uses this to create a file in the directory specified by that data. When we create a file, we allocate enough space to fit the two DEs '.' and '..', and, unlike directory's we set the size in bytes to be 0, so that this number represents its content size, and not its size on disk. This is clarity for users, as well as for read/write functions later. This means that operations we do on the file are offset by sizeof(DE)*2.
- free_space_helpers.c
 - GetFreeBlock
 - The get free block function takes an integer starting position of where to search in the bitmap. The purpose of this function is to find freespace

from a given position and then return the position of that block in the bitmap. Essentially, it returns the location of the first free block; it does not mark it used.

- getNFreeBlocks
 - The getNFreeBlocks function takes an integer representing the number of free blocks needed. it does this by looping through the bitmap finding contiguous free blocks that satisfy the requested amount. If there are less blocks available than requested the function will return a -1 indicating an error, otherwise it will return the starting position of the contiguous free space. If it fails to find N blocks in one contiguous space, it resumes checking on the next free space. This function marks the blocks it gives as used.
- MarkBlocksUsed
 - The MarkBlockUsed function takes an integer size and an integer start as its arguments. Using it the start position given the function starts at that location in the bitmap and loops through each bit flipping the respective bits to indicate that the location in the bitmap is used. The return of this function is the number of blocks marked used.
- MarkOneBlockUsed
 - A helper function that will take a single block and call MarkBlocksUsed to mark it used.
- MarkOneBlockFree
 - A helper function that will take a single block and call MarkBlocksFree to mark it free.
- MarkBlocksFree
 - Finds the block location in the bitmap by converting the integer block position, and flips the bits to represent as free.
- bit_math.c
 - BitCounter
 - Takes one byte as input, then checks how many bits within that byte we would consider free. Returns the number of free bits in the byte.
 - FindFreeBit
 - Takes one byte as input, then finds the first free bit within that byte, and returns the index of that bit within the byte.
 - power
 - Simple power operator that takes input base and input power to compute exponents. Returns the result.
 - FlipBitUsed
 - The FlipBitUsed function takes in an unsigned char byte and an integer bit as parameters. The purpose of this function is to flip a bit using the bitwise AND operator to indicate that the bit is used.
 - FlipBitFree
 - The FlipBitFreefunction takes in an unsigned char byte and an integer bit as parameters. The purpose of this function is to flip a bit using the bitwise OR operator to indicate that the bit is free.

- fsInit.c
 - initBitmap
 - Sets up the bitmap for use across the system. The bitmap tracks the number of free blocks on the system. The bitmap is kept in memory, and is a char* that holds a long string of FF, where each byte FF represents 8 blocks on the system that are free. As it initializes this bitmap, it sets the first few blocks as used, since the bitmap itself takes up blocks on the system.
 - initFileSystem
 - The initFileSystem function takes in an integer representing the number of blocks and an integer representing the size of the block. The first block is then read and checked to see if we own the block by comparing our signature with the signature of the volume control block. If it does have the signature then reads the first 5 blocks and stores it in the bitmap variable. If it doesn't have the signature then we will populate the volume control block with the appropriate settings and the signature. Next the function initializes the root directory and writes everything back to the first block or the VCB. Then finally initializes the current working directory in this case it would be "\ ". The function returns a 0 indicating success.
 - exitFileSystem
 - The exit file system function writes any information from the VCB and the Bitmap to prevent the loss of work. The function ends with freeing the VCB, Bitmap, and the Current working directory.

What Works: The functions given in header files are fully implemented, and each of the commands in fsshell work.

