File System:

- **File:**
  File is a collection of related information.

- **File system:**
  It is the way in which files are named and stored. It can be different from one operating system to other.

- **File system consists of two distinct parts**:
  1. Collection of files: each storing related information.
  2. Directory structure: which organizes and provide information regarding all the files in the system.

- **Types of files:**
  1. **Program files**: sequence of subroutines and functions (source file) and sequence of bytes organized into blocks understandable by linker (object file).
  2. **Data files**: numeric, alphabetic or binary.
  3. **Text files**: sequence of characters organized into lines.
  4. Others like executable, batch, multimedia etc.

- **File Attributes**:
  1. **Name**: the symbolic file name that is human readable.
  2. **Identifier**: identifies the file within the file system.
  3. **Type**: this information is needed by operating system that supports different type of file.
  4. **Location**: it is the location of the file on the system.
  5. **Size**: current size of the file.
  6. **Protection**: access control rights (read, write, execute)

- **File operation:**
  1. **Create**: while creating file, first space must be found for the file and second is entry for the new file must be made in the directory.
  2. **Write**: system call is used that specifies the name of the file and the information to be written to the file.
  3. **Read**: system call is used that specifies the name of the file and where the next block of the file should be put.
  4. **Repositioning**: this is also known as file seek. Repositioning within a file need not involve any actual I/O.
  5. **Delete**: release the file space.
  6. **Truncate**: erase content of file but keep its attribute.

- **Information required for accessing a file:**

  1. **File pointer (FP):** it is pointer to a structure which contain information about file like name of the file or current position of the file etc.

  2. **File open count (FOC):** number of process have currently opened a file. If FOC (file open count) = 0, means all process closes the file and delete that entry.

  3. **Disk location of a file (FL):** file location to hard disk.

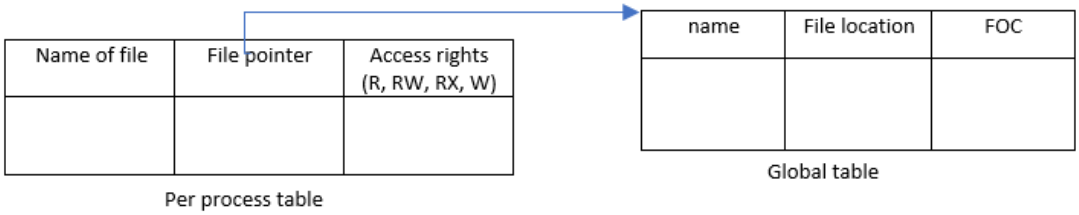
  4. **Access rights**: each process opens a file in an access mode. This information is stored on the per process table.

  Whenever we open a file, operating system creates an open file table.

  Per process file table: all the file which are open by the process is going to maintain contains the information which is relevant to the process in order to access the file.

Operating system also maintains global table for open table.

Global file: contains the information which is relevant to every process in order to access the file.



Now you have basic idea about files now you able to learn basic functionality of file system: https://www.geeksforgeeks.org/file-system-operating-systems/

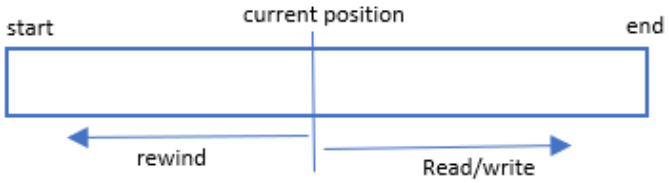
Operating system UNIX file system: https://www.geeksforgeeks.org/operating-system-unix-file-system/

❖ File Access methods:

First go through this link**:** https://www.geeksforgeeks.org/operating-system-file-access-methods/

As file store information so this information can be accesses in many ways:

1. **Sequential access**:
   a. Information in the file is accessed in order, one after other.
   b. It uses two pointers *read next and write next*.
      read next: it reads the next portion of the file.
      write next: appends to the end of the file.



2. **Direct access:**
   a. It is also known as relative access.
   b. It provides immediate access to large amount of information.
   c. It uses two pointes: *read n* and *write n*.
      read n: it reads the nth block number.
      write n: it appends to the nth block number.

