EZFS Specification

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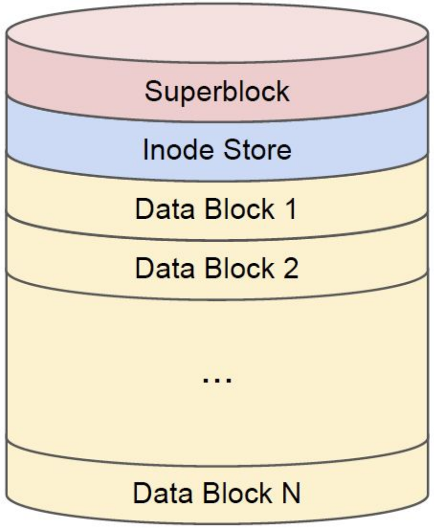
EZFS Layout

- Each slice shown to the right is one block.
- Each block is 4096 bytes.



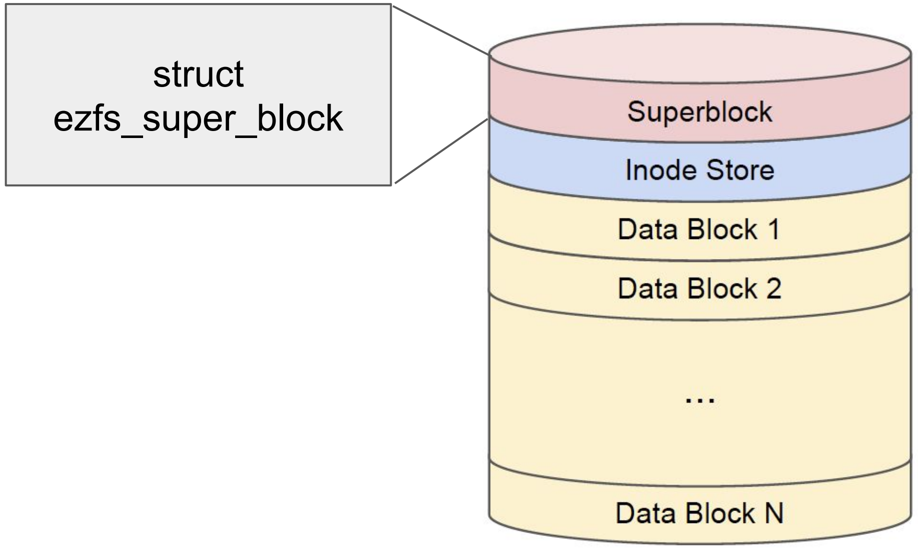
The Superblock

- The ezfs_super_block is padded to be 4096 bytes, so it fits directly in the first block.
- Contains bit vectors representing which inodes and data blocks are free.
- Bit vectors declared by macros:

```
DECLARE_BIT_VECTOR(free_inodes, EZFS_MAX_INODES)

DECLARE_BIT_VECTOR(free_data_blocks,
EZFS_MAX_DATA_BLKS)
```

- We indicate that an inode or date block is **occupied** by setting the corresponding location in the bit vector to 1



The Inode Store

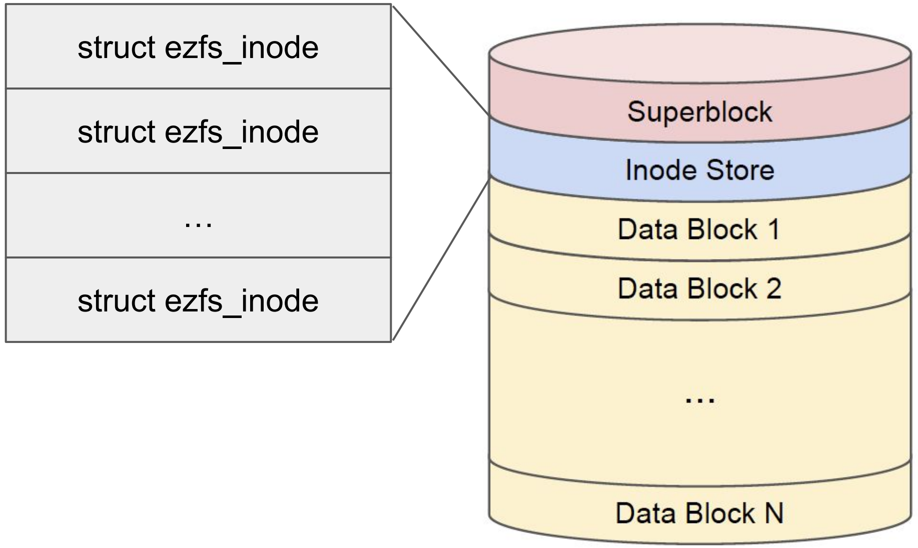
- The inode store is filled with contiguous ezfs_inodes. The maximum possible number of inodes is crammed into the inode store:

```
#define EZFS_MAX_INODES (EZFS_BLOCK_SIZE / sizeof(struct
ezfs_inode))
```

- ezfs_inode stores metadata about a file or directory (size, access times, mode, etc).