- ls command WORKS

- output:

```

student@student-VirtualBox: ~/Desktop/csc415-filesystem-thebeermanfanclub
File Edit View Search Terminal Help
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872; BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512

VCB already exist!
Size of a Block: 512
Number of Blocks: 19531
Blocks Available: 19305
Signature: 790526
Prompt > ls

meow
Prompt > ls -l

D      15504  meow
Prompt > ls -a

.
..
meow
Prompt > ls -al

D      15504  .
D      15504  ..
D      15504  meow
Prompt >

```

- cp command

```

Prompt > cat a
Some text of some kind
Prompt > cp a d
Prompt > cat d
Some text of some kind
Prompt >

```

- mv command

```

Prompt > ls

Dir
Prompt > cd Dir
Prompt > ls

NewDir
Prompt > mv NewDir ..
Prompt > ls

Prompt > cd ..
Prompt > ls

NewDir
Dir
Prompt >

```

- md command

- output:

```
student@student-VirtualBox: ~/Desktop/csc415-filesystem-thebeermanfanclub
File Edit View Search Terminal Help
b_io.h    bit_math.o    directory_entry.o  free_space_helpers.o  fsLowM1.o  fsshell.o  nfs.h    test
b_io.o    constants.h    file               fsInit.c              fsLow.o    Hexdump   nfs.o    yay
bit_math.c directory_entry.c free_space_helpers.c fsInit.o          fsshell   Makefile  README.md
student@student-VirtualBox:~/Desktop/csc415-filesystem-thebeermanfanclub$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872; BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512

VCB already exist!
Size of a Block: 512
Number of Blocks: 19531
Blocks Available: 19492
Signature: 790526
Prompt > ls

Prompt > md TestDirectory
Prompt > ls

TestDirectory
Prompt > ls -l

D          15504  TestDirectory
Prompt > cd TestDirectory
Prompt > pwd
~/TestDirectory/
Prompt > 
```

- rm command

```
Prompt > ls

Dir
File
Prompt > rm File
Prompt > ls

Dir
Prompt > rm Dlr
The path Dlr is neither a file not a directory
Prompt > rm Dir
Prompt > ls

Prompt > 
```

- touch command

```
Prompt > touch File
Prompt > ls

File
Prompt > 
```

- cat command

```
Prompt > touch File
Prompt > cp2fs cp2f.txt File
Prompt > cat File
Some text of some kind
Prompt >
```

- cp2l command

```
Prompt > cat File
Some text of some kind
Prompt > cp2l
Usage: cp2l srcfile [Linuxdestfile]
Prompt > cp2l File cp2l.txt
Prompt >
```

-

```
≡ cp2l.txt
1 Some text of some kind
2
```

-

- cp2fs command

```
≡ cp2f.txt
1 Some text of some kind
2
```

-

```
Prompt > touch File
Prompt > cp2fs cp2f.txt File
Prompt > cat File
Some text of some kind
Prompt >
```

-

- cd command

```
Prompt > pwd
/
Prompt > cd Dir
Prompt > pwd
/Dir/
Prompt >
```

-

- pwd command

```
Prompt > pwd
/
Prompt > cd Dir
Prompt > pwd
/Dir/
Prompt >
```

-

- history command

- output:

```
student@student-VirtualBox: ~/Desktop/csc415-filesystem-thebeermanfanclub
File Edit View Search Terminal Help
h.o mfs.o b_io.o fsLow.o -g -I. -lm -l readline -l pthread
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872; BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > history
history
Prompt > ls

Dir
File
Prompt > ls -al

D          15504  .
D          15504  ..
D          15504  Dir
-           22   File
Prompt > history
history
ls
ls -al
history
Prompt >
```

- help command

- output:

```
student@student-VirtualBox: ~/Desktop/csc415-filesystem-thebeermanfanclub
File Edit View Search Terminal Help
student@student-VirtualBox:~/Desktop/csc415-filesystem-thebeermanfanclub$ make run
./fsshell SampleVolume 10000000 512
File SampleVolume does exist, errno = 0
File SampleVolume good to go, errno = 0
Opened SampleVolume, Volume Size: 9999872; BlockSize: 512; Return 0
Initializing File System with 19531 blocks with a block size of 512
Prompt > help
ls      Lists the file in a directory
cp      Copies a file - source [dest]
mv      Moves a file - source dest
md      Make a new directory
rm      Removes a file or directory
touch   Touches/Creates a file
cat     Limited version of cat that displace the file to the console
cp2l    Copies a file from the test file system to the linux file system
cp2fs   Copies a file from the Linux file system to the test file system
cd      Changes directory
pwd     Prints the working directory
history Prints out the history
help    Prints out help
Prompt > █
```