❖ Directory structure:

Before starting this first read about what is file directory and path name: https://www.geeksforgeeks.org/operating-system-file-directory-path-name/

Structure of file directory with advantages and disadvantages: https://www.geeksforgeeks.org/operating-system-structures-of-directory/

❖ File Protection:

The protection is provided with some access control rights and some password or authentication mechanism. So, access can permit or denied depending on several factors, one of which is the type of access requested. Several different types of operations may be controlled:

1. Read(r): read from file.
2. Write(w): write the file.
3. Execute(x): load the file from disk into memory and execute it.
4. Append: write new information at the end of the file.
5. Delete: delete the file and free its space.
6. List: list the name and attribute of the file.

Access control:

Since different users need different type of access to a file or directory. The most common approach is to implement an ACL (Access Control List) which specifies the usernames and type of access allowed to for each user.

Whenever a user wants to access a file, the OS firs check the ACL associated with that file. If the user's entry present in that list, then access s allowed otherwise protection violation occurs.

Classification of users in connection with each file are:

Owner: user who created the file.

Group: group of users who are sharing the file.

Others/Universe: all other users in the system.

If you want to know how the permission is controlled using this classification then you can refer this link: https://www.geeksforgeeks.org/permissions-in-linux/

❖ File system:

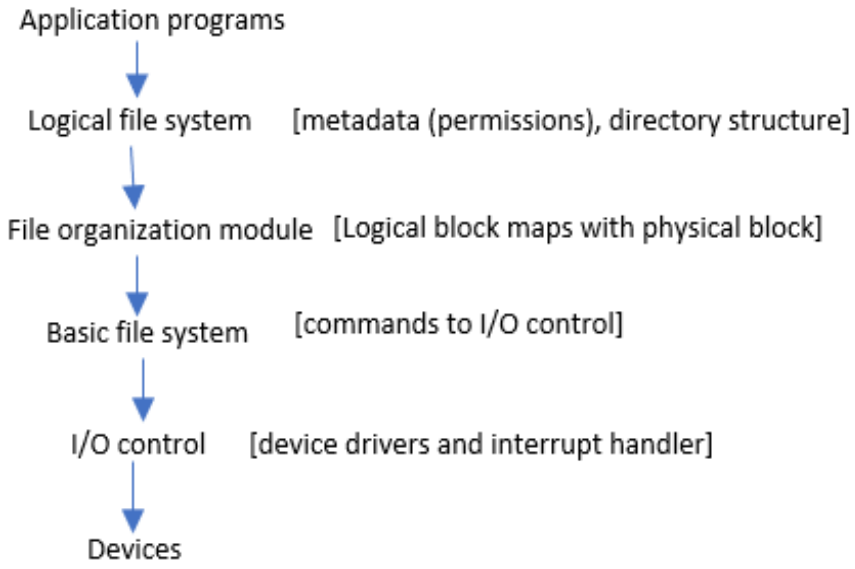
File system provides the mechanism fir storage and access to file contents, including data and programs.

File system deals with the following issues:

1. File structure.
2. To allocate disk space.
3. Recovering free space.
4. To track the locations of data.

File system structure:

File system provide efficient and convenient access to the disk by allowing information to be stored, located and retrieved easily. File system usually composed of different layers:



- **File system implementation**:

A. **On disk data structure uses in file system implementation**:

On disk, file system may contain information regarding booting of operating system, total number of blocks, location of free blocks etc.

1. **Boot control block** (per volume): it contains information needed by the system to boot an operating system from that volume. In UFS (UNIX file system) it is called as boot block and in NTFS it is called as partition boot sector.

2. **Volume control block**: it contains volume details such as the number of blocks in the partitions, size of the block. In UFS (UNIX file system) it is called as super block and in NTFS it is stored in master file table.

3. **Directory structure per file system**: it is used to organize the files. In UFS this includes file names and associated inode numbers.

4. **File control block (FCB):** it contains details about the file.

File permissions
File dates (create, access, modified)
File owner, group, ACL
File size
File data blocks or pointers to file data blocks

B. **In memory data structures in file system implementation**:

In memory data structures is used for both the file system management and performance improvement via caching.

Mounting: whenever we mount the new hard disk or new partition/volume connected to a computer then we must get all the information present in the device into the main memory.

In memory mount table: it gives information regarding all the hard disk or the partitions or devices which are connected to the computer.

In memory directory structure cache: it gives the information of recently accesses directory.

System wide open file: it contains the FCB of each open file.

