

- Process mg^m
- CPU sched.
- mem mg^m
- File mg^b



File Management

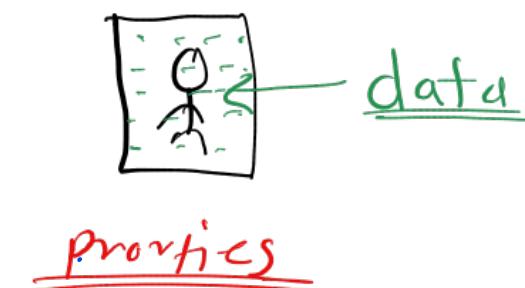
Q. What is file?

❖ User view:

- File is a container which contains logically related information/data.
- File is a collection of characters/records/lines.
- File is a basic storage unit .

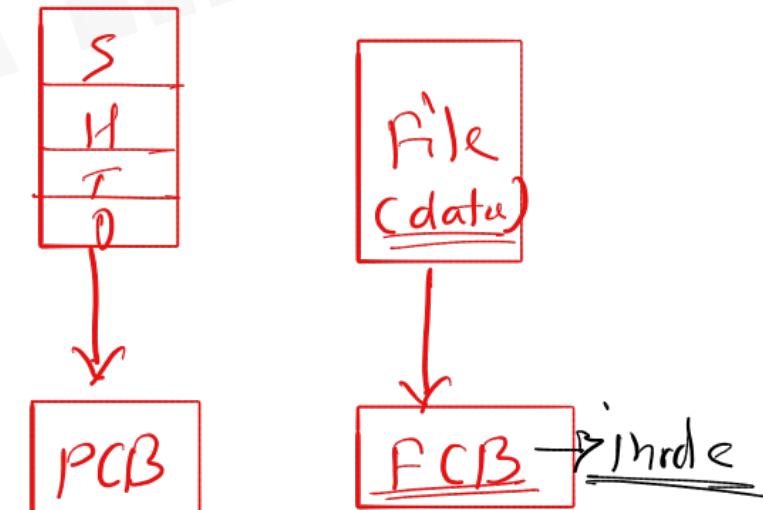
❖ System view:

- File is a **stream of bits/bytes.** => 010100001111.....
- **File = data + metadata**
 - data = actual file contents.
 - metadata = information about the file..



Operating Systems Concepts

- Data of the file exists inside the file whereas information about the file gets stored inside one structure referred as **FCB (File Control Block)**.
- In UNIX environment FCB is also called as an **iNode**.
- **FCB / iNode contains information about the file like:**
 1. iNode number: unique identifier of a file
 2. Name of the file
 3. Type of the file
 4. Size of the file
 5. Parent folder location
 6. Access permissions
 7. Time stamps etc...



Operating Systems Concepts

- Per file one iNode/FCB gets created by the system and
-i.e. hence no. of iNodes = no. of files onto the disk.
- **data + metadata** of all the files are kept onto the disk, as disk may contain thousands of files, so thousands of iNodes and millions of bytes of data gets stored onto the disk, and hence all this **data + metadata** of all files need to be kept onto the disk in an organized manner so that it can be accessed efficiently.



○ **File system** : file system is a way to store data onto the disk in an organized manner so that it can be accessed efficiently and conveniently.

- e.g. Each OS has its own file system like,
- UNIX: UFS(UNIX File system),
- Linux: Extended File system ext2, ext3, ext4,
- Windows: FAT, NTFS etc..., FAT 32, CDFS
- MAC OSX: HFS(Hierarchical File system) etc...

FAT \Rightarrow File allocation Table

NTFS = New Tech. file system.

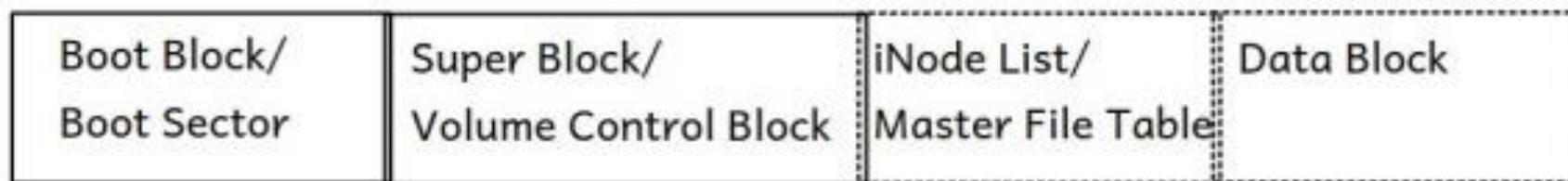
Operating Systems Concepts

Formatting \Rightarrow Create New F.S.

- **File system Structure:** File system divides disk/partition logically into sectors/blocks, like boot sector/boot block, volume control block/super block, master file table/iNode list block and Data Block.



FILESYSTEM STRUCTURE



1. Boot Block: It contains information about booting the system like bootstrap program, bootloader etc...
2. Super Block: It contains information about remaining sections, like total no. of data blocks, no. of free data blocks, no. of allocated data blocks etc....
3. iNode List: It contains linked list of iNode's of all files exists on a disk.
4. Data Block: It contains actual data.

Operating Systems Concepts

➤ Disk space allocation methods:

- When a file is requesting for free data blocks, then in which manner free data blocks gets allocated for that file and how its information can be kept inside inode of that file is referred as disk space allocation method.

❖ Three disk space allocation methods are there:

1. Contiguous Allocation (Car)
2. Linked Allocation (Link-list)
3. Indexed Allocation (Hash table)

Operating Systems Concepts

1. Contiguous Allocation : free data blocks gets allocated for a file in a contiguous manner.

□ Advantages :

1. Sequential access.
2. Random access .
3. Simple to implement.

□ Disadvantages :

1. File may not grow(Limitations).

2. External fragmentation

-Number of blocks required are available but not contiguous.