Hexdump

000000 to 0001FF

- This is not the VCB, but instead the low-level file system's partition block
- fsLow.h told us that the first block is inaccessible to us and holds information on the hard drive.
- 00000000 to 00003013 is the drive caption. This is a 59-byte String, with null as the 59th

byte. This lines up with what we see at this point in the dump, with 59 bytes in a row, ending on 00.

- 00004000 to 0000400F is the partition signature2, perfectly matching the 0x4220747265626F52 in the header file.

- 00007000 to 0000700F is the partition signature, perfectly matching the 0x526F626572742042 in the header file.

000200 to 0003FF is our Volume Control Block

- Our VCB is a struct containing the size of a block, the number of blocks in the volume, the number of free blocks, the starting index of the bitmap, and a signature.

- Each of these is a uint_64, 8 bytes each.

- 000200 to 00020F is the size of a block.

- This number is 512, or 0x200. The number here is 00 02 00 00 00 00 00 00, which matches up when accounting for little endian.

- 000201 to 00020F is the number of blocks on the volume, according to the VCB. This is 19531, or 4C4B in hex. On the hex dump, we see 4B 4C. Accounting for little endian, the numbers match.

- 000210 to 000217 is the number of free blocks available. We marked 70 blocks as used, meaning 19461 remain. The number in the hex dump is 05 4C, which is equivalent to decimal 19461.

- 000218 is the starting index of the bitmap. On our volume, this is in index 1, just after the VCB. In the dump, we see 01, or 1.

- 000220 to 000227 is the signature of our VCB. We chose this to be 0xC0FFE, equivalent to 0x0C0FFE. Here in the dump is FE 0F 0C, the same number.

000400 to 000DFF represents our bitmap

- Bitmap was initialized to FF on all free blocks (0b11111111). Because of that, we can tell that the FF here is free blocks.

- The first 00 00 00 00 00 00 00 03 represents the number of blocks we used (are not free)

- Each '0' is 4 bits. One bit in the bitmap represents one block. We used 1 block for the VCB, 5 blocks for the bitmap, and 31 blocks for the root directory. In addition, we used another 31 for an extra directory, and 2 for a non-directory file. If we count the number here, we have $8*8 + 4 + 2$, or 70 - the same as the number of unfree blocks.

- If we continue this and count how many bits are represented here, we come out to 20480 - the same number as the amount of bits our bitmap takes up.

000E00 to 004BFF is our root directory.

- Our root directory holds 51 DEs in 31 blocks, and is 15504 bytes. A DE is made up of a char[256] as the name, four uint_64, and two time_t, for $256 + 8 + 8 + 8 + 8 + 8 + 8$ bytes.

- Our first DE is from 000E00 to 000F27.

- It's named ".", which is ASCII 2E. We see that right at 000E00. This goes for 256 bytes, from 000E00 to 000EFF.

- Then, from 000F00 to 000F07 should be the size (1F = 31, our #blocks), with 000F08 to 000F0F as the size in bytes (3C90 = 31 blocks * size of DE), then 000F10 to 000F17 as the location.
- From 000F20 to 000F27 is the creation date, followed by 000F28 to 000F2F. It's hard to verify that the create date matches when we created it, but we see that both of these are the same, since the last modify and the create date are the same for now.
- Our second DE starts at 000F30 and goes to 00104A.
- It's named ".." which is ASCII 2E twice, 2E2E. We see that at 000F28.
- The same logic for everything in the first DE applies here, including the dates.

