

Implementation of a FAT32 File Explorer/Reader

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Overview

- What is FAT?
- Brief history of development of FAT32
- How FAT32 works
- Organization of a FAT32 Volume
- Demo of our implementation of FAT32
- Challenges and experiences from this project
- Questions

What is FAT?

- File Allocation Table
- Created by Bill Gates and Marc McDonald in 1977
- Managing disks in Microsoft Disk BASIC
- Uses centralized table of information about file areas, areas free or unusable, and where each file is stored on the disk
- **Clusters** - contiguous hardware sectors of disk space
- FAT file system has maintained backward compatibility with its evolution

FAT12

- Initial version of FAT file system
- File system for floppy disks and hard drive partitions smaller than 16MB
- No support for hierarchical directories
- Clusters 12 bits long -> 4084 max clusters
- Size 16 bit disk sectors
- Max Partition -> 32MB

FAT16

- Cluster addresses now 16 bits -> up to 65,517 clusters
- Increase from 16 to 32 bit sector size
- Used for small to medium sized hard disk volumes
- Maximum partition size of 2GB

FAT32

- Cluster addresses now up to 32 bits
- 28 bits are currently used
- Should support up to approximately 268,435,456 (2^{28}) clusters in theory
- Allows up to 8TB partition size with about 32K clusters each
- Maximum file size is 4GB minus 1 byte or 4,294,967,295 ($2^{32} - 1$) bytes
- Mainly used on flash drives and external hard drives nowadays but can be used on 2TB hard drives

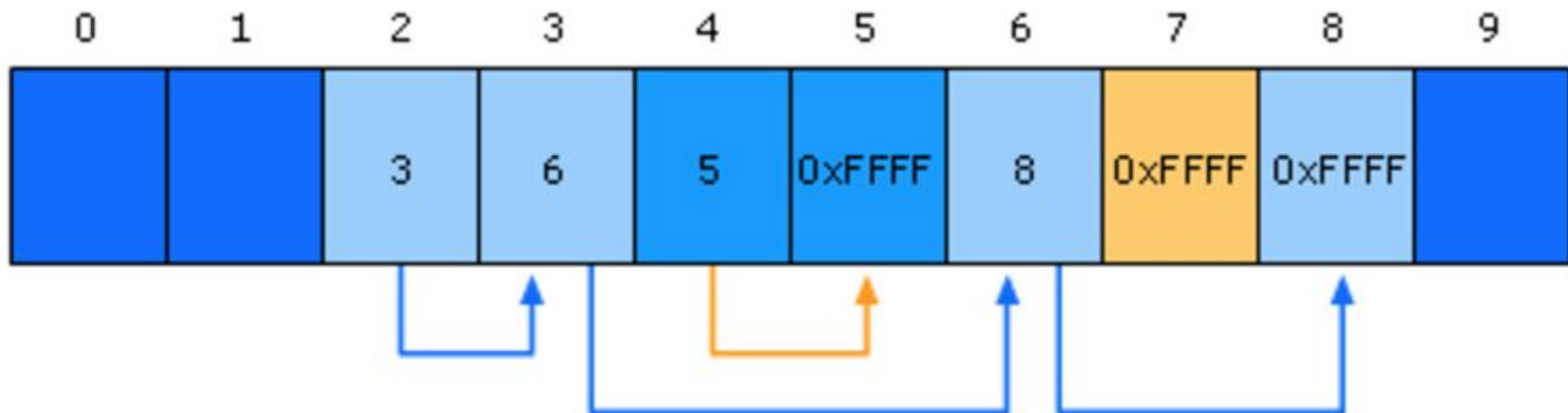
Organization of a FAT32 Volume

Boot Sector	Reserved Sectors	FAT 1	FAT 2 (Duplicate)	Root Folder	Other Folders and All Files
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How FAT32 Works

- When a file is saved:
 - File info stored in clusters on hard drive
 - If $|file| > |cluster|$, FAT stores file info on next available cluster until all info is stored
- When a file is deleted:
 - File info remains intact until it is overwritten (data can be recovered until then)
- When a file is accessed/read:
 - First, go to cluster address listed in the FAT
 - Follow pointers to the following clusters until the end of the file is reached, returning file info to the user

FAT Cluster File Processing



Limitations of FAT32

- Clusters cannot be larger than 64KB
- A volume must contain at least 65,257 clusters to use FAT32
- Maximum possible amount of clusters is 268,435,456. With a maximum of 32 KB per cluster to allow space for FAT, this is equal to the max disk size of 8TB
- A FAT32 partition cannot hold a file greater than 4GB

Demo

Our Experience

Challenges

- Fully understanding how files are stored (backwards compatibility makes certain fields non-contiguous)
- Dealing with alignment issues
- Successful maneuvering between directories, subdirectories, and files

What We Learned

- How FAT32 was developed
- How to implement a FAT32 file explorer/reader
- When a file is deleted the file information remains until overwritten
- If a file is larger than 4GB - 1 byte, a different file system must be used

References

- <http://www.howtogeek.com/235596/whats-the-difference-between-fat32-exfat-and-ntfs/>
- <http://www.wizcode.com/articles/comments/a-brief-introduction-to-fat-file-allocation-table/>
- [https://technet.microsoft.com/en-us/library/cc776720\(v=ws.10\).aspx](https://technet.microsoft.com/en-us/library/cc776720(v=ws.10).aspx)
- <https://support.microsoft.com/en-us/kb/184006>
- <https://support.wdc.com/knowledgebase/answer.aspx?ID=1287>

Questions?

Thank You!