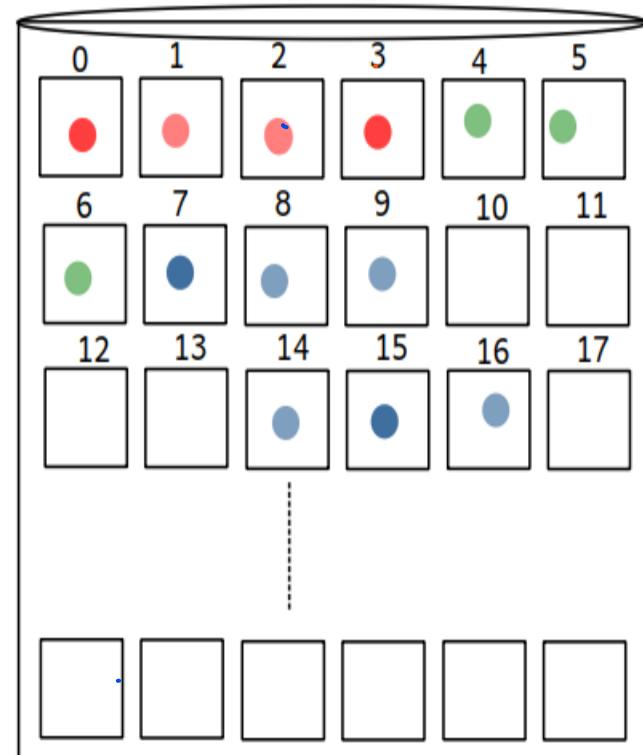
❖ Defragmentation :

-Moves files on disk so that maximum contiguous free space is available.

Compaction → RAM X

Disk Space Allocation Method:

1. Contiguous Allocation



Operating Systems Concepts

2. Linked Allocation: any free data blocks gets allocated for a file in a linked list manner.

Advantages :

1. Sequential access.
2. No file grow limit.
3. No external fragmentation.

Disadvantages :

1. Slow random access.

Example : FAT

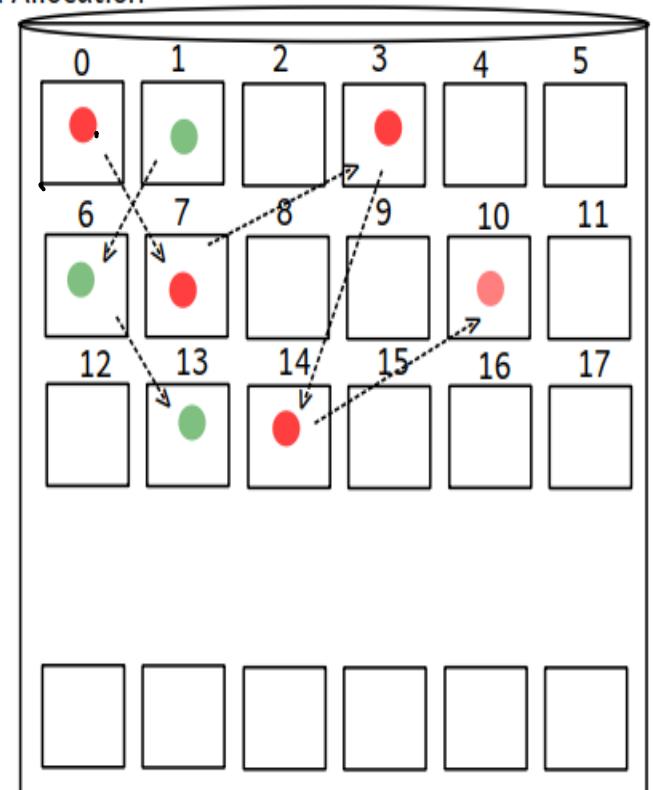
S U N

india.txt
- inode number: 101
- addr of starting data block=0
- addr of end data block=10

pakistan.txt
- inode number: 201
- addr of starting data block=1
- addr of end data block=13

Disk Space Allocation Method:

2. Linked Allocation



Operating Systems Concepts

3. **Indexed Allocation** : any free data blocks gets allocated for a file, as by maintaining an index data block information about allocated data blocks can be kept inside it.

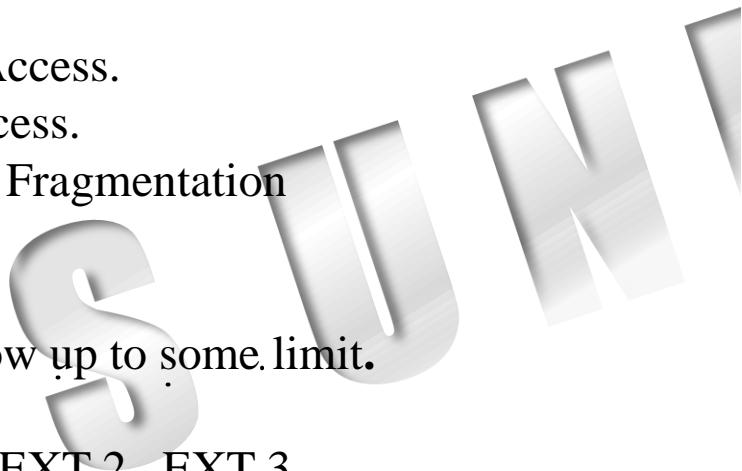
Advantages :

1. Sequential Access.
2. Random Access.
3. No External Fragmentation

Disadvantages :