Our third DE is from 0010600-00118F

- 001060-00115F is the name of the directory "Dir". That's a hex of 44 69 72, which matches what we see here.
- As before, the following info is the size, size in bytes, and location. The location of this DE is 37, which is hex 25, which we see at 001170 to 001177

Our third DE is from 001190-001

- 001190-00128F is the name of the file, "File". That's hex 46 69 6c 65, which we see at this spot.

- Throughout the rest of root are some sporadic 01. These are the flag indicating that the DE is a directory, and is the only data set for the unfilled DEs.

004C00-0089F0 is the directory named "Dir"

- We see the name "." from 004C00-004CFF
- The size, size in bytes, and location are as above, starting at 004D00, 004D0F, and 004D10 respectively, followed by the dir flag at 004D1A, and then the create and modified dates, which are the same
- Dir's second DE starts at 004D30, and follows similarly. The location is instead 06, at 004E40, since that is the parent's location

Root's fourth DE is 008A00-008DFF

- Its first entry is the name ".", hex 2E. This is 008A00-008AFF
- The size in blocks is 2 (hex 02), the size in bytes is 22 (hex 16), and the location is 68 (hex 44). We see these at 008B00, 008B0A, and 008B10, respectively
- The create and modify time are at 008B20 and 008B2A, respectively. Note the modify time is greater than the create, because this file was modified after creation
- Its second DE starts at 008B30, with the name "..", or 2E 2E
- The rest of its info 008C30, with the size of root 1F, size of root in bytes with 90 3C at 008C3A, and the location of root as 6, at 008C40. Then the create and modify time is at 008C50 and 008C5A, respectively. They match root's info, because this is "."
- The content of the file starts at 008C60 and goes to 008C65. That matches the 22 bytes from the size in bytes, and the text reads "Some text of some kind", which is from a text file that was previously copied to the file system with the cp2fs command.

```

000000: 43 53 43 2D 34 31 35 20 2D 20 4F 70 65 72 61 74 | CSC-415 - Operat
000010: 69 6E 67 20 53 79 73 74 65 6D 73 20 46 69 6C 65 | ing Systems File
000020: 20 53 79 73 74 65 6D 20 50 61 72 74 69 74 69 6F | System Partitio
000030: 6E 20 48 65 61 64 65 72 0A 0A 00 00 00 00 00 00 | n Header.....
000040: 42 20 74 72 65 62 6F 52 00 96 98 00 00 00 00 00 | B treboR.♦♦.....
000050: 00 02 00 00 00 00 00 00 4B 4C 00 00 00 00 00 00 | .....KL.....
000060: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000070: 52 6F 62 65 72 74 20 42 55 6E 74 69 74 6C 65 64 | Robert BUntitled
000080: 0A 0A 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000090: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0000A0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0000B0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0000D0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0000E0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0000F0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....

000100: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000110: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000120: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000130: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000140: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000150: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000160: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000170: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000180: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000190: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0001A0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0001B0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0001C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0001D0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0001E0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0001F0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....

```

000200:	00	02	00	00	00	00	00	00	00	4B	4C	00	00	00	00	00	00	00	00	.....KL.....
000210:	05	4C	00	00	00	00	00	00	00	01	00	00	00	00	00	00	00	00	00	.L.....
000220:	8A	09	00	00	00	00	00	00	00	05	00	00	00	00	00	00	00	00	00	♦.....
000230:	06	00	00	00	00	00	00	00	00	1F	00	00	00	00	00	00	00	00	00	.....
000240:	FE	0F	0C	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	♦.....
000250:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000260:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000270:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000280:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000290:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0002A0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0002B0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0002C0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0002D0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0002E0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0002F0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000300:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000310:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000320:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000330:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000340:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000350:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000360:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000370:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000380:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
000390:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0003A0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0003B0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0003C0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0003D0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0003E0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....
0003F0:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	.....

