MP4 Walkthrough

Due: May 7th 11:59 pm CT

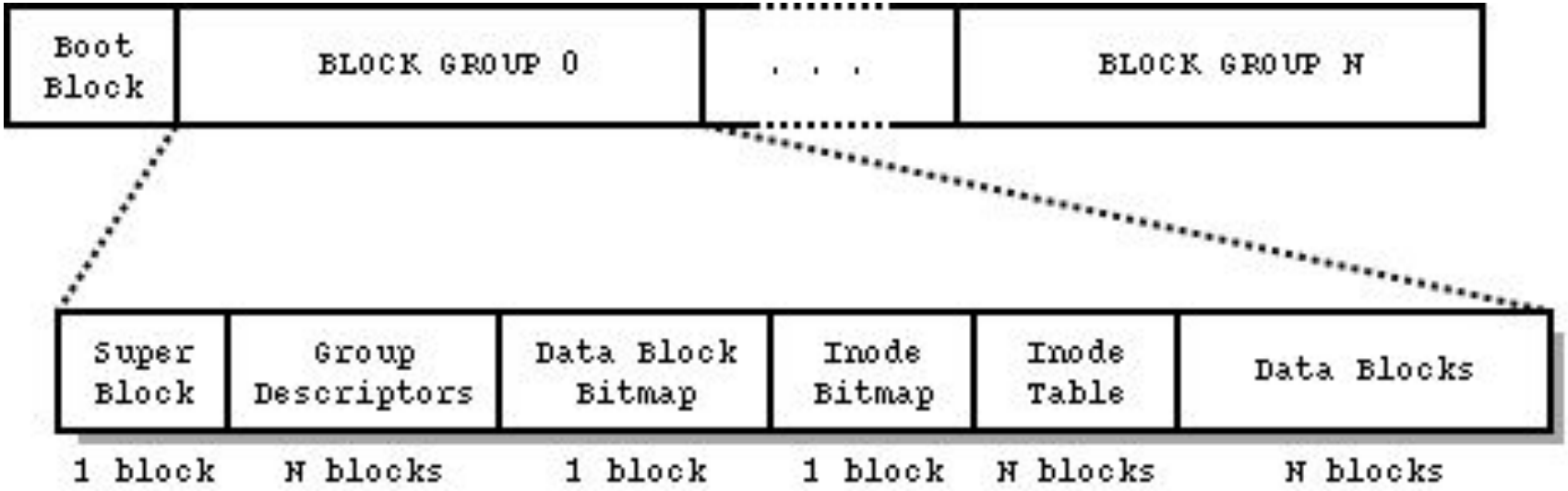
Goal

Reconstruct all jpg files (both un-deleted and deleted ones) from a given ext2 disk image

How

1. Traverse ext2 file system
2. Identify jpg files
3. Copy file content

Ext2



Credit: https://www.science.smith.edu/~nhowe/262/oldlabs/img/ext2.png

Basic Concepts

Block

Logical block, the size can be determined by Superblock's `s_log_block_size`. **Block starts with 0.**

Inode

A structure on the disk that represents a file, directory, symbolic link, etc. It *DOES NOT* contain the data, but links to the blocks containing the data. **Inode starts with 1.**

Block Group

Blocks, along with inodes. Each block group reserves a few of its blocks for special purposes, e.g. a bitmap of free/allocated blocks within the group. **Block group starts with 0.**

Simplifications

- 1KB (1024 bytes) block size only
- No directories using more than one data block
- No huge file using the third indirect block

Superblock

- Always take 1024 bytes in length after the boot block (1024 bytes)
- Contains all the information about the configuration of the filesystem
- To compute the number of block groups
  - ceil(`s_blocks_count` / `s_blocks_per_group`)
- There are backup copies stored in specific groups
  - Group 0, 1, and powers of 3, 5, 7

Block Group Descriptors

- The block immediately following the Superblock
- Contains one descriptor for each block group within the file system
  - *N* block groups means *N* entries in the table

Inode

Important fields:

- `i_mode` → format of the described file and the access rights
- `i_size` → size of the file
- `i_links_count` → number of links to the inode
- `i_block[]` → 12 direct points, 1 indirect pointer, 1 double indirect pointer, 1 triple indirect pointer

Directory File

- A linked list of `ext2_dir_entry_2` structure

Search

Locate Block Group for a given inode

block group = (inode - 1) / `s_inodes_per_group`

Locate inode in a block group

index = (inode - 1) % `s_inodes_per_group`

Locate block in a block group

block = (index * sizeof(inode)) / sizeof(block)

Magic Number

- Uniquely identify the type of the file
- jpg magic number: `FF D8 FF {E0, E1, E8}`

```
int is_jpg = 0;

if (buffer[0] == (char)0xff &&
    buffer[1] == (char)0xd8 &&
    buffer[2] == (char)0xff &&
    (buffer[3] == (char)0xe0 ||
     buffer[3] == (char)0xe1 ||
     buffer[3] == (char)0xe8))
{
   is_jpg = 1;
}
```

Resources

- https://wiki.osdev.org/Ext2
- https://www.nongnu.org/ext2-doc/ext2.html