1. File cant grow up to some limit.

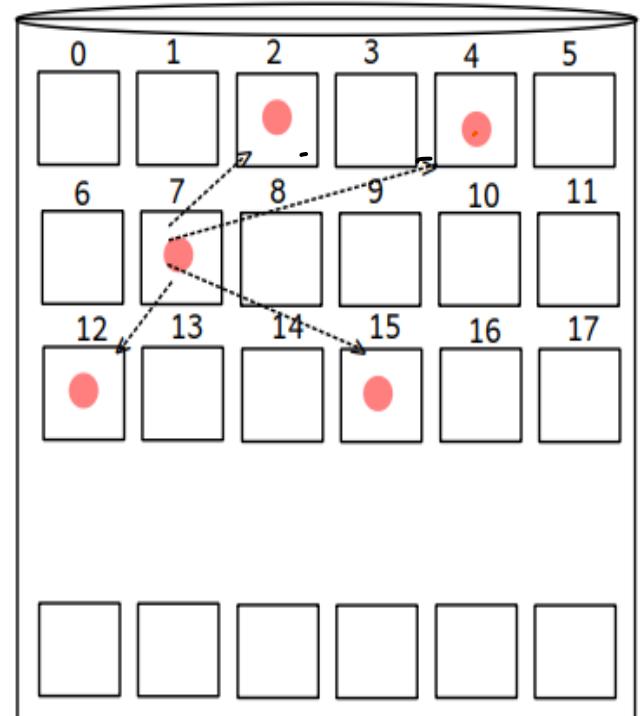
Example : UFS , EXT 2 , EXT 3



india.txt
- inode number: 101.
- addr of index data block=7

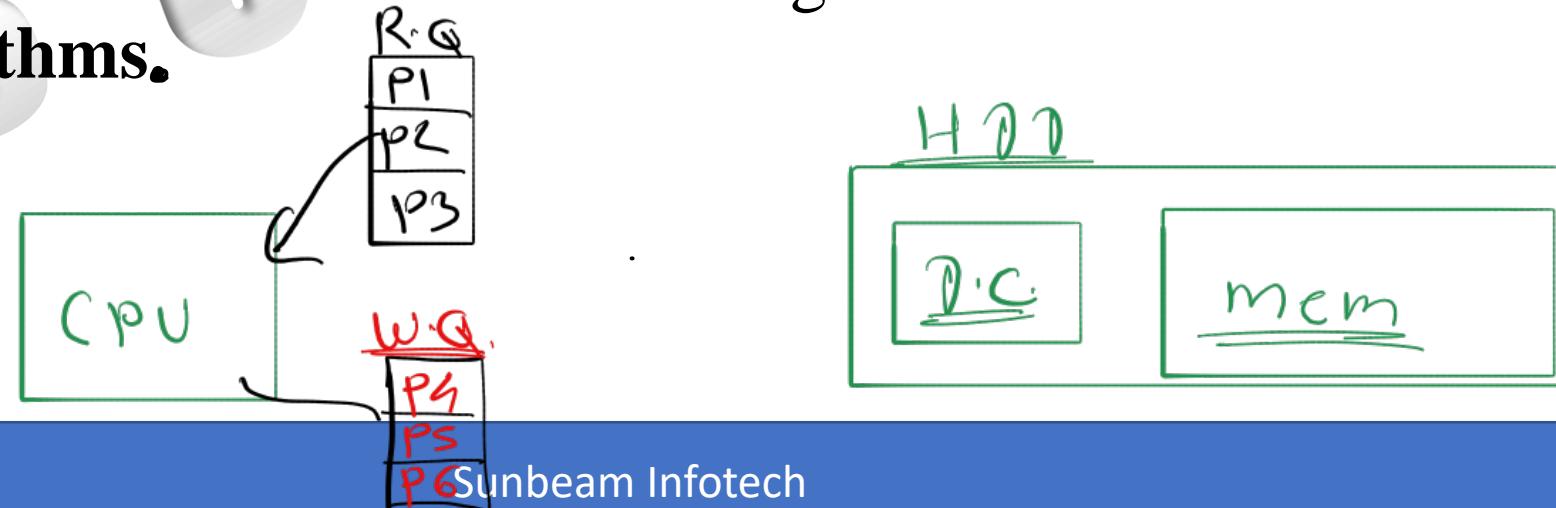
Disk Space Allocation Method:

3. Indexed Allocation



➤ Disk Scheduling Algorithms:

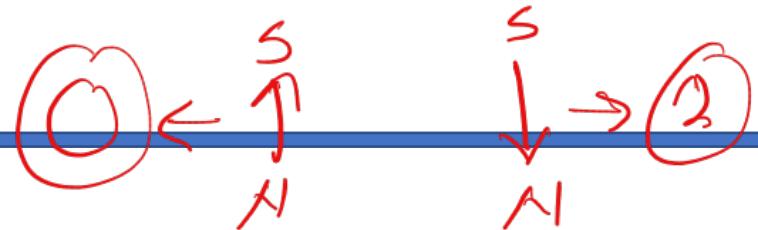
- When system want to access data from a disk, request can sent to disk controller and disk controller accepts one request at a time and complete it.
- There are chances that at a time more than one requests for accessing data from the disk can be made by the processes running in a system, in that case all the requests can **be kept in a waiting queue of the disk maintained by an OS, and** there is need to **schedule/select only one request at a time and sent it to the disk controller**, to do this there are certain algorithms referred as **disk scheduling algorithms**.



Operating Systems Concepts

1. **FCFS (First Come First Served)**: request which is arrived first gets accepted and completed.
2. **SSTF (Shortest Seek Time First)**: request which is closest to the current position of the head gets accepted and completed. *Starvation*
3. **SCAN**: head keeps scanning the disk from starting cylinder to end cylinder and whichever request came across gets accepted and completed.
4. **C-SCAN (Circular SCAN)**: head scans the disk only in one direction.
5. **LOOK**: this policy can be used either with SCAN/C-SCAN, in this, if there is no request in a waiting queue then movement of the head gets stopped.





► Magnetic Disk : Hard Disk Drive Structure

- HDD is made up of one or more circular platters arranged like CD rack.
- A Circular platter is made up of non-magnetic substance like aluminum or aluminum alloy, which is coated with a magnetic substance.
- Coating of magnetic substance is either from one side to the platter or from both the sides (for increasing its capacity) and hence platter in a magnetic disk may be either single sided platter or double sided platter.
- Circular platter is divided into the hundred's of concentric rings called as **tracks** whereas each track is divided into thousands of same size of blocks called as **sectors**.
- Usually the size of each sector is **512 bytes**
- There is one conducting coil referred as head which is used to access data from the sector i.e. head can read and write data from and into a sector at a time.
- Head writes and read data sector by sector i.e. block by block, and magnetic disk is also called as **block device**. **(512 bytes)**