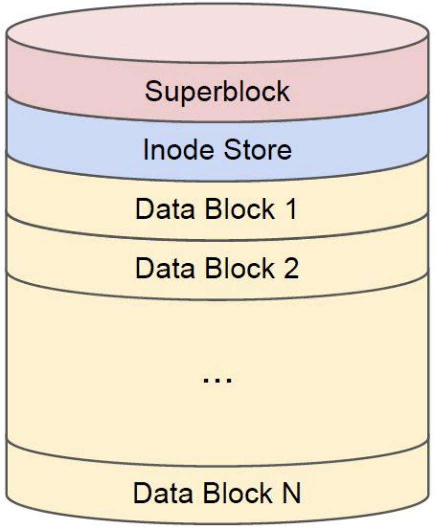
- Each ezfs_inode is associated with data blocks via data_block_number (the first data block) and nblocks (number of data blocks). The data block, ***not the inode*** stores file or directory contents.

- Each inode is indexed by its position. The 1st indode is inode 1; the 10th inode is inode 10. Note that inodes are indexed from 1, not 0. The reason is that functions in VFS that return inodes return an unsigned int. On error, they return 0.



The Data Blocks

- Case 1: Inode corresponds to a directory
- Case 2: Inode corresponds to a regular file



The Data Blocks: Case 1 (directory)

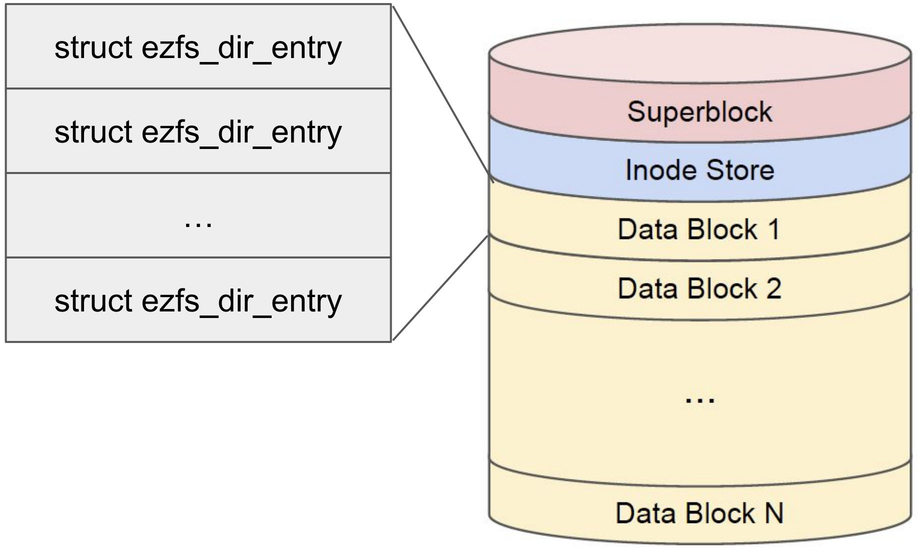
- Inode corresponds to a directory only has **one** data block.

- Data block is a series of contiguous ezfs_dir_entry. The maximum number of entries that can be crammed into the data block is given by:

```
#define EZFS_MAX_CHILDREN (EZFS_BLOCK_SIZE / sizeof(struct
ezfs_dir_entry))
```

- ezfs_dir_entry maps filename to inode number.

- Each ezfs_dir_entry has a flag indicating whether it's active or not. When we unlink a file (rm command), we lazily delete the file by setting flag to 0.



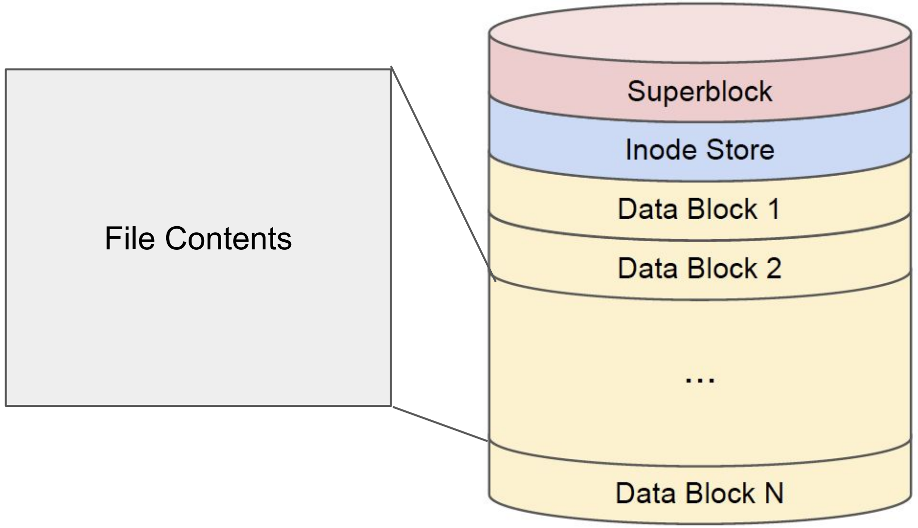
The Data Blocks: Case 2 (regular file)

- Inode corresponds to a regular file can have multiple data blocks referenced by a single direct block and a single indirect block

- A file that only has one data block should not have an allocated indirect block.

