File

- File is collection of data/information on storage device.
  - File = Contents (Data) + Information (Metadata)
  - The data is stored in zero or more Data blocks (in FS), while metadata is stored in the FCB (in filesystem).
- FCB is called as "inode" on UNIX/Linux. It contains
  - type: UNIX/Linux has 7 types of files
    - -: regular, d: directory, l: symbolic link, p: pipe, s: socket, c: char device, b: block device
  - size: number of bytes
  - links: number of hard links
  - mode (permissions): (u) rwx, (g) rwx, (o) rwx
  - user & group
  - time-stamps: modification, creation, access.
  - info about data blocks
- terminal> ls -l
  - type, mode, links, user, group, size, timestamp, name.
- terminal> stat filepath

File System

- Files are stored on storage device. Arrangement of files in storage device is called as "File System".
- e.g. FAT, NTFS, EXT2/3/4, ReiserFS, XFS, HFS, etc.
- File System logically divide partition into 4 sections.
  - Boot block/Boot sector
    - Contains programs/info required for booting of OS
    - Typically contains bootstrap program and bootloader program
  - Super block/Volume control block
    - Contains information of whole partition.
    - Capacity, Label.
    - terminal> df -h
      - Total number of data blocks/inodes.
      - Number of used/free data blocks/inodes.
      - Information of free data blocks/inodes.
  - Inode List/Master file table
    - Inodes (FCB) for each file
  - Data blocks
    - Stores data of the file.
    - Each file have zero or more data blocks.
    - Size of data blocks can be configured while creating file system
- File system is created by the format utility while formatting the partition.
  - Windows: format.exe
  - Linux: mkfs

        - terminal> sudo mkfs -t ext3 /dev/sdb1
        - terminal> sudo mkfs -t vfat /dev/sdb1
        - -t fs_type e.g. ext3, ext4, vfat, ntfs, ...
        - partition e.g. /dev/sdb1

- Disk/partition naming conventions
    - Windows:
        - Disks are named as disk0, disk1, ...
        - partitions are named as drives i.e. C:, D:, E:, ...
    - Linux:
        - Disks are named as /dev/sda, /dev/sdb, /dev/sdc, etc.
        - Partitions per disk are named as
            - sda partitions: sda1, sda2, sda3, ...
            - sdb partitions: sdb1, ...

File Systems

- Way of organizing files on the disk is called as "File Systems".
- e.g. FAT (File Allocation Table), NTFS (New Technology FileSystem), EXT2/3/4 (Extended 2/3/4), HFS (Hierarchial File System), ZFS, AFS, UFS, ...

FAT -- File Allocation Table

```
* Max file size = 4 GB.
* Disk allocation = Linked list based
* Prone to virus (Simple FS)
```

NTFS -- New Technology File System

```
* Max file size = Not specified
* Disk allocation = B-tree based
* Less Prone to virus (More complex)
```

File System architecture

- System calls: Applications/library functions invoke file system syscalls like open(), close(), read(), write().
- Virtual file system: Also called as logical file system. Provides unified view of files to apps irrespective of underlying file system.
- File system managers: Also called as physical file systems. e.g. NTFS, FAT, etc. Responsible for managing actual file system on the partition.
- IO subsystem: Responsible for performing disk IO using appropriate disk driver. Also holds disk/buffer cache to handle speed mismatch between RAM and disk