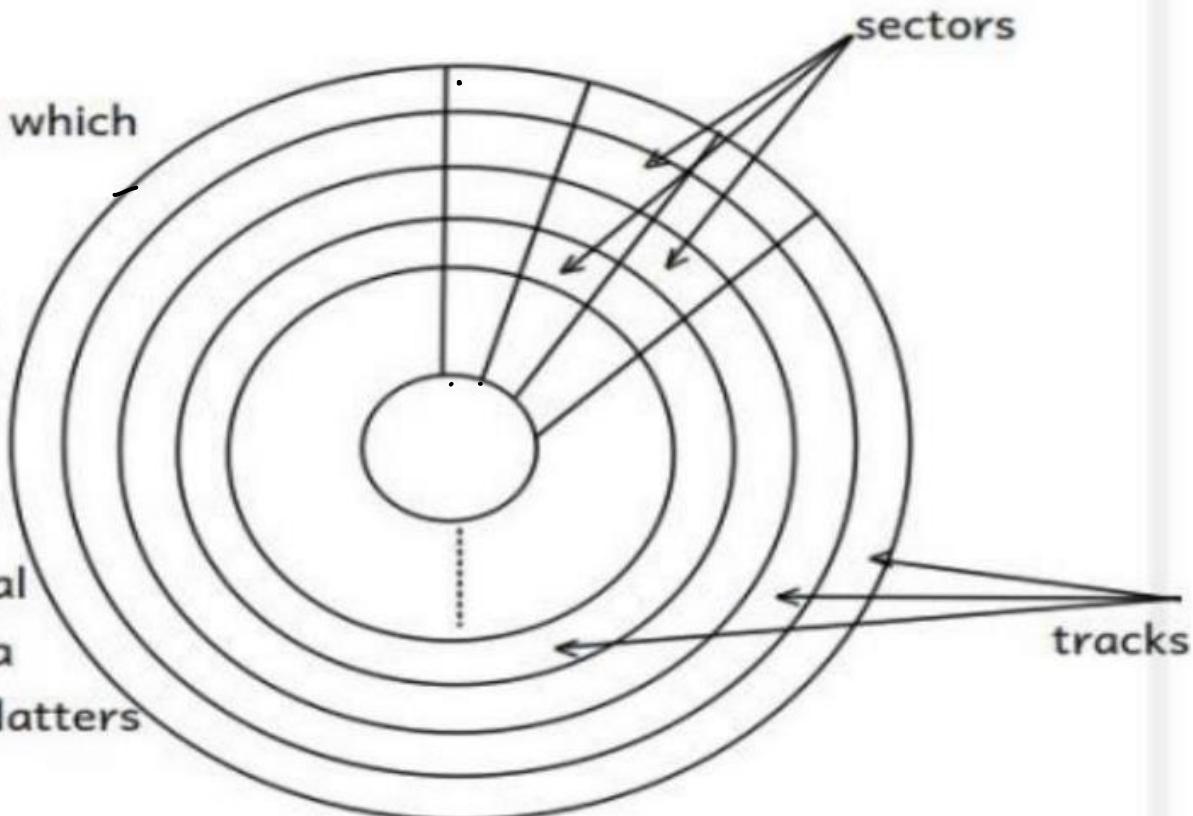
Computer Fundamentals and Operating Systems

- All the operations like read, write, control etc... in a HDD are controlled by **disk controller**, and hence movement of the head also controlled by it.
- **Seek Time:** time required for the disk controller to move head from its current position to the desired track.
- **Rotational Latency:** after reaching head at desired track, circular platter gets rotated till the head does not comes aligned with the desired sector, and time required for this rotation is referred as rotational latency.
- **Access Time = Seek Time + Rotational Latency.**

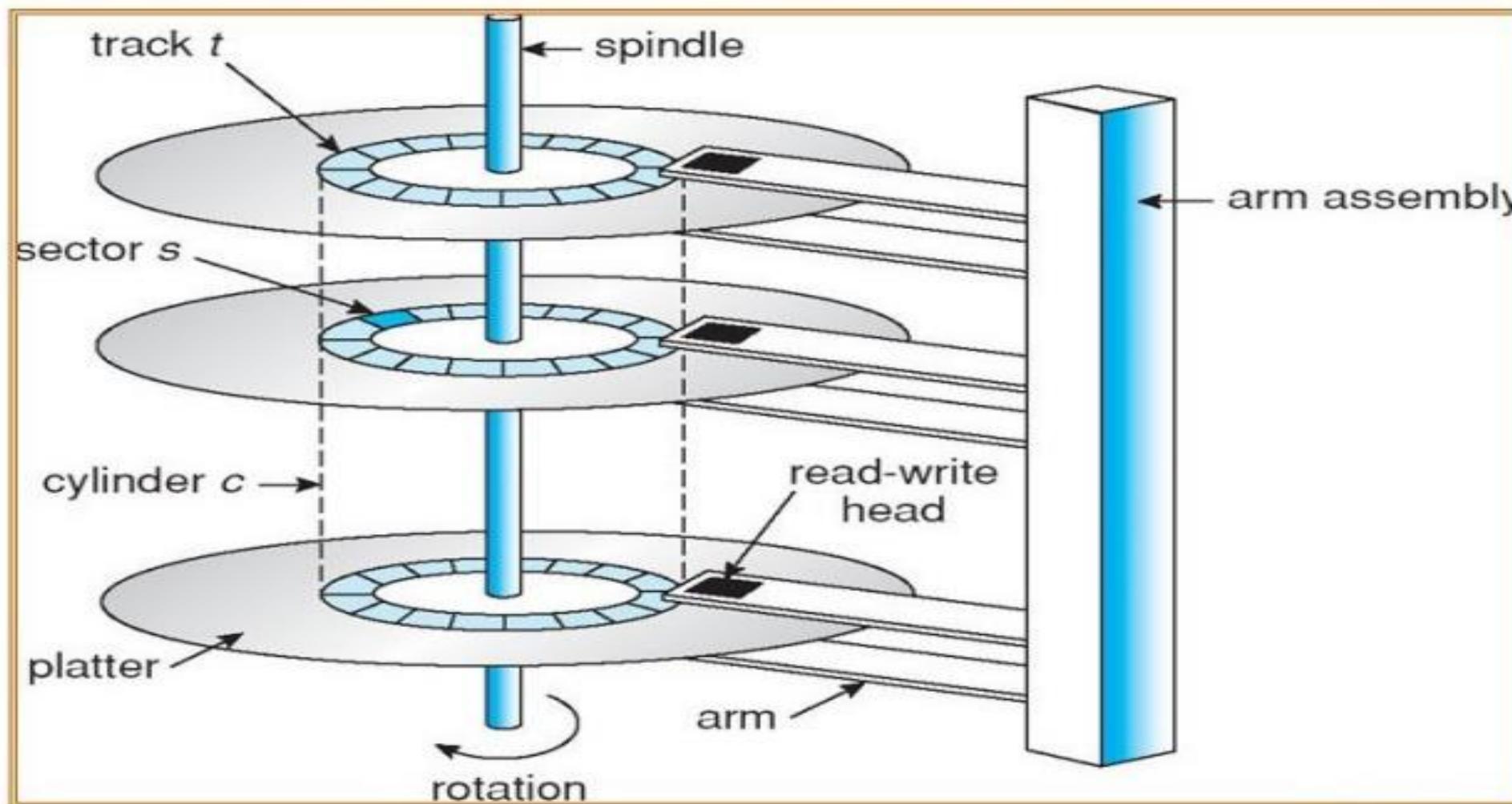


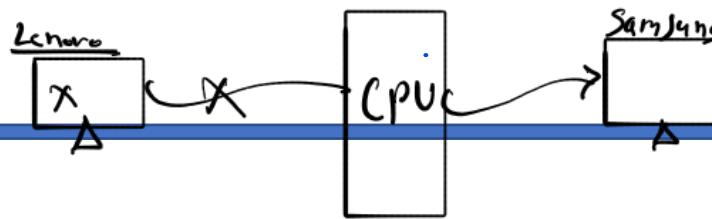
Hard Disk Drive:(HDD)

- It contains a "circular platter"(s) made up of non-magnetic material like alluminum or alluminium alloy, which is coated with a magnetic substance.
- Each platter is divided into hundreds of concentric rings called as "tracks" and each track is divided into fixed size of blocks called as "sectors".
- Size of each sector on each track is same usually size of the sector = 512 bytes.
- Cylinder: A cylinder is any set of all of tracks of equal diameter in a hard disk drive. It can be visualized as a single, imaginary, circle that cuts through all of the platters (and both sides of each platter) in the drive.
- Seek Time: it is the time required for a disk controller to move head from its current position to desired cylinder.
- Rotational Latency: Once head moved at desired cylinder, time required to rotate the platter to get aligned with desired sector is called as rotational latency.



