

Operating Systems

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Operating System Components

- **User Interface:** Communicates with users
 - Text based (Shell)
 - Graphical user interface (GUI)
- **Kernel:** Performs basic required functions
 - File manager
 - Device drivers
 - Memory manager
 - Scheduler and dispatcher

File Manager

- **Directory (or Folder):** A user-created bundle of files and other directories (subdirectories)
- **Directory Path:** A sequence of directories within directories

What is a file system?

- Describes on-disk layout of files
 - Location of files
 - Provides directory hierarchy
 - Keeps track of free space
- Associates meta-data with files and directories

What are FSs for?

- User-transparent management of files
- Allow I/O libraries for applications
- Make it possible to share files between applications
- Allow users to manually access, modify, delete, and move files

Data vs. Meta-data

- Files
- Directories
- File size
- User ID
- Group ID
- Time stamps
- Permissions
- Thumbnail or Icon
- ...

FS perspective

- Partition is viewed as contiguous space
- Space is organized into basic units called blocks or clusters
- This imposes limitations on the file system: maximum number of units and fixed block size.

Superblocks

- A superblock contains parameters for the file system.
- Sometimes superblock and boot sector are the same.
- Serves as “starting point” for a file system where the OS reads information.

The FAT file systems

- Microsoft's file system originally designed for DOS
- Named after "File Allocation Table"
- FAT12, FAT16, FAT32

FAT layout

Boot Sector
1st FAT
...
last FAT
Root Directory
Cluster 2
...
Cluster n

FAT limitations

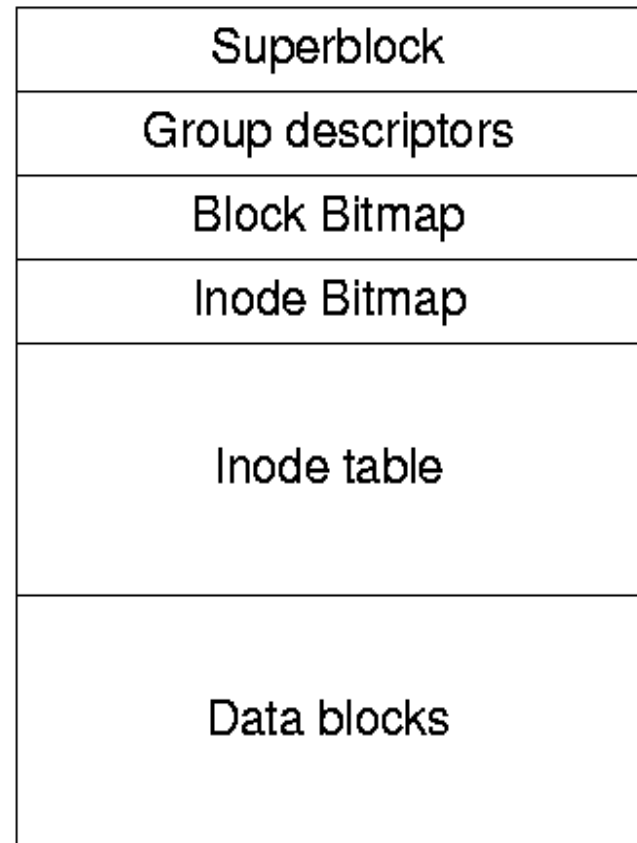
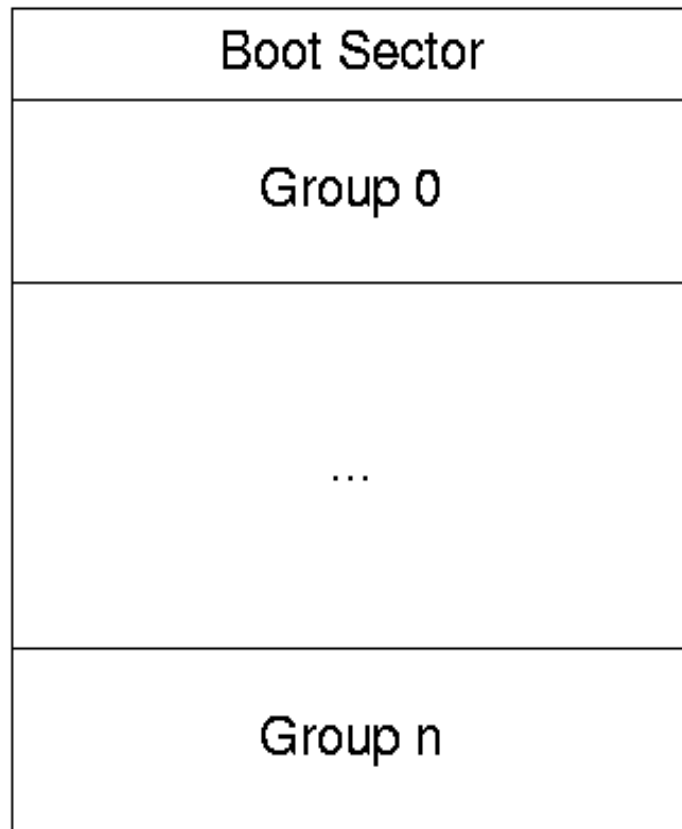
	# clusters	Cluster sizes	Total max
FAT 12	4,096	512bytes – 8k	32 MB
FAT 16	65,536	512bytes – 64k	4 GB
FAT 32	268,435,456	4k – 32k	8192 GB