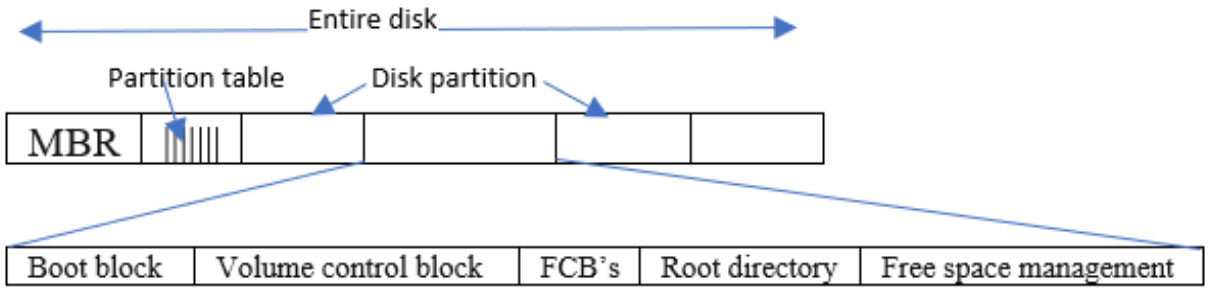
C. Master Boot Record (MBR):

It is the information that is read from first sector of the hard disk i.e. the first 512 bytes on a hard drive contains MBR. MBR contains boot code and partition table where –

Boot code processes the partition table to identify which partition is bootable. It knows where the operating system code is present and how to load that code.

Partition table identifies the file system on the disk partitions. Every entry in the partition table gives the information about where each partition is going to begin.

How the disk is partitioned?



In single computer we want to run multiple file system or multiple operating system in that case we take entire hard disk and divide it into partition/volume where each partition loaded with different operating system.

BIOS: it helps to find out where the code related to Window or Linux present and which one to use. It fetches the first block from hard disk which contain MBR to main memory.

So, CPU start executing the instructions of MBR.

All the messages like- which operating system you want to load in starting of computer are stored in MBR.

❖ File allocation methods:

https://www.geeksforgeeks.org/file-allocation-methods/

❖ Free space management:

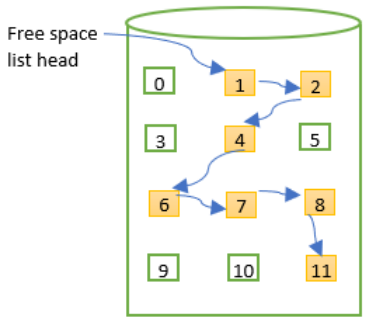
First explore this link: https://www.geeksforgeeks.org/operating-system-free-space-management/

Since disk space is limited, we need to reuse the space from deleted files for new files. So, to keep track of free disk space, the system maintains the free space list.

1. **Bit vector:**
   a. This approach is also known as bit map.
   b. Keep track of free spaces and occupied spaces in memory.
   c. Free space list is implemented as a bit map.

d. Each block is represented by 1 bit. If the block is free bit is 1 and else, it is 0.
e. The main advantage of this approach is simplicity
f. Example: consider a disk where blocks 2, 3, 4, 5, 8 , 9 are free and the rest of the blocks are allocated and if the block is free, the bit is set to 1 ; if the block is occupied, the bit is 0.
So, the free space bitmap would be: 001111001100…

2. **Linked list:**
   a. It is also known as free list.
   b. It links together all the free disk blocks, keeping pointer to the first free block in special location on the disk and caching it in memory. The first disk block contains a pointer to the next free disk block and so on.



- **Secondary Storage:** https://www.geeksforgeeks.org/secondary-memory/
- **Secondary memory: hard disk drive**: https://www.geeksforgeeks.org/operating-system-secondary-memory-hard-disk-drive/
- **Disk scheduling algorithms:**
  Please read these links in the given sequence:
  1. https://www.geeksforgeeks.org/disk-scheduling-algorithms/
  2. https://www.geeksforgeeks.org/program-for-sstf-disk-scheduling-algorithm/
- **Spooling**: https://www.geeksforgeeks.org/what-exactly-spooling-is-all-about/
- **Difference between spooling and buffering**: https://www.geeksforgeeks.org/difference-between-spooling-and-buffering/

Last minute notes: https://www.geeksforgeeks.org/last-minute-notes-operating-systems/