Moving-head Disk Mechanism



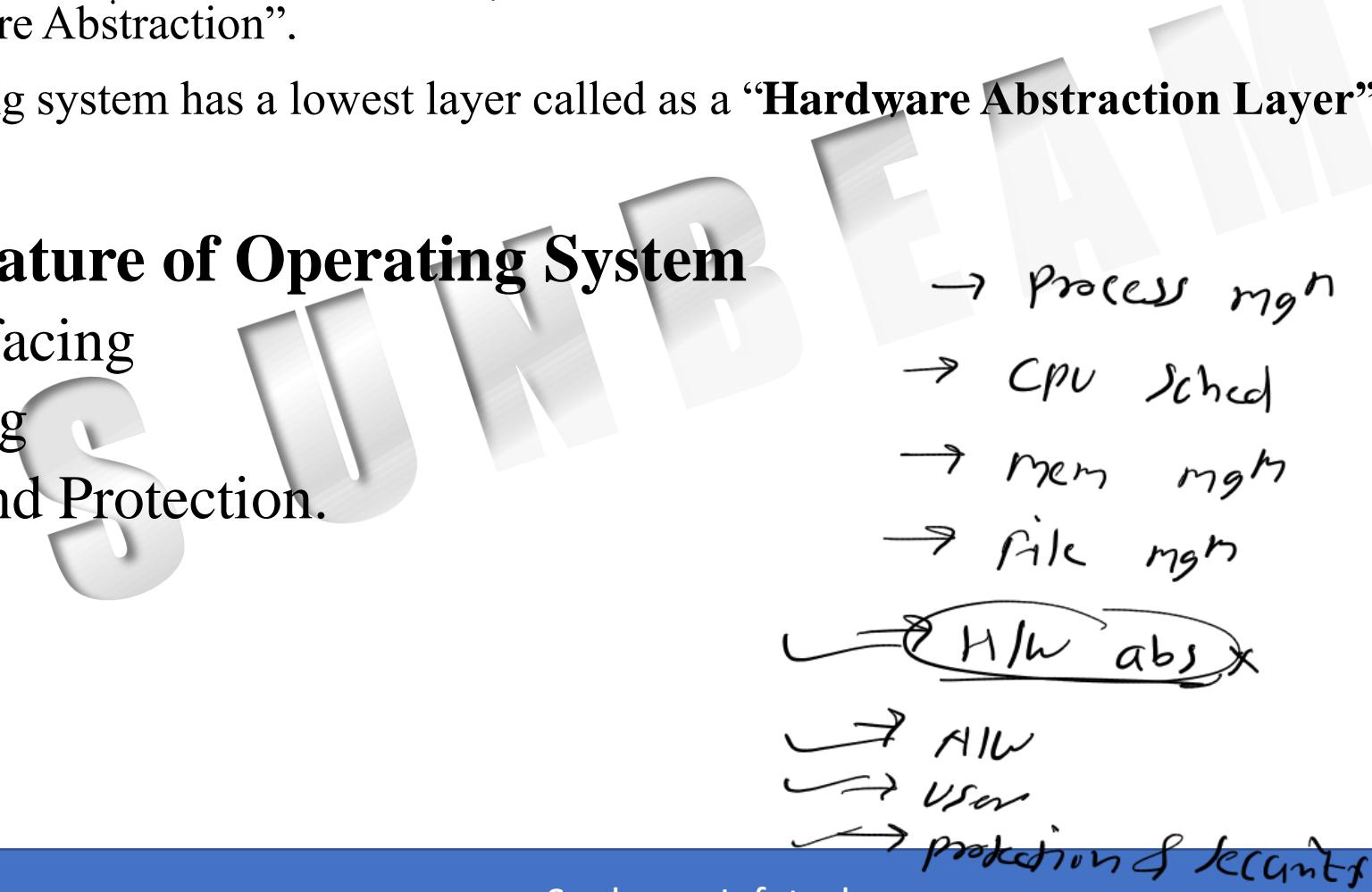


➤ Hardware Abstraction

- Operating System Hides Hardware intricacies(Complication) from the end user and the Other program. This is called as “Hardware Abstraction”.
- For these Operating system has a lowest layer called as a “**Hardware Abstraction Layer**” (HAL).

➤ Optional Feature of Operating System

- User Interfacing
- Networking
- Security and Protection.



USER INTERFACE

1. CUI/CLI : Command User Interface/Command Line Interface

- By using this kind of interface user can interacts with an OS by means entering commands onto the terminal/command line in a text format.
- e.g. In Windows name of the program which provide CUI => cmd.exe , *Powershell*
- command prompt In Linux name of an application program which provides CUI => shell/terminal
- In MSDOS name of the program which provides CUI => command.com (Microsoft Disk Operating System).

2. GUI : Graphical User Interface

- by using this kind of interface user can interacts with an OS by means making an events like click on buttons, left click/right click/double click, menu bar, menu list etc....
- **Windows = User friendly GUI.**
- e.g. In **Windows** name of an application program which provides GUI => **explorer.exe**
- In **Linux** name of an application program which provides GUI => **GNOME/KDE** (GNU Network Object Model Environment / Common Desktop Environment).



➤ Security and Protection

- **Security:**

- Securing the Computer from **external threats**(Threats possibly malicious program) like virus,worms, Trojans, malware and hacking.
- Usually security is not the part of many OS. However, nowadays Windows OS provide security with **Windows Defender**.
- Mostly security handle by **Antivirus program and Firewall**.

- **Protection:**

- Protecting the system component from **internal threats / Programs**.
- Files of one user are not accessible to other user.
- Dual Mode protection i.e. CPU modes –User Mode/ System Mode.
- Memory of one process protected from another process.