- For FAT12/16 the root directory is limited to 255 entries.
- Windows limits FAT32 to a maximum volume size of 32 GB.

ext2

- Evolved from minix file system and shares many similarities with UFS
- Most commonly used FS for Linux
- Developed by Card, Ts'o, and Tweedie

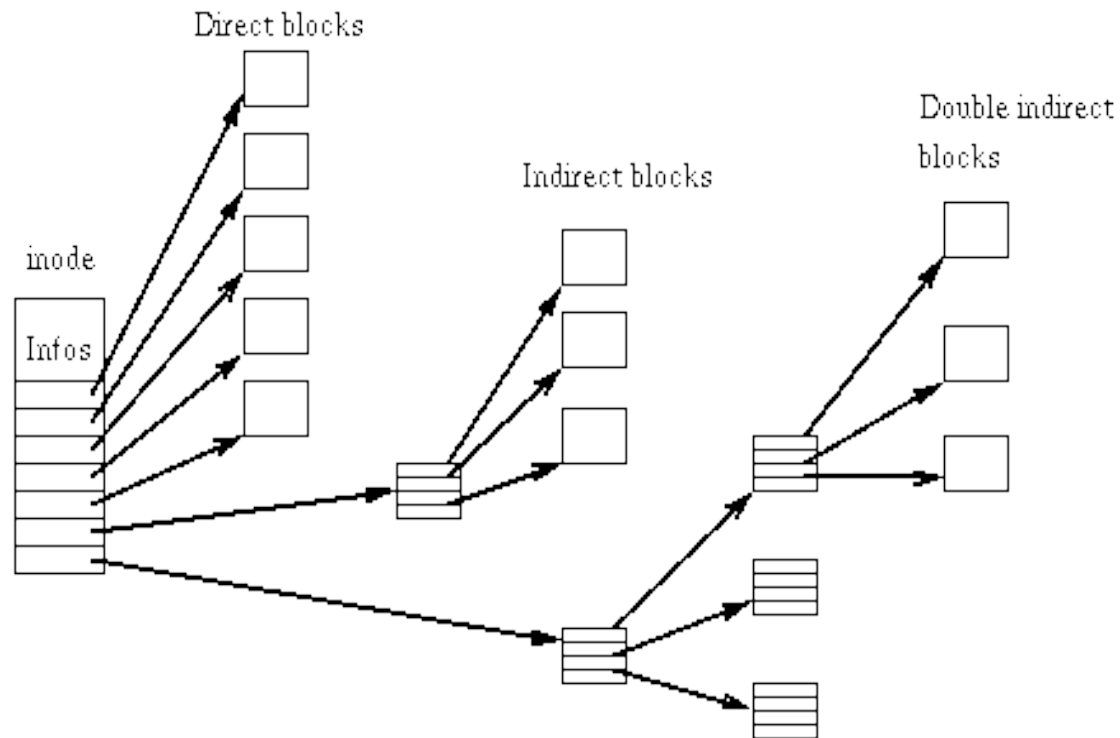
ext2 structure



Inodes

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xa	0xb	0xc	0xd	0xe	0xf
0x0000	Mode		UID		Size			Atime				Ctime				
0x0010	Mtime				Dtime			GID		Link count		Blocks				
0x0020	Flags				Osd1											
0x0030																
0x0040					Direct blocks											
0x0050								Indirect blocks				Double indirect				
0x0060	Triple indirect				Generation			File ACL				Dir ACL				
0x0070	Faddr							Osd2								

Block referencing



ext2 limitations

- $2^{32} = 4$ billion files
- 4 TB maximum partition size
- 2 GB maximum file size
- 255 characters per file name

New Technologies File System (NTFS)

- Developed by Microsoft to replace FAT
- No official documentation exists
- Scalable data structures are used to accommodate large storage devices
- Support for access control
 - FAT has no concept of a “user” and thus no AC mechanisms can be used on the file system level

Master File Table

- Contains information about all files and directories
- Consists of MFT Entries, which describe the file or directory
- One entry per file/directory (usually)
- MFT entries are of fixed size (1024 bytes)