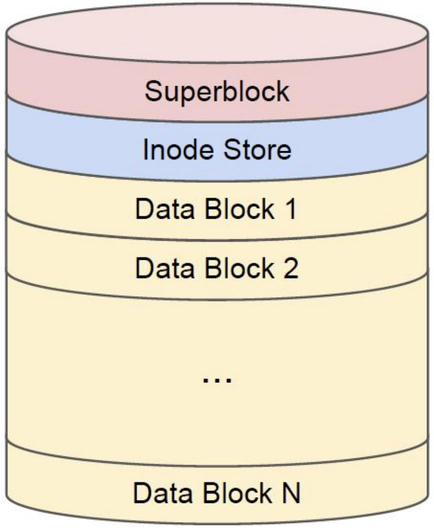
- A data block is a series of bytes representing file contents.

- **Empty regular file should have 0 data block.**



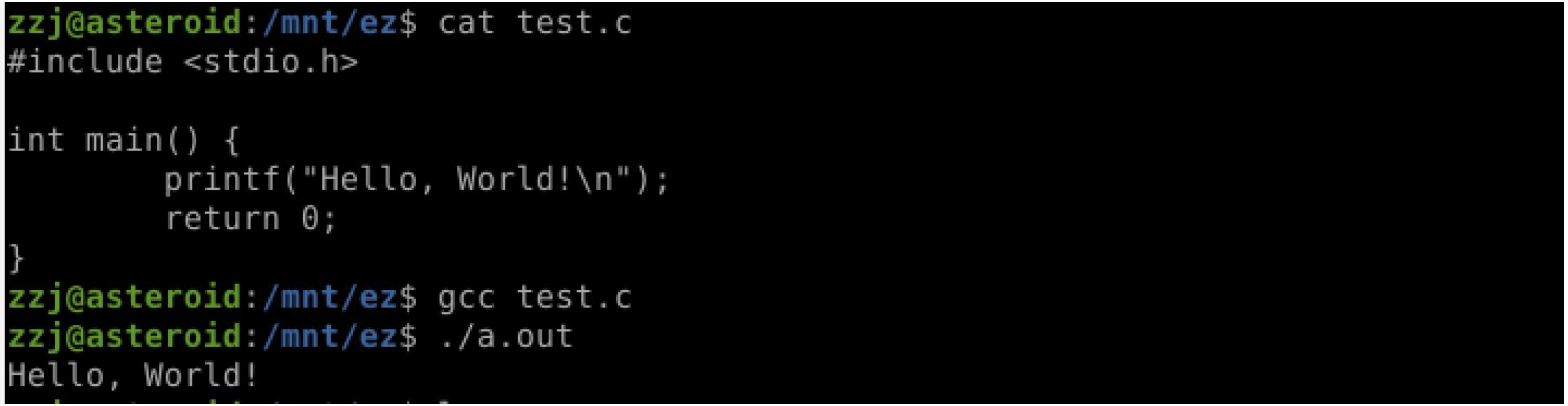
EZFS Data Block Index Allocation Policy

- As the size of a regular file extends, it might request for more data blocks.
- Assign an empty block with the lowest data block number to it.



EZFS Additional Features

- EZFS support mmap, thus executable files.



```
zzj@asteroid:/mnt/ez$ cat test.c
#include <stdio.h>

int main() {
        printf("Hello, World!\n");
        return 0;
}
zzj@asteroid:/mnt/ez$ gcc test.c
zzj@asteroid:/mnt/ez$ ./a.out
Hello, World!
```

EZFS Limitations

- Although each inode can have multiple blocks, the size of a EZFS file cannot be more than the number of entries across the direct and indirect blocks.
- Directory only has one data block, thus it can only have EZFS_MAX_CHILDREN children.

```
#define EZFS_MAX_CHILDREN (EZFS_BLOCK_SIZE / sizeof(struct ezfs_dir_entry))
```

- The number of inodes is limited by the macro EZFS_MAX_INODES. Therefore, at any given time:

  # files + # directories ≤ EZFS_MAX_INODES

  recall that EZFS_MAX_INODES is defined as:

```
#define EZFS_MAX_INODES (EZFS_BLOCK_SIZE / sizeof(struct ezfs_inode))
```

Reference

- https://cs4118.github.io/pantryfs/pantryfs-spec.pdf, Mitchell Gouzenko