➤ Networking

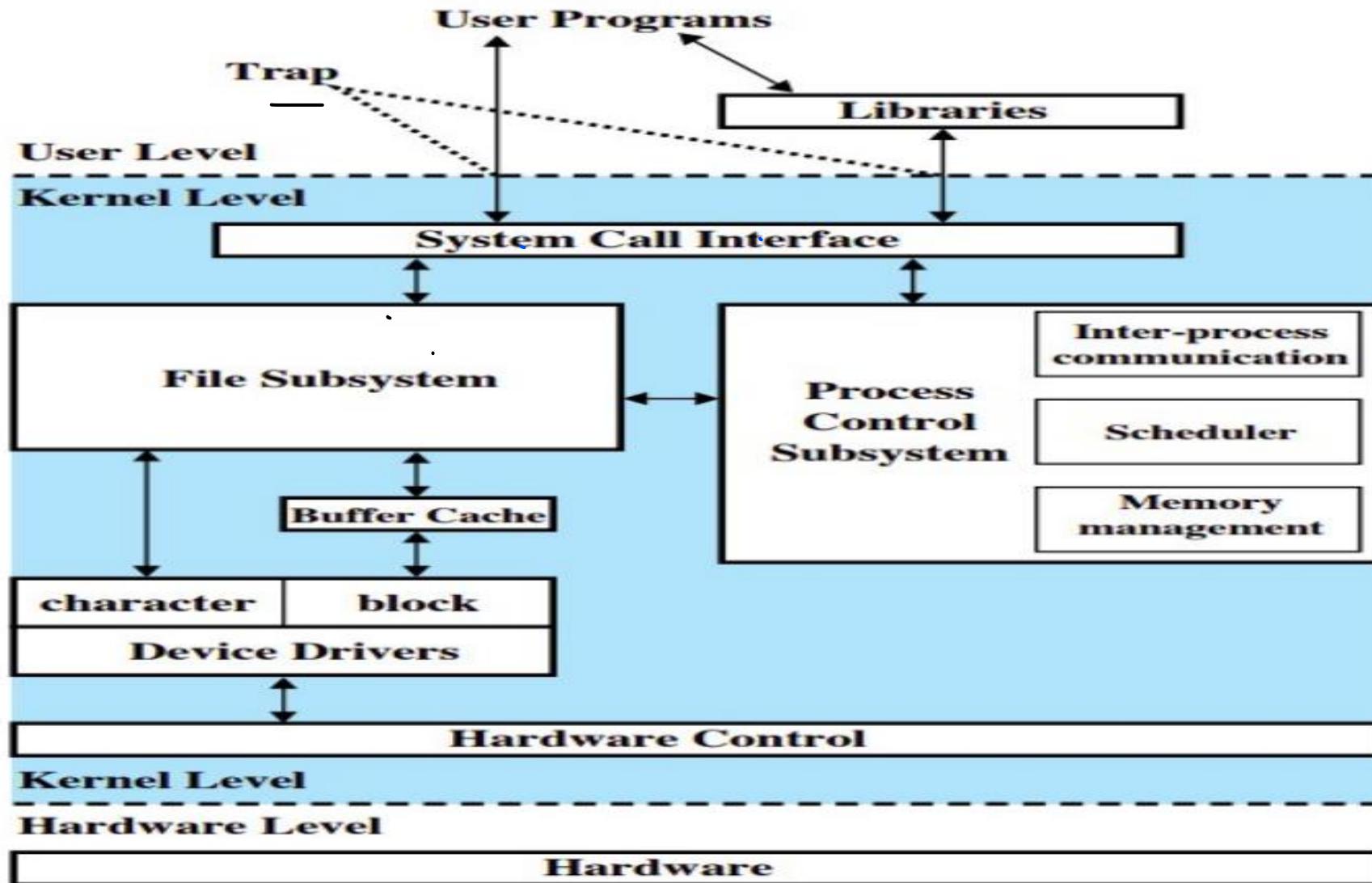
- Now Days Networking is supported by all OS.
- Internally OS does transfer data to other computer using Socket IPC. ← DCH

Operating Systems Concepts

- **UNIX Operating System:**
- **UNIX** : UNICS – Uniplexed Information & Computing Services/System.
- **UNIX** was developed at AT&T Bell Labs in US, in the decade of 1970's by Ken Thompson, Denies Ritchie and team.
- It was first run on a machine **DEC-PDP-7** (Digital Equipment Corporation Programmable Data Processing-7).
- **UNIX is the first multi-user, multi-programming & multi-tasking operating system.**
- **UNIX** was specially **designed for developers by developers**.
- System architecture design of **UNIX** is followed by all modern OS's like Windows, Linux, MAC OS X, Android etc..., and hence **UNIX is referred as mother of all modern operating systems.**



Operating Systems Concepts



Operating Systems Concepts

- Kernel acts as an interface between programs and hardware.
- Operating System has subsystems like System **Call Interface Block**, **File Subsystem Block**, **Process Control Subsystem Block** (which contains IPC, Memory Management & CPU Scheduling), **Device Driver**, **Hardware Control/Hardware Abstraction Layer**.
- There are two major subsystems:
 1. Process Control Subsystem.
 2. File Subsystem
- In UNIX, whatever is that can be stored is considered as a file and whatever is active is referred as a process.
- File has space & Process has life.

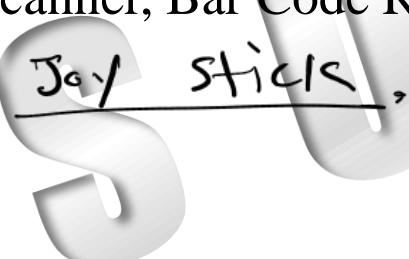


Computer Fundamentals and Operating Systems

➤ Input / Output Devices

- Devices which are connected to the motherboard externally through ports referred as **peripheral devices** or **peripherals**.
- An IO Devices are also referred as an **external devices**.