[illegible]

[illegible]

[illegible]

```

000E00: 2E 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000E10: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000E20: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000E30: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000E40: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000E50: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000E60: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000E70: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000E80: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000E90: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000EA0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000EB0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000EC0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000ED0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000EE0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000EF0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....

000F00: 1F 00 00 00 00 00 00 00 90 3C 00 00 00 00 00 00 | .....<
000F10: 06 00 00 00 00 00 00 00 01 00 00 00 00 00 00 00 | .....
000F20: D6 66 88 63 00 00 00 00 D6 66 88 63 00 00 00 00 | fC...fC...
000F30: 2E 2E 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000F40: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000F50: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000F60: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000F70: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000F80: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000F90: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000FA0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000FB0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000FC0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000FD0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000FE0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
000FF0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....

```

```

001000: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001010: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001020: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001030: 1F 00 00 00 00 00 00 00 00 90 3C 00 00 00 00 00 00 | .....<.....
001040: 06 00 00 00 00 00 00 00 00 01 00 00 00 00 00 00 00 | .....
001050: D6 66 88 63 00 00 00 00 00 D6 66 88 63 00 00 00 00 | ffc....ffc....
001060: 44 69 72 00 00 00 00 00 00 00 00 00 00 00 00 00 | Dir.....
001070: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001080: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001090: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0010A0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0010B0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0010C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0010D0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0010E0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0010F0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....

001100: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001110: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001120: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001130: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001140: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001150: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001160: 1F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001170: 25 00 00 00 00 00 00 00 00 01 00 00 00 00 00 00 | %.....
001180: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
001190: 46 69 6C 65 00 00 00 00 00 00 00 00 00 00 00 00 | File.....
0011A0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0011B0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0011C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0011D0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0011E0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
0011F0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....

```


[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

004C00:	2E 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004C10:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004C20:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004C30:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004C40:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004C50:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004C60:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004C70:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004C80:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004C90:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004CA0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004CB0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004CC0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004CD0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004CE0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004CF0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004D00:	1F 00 00 00 00 00 00 00	90 3C 00 00 00 00 00 00	|	.....<.....
004D10:	25 00 00 00 00 00 00 00	01 00 00 00 00 00 00 00	|	%.....
004D20:	DB 66 88 63 00 00 00 00	DB 66 88 63 00 00 00 00	|	fC.....fC.....
004D30:	2E 2E 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004D40:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004D50:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004D60:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004D70:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004D80:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004D90:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004DA0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004DB0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004DC0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004DD0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004DE0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....
004DF0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	|	.....

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]


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008A00: 2E 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008A10: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008A20: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008A30: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008A40: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008A50: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008A60: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008A70: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008A80: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008A90: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008AA0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008AB0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008AC0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008AD0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008AE0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008AF0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....

008B00: 02 00 00 00 00 00 00 00 16 00 00 00 00 00 00 00 | .....
008B10: 44 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | D.....
008B20: E1 66 88 63 00 00 00 00 F2 66 88 63 00 00 00 00 | ♦f♦c....♦f♦c....
008B30: 2E 2E 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008B40: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008B50: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008B60: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008B70: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008B80: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008B90: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008BA0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008BB0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008BC0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008BD0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008BE0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....
008BF0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | .....

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008C00:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
008C10:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
008C20:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008C30:	1F 00 00 00 00 00 00 00	90 3C 00 00 00 00 00 00	| .....<.....
008C40:	06 00 00 00 00 00 00 00	01 00 00 00 00 00 00 00	| .....
008C50:	D6 66 88 63 00 00 00 00	D6 66 88 63 00 00 00 00	| ♦♦C....♦♦C....
008C60:	53 6F 6D 65 20 74 65 78	74 20 6F 66 20 73 6F 6D	| Some text of som
008C70:	65 20 6B 69 6E 64 00 00	00 00 00 00 00 00 00 00	| e kind.....
008C80:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008C90:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008CA0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008CB0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008CC0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008CD0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008CE0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008CF0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D00:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D10:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D20:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D30:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D40:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D50:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D60:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D70:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D80:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008D90:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008DA0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008DB0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008DC0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008DD0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008DE0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....
008DF0:	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	| .....