❖ Input Devices :

- The Input unit allows program and data into to be entered into the Computer.
- Keyboard, Mouse, Scanner, Bar Code Reader, Eye Recognition System, Voice Recognition System, Touch Pad, Touch Screen etc... , 

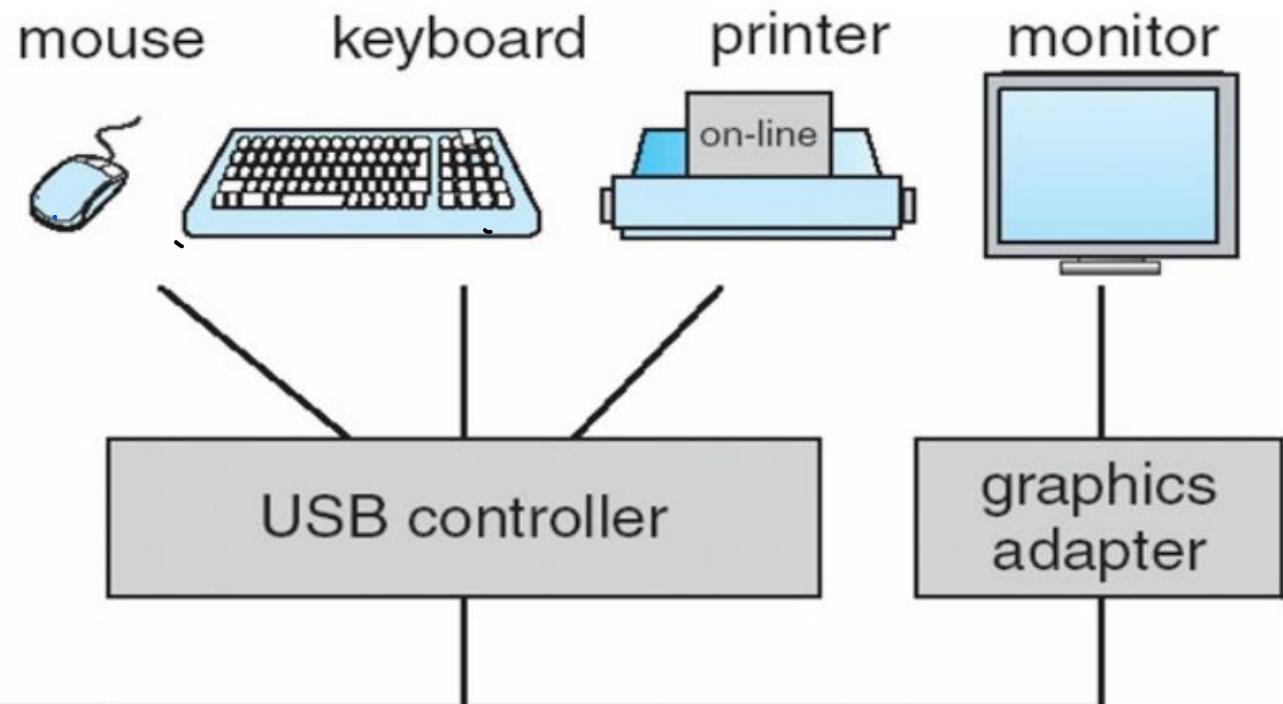
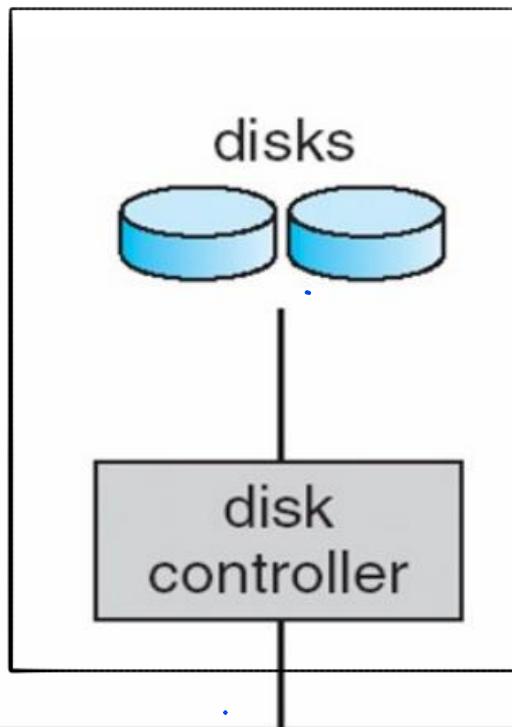
❖ Output Device :

- The Output unit allows the result of processing to be exported to the outside world or Other device or saved to be used later.
- Monitor, Printer, Speakers, Projector etc... , 



Computer Fundamentals

~~Device
Drivers~~



Computer Fundamentals and Operating Systems

➤ IO Modules/IO Controller:

- Core Computer system is not able to communicate directly with any external device and hence I/O modules acts as an interface between core computer system and an I/O devices.
- **Each IO device has its own internal dedicated processing unit called ‘as IO module’.**
- I/O Modules contains all the logic to communicate with an I/O devices.
- Single I/O module can be used for communication between one device or with more than one devices as well.



❖ **Device Driver** - is a program within operating system that **send/receive data/command to/from** IO device controller and also handles interrupts send From the device



❖ Functions Of IO Module :

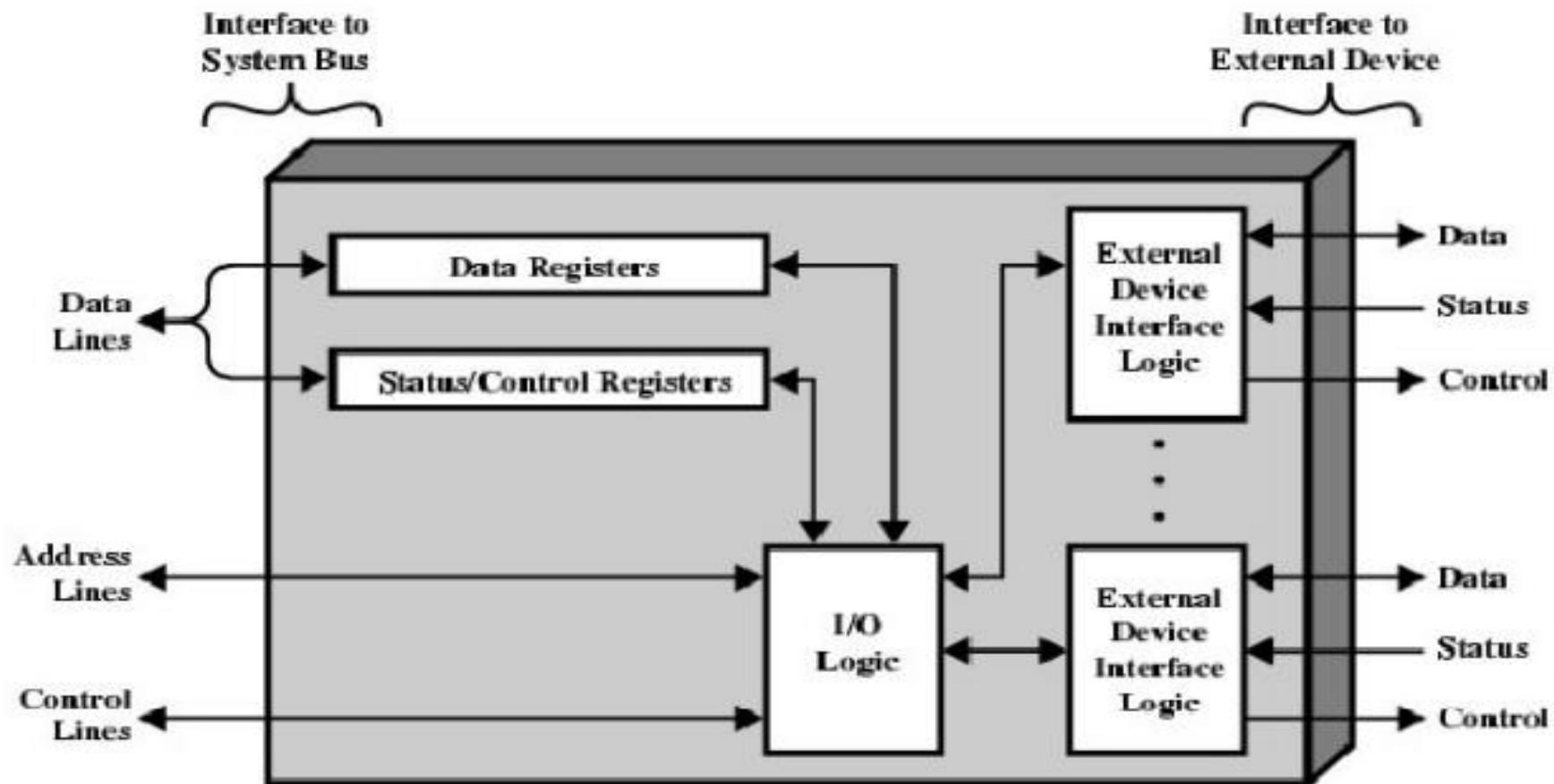
1. Control and Timing
2. CPU communication
3. Device communication
4. Data Buffering
5. Error Detection.

SUNBEAM



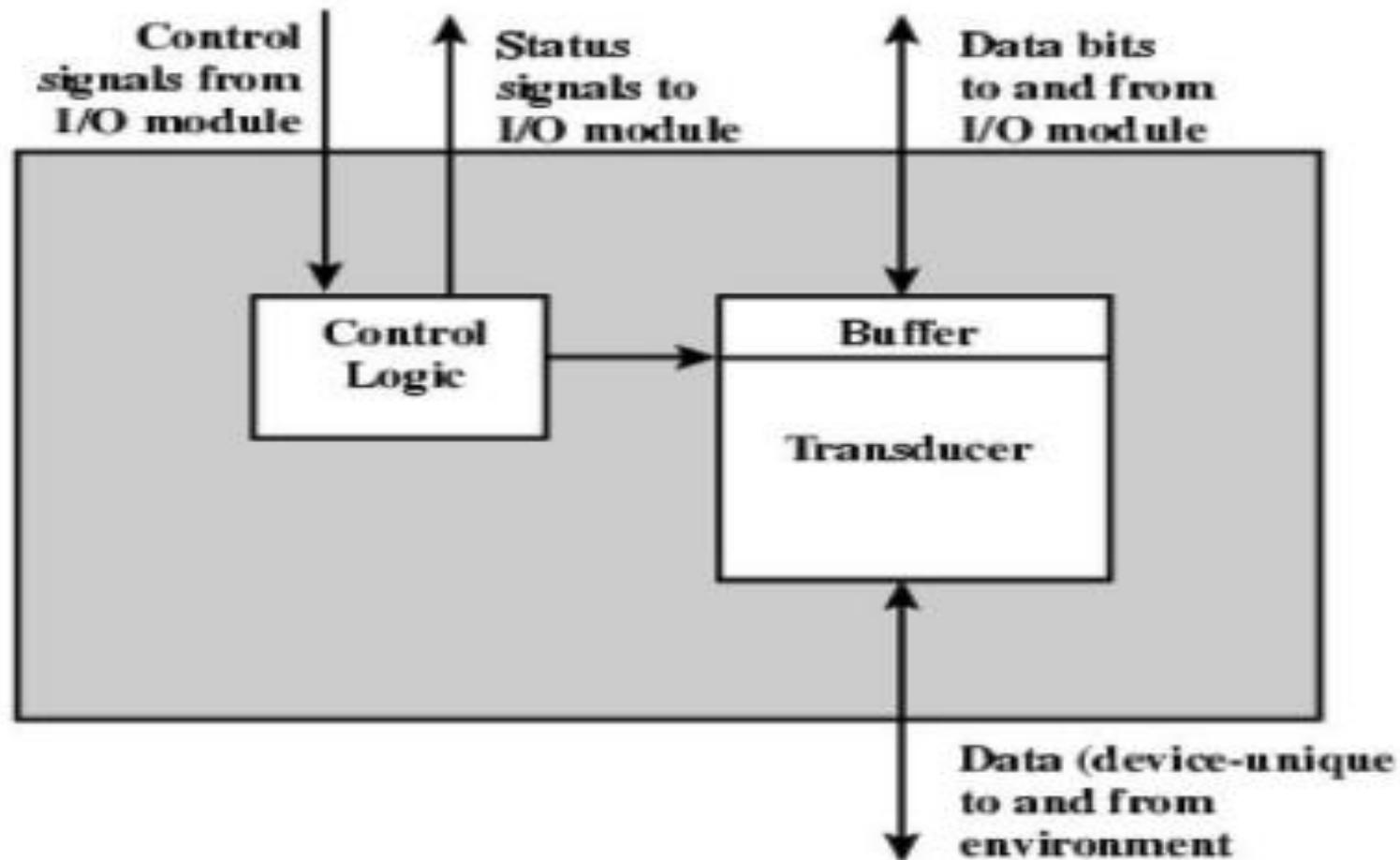
Computer Fundamentals and Operating Systems

➤ I/O Module Structure Diagram :



Computer Fundamentals and Operating Systems

➤ External Device Block Diagram :



Computer Fundamentals and Operating Systems

➤ Structure of an External Device

- External Device has three major blocks:

1. **Control Logic Block(Controller):** controls all the operations of that device.
2. **Buffer:** each device has its own memory in which data can be stored temporarily referred as a buffer.
3. **Transducer:** this component converts any other form of energy into an electrical energy and converts an electrical energy into another form, this block of an external device is used to do communication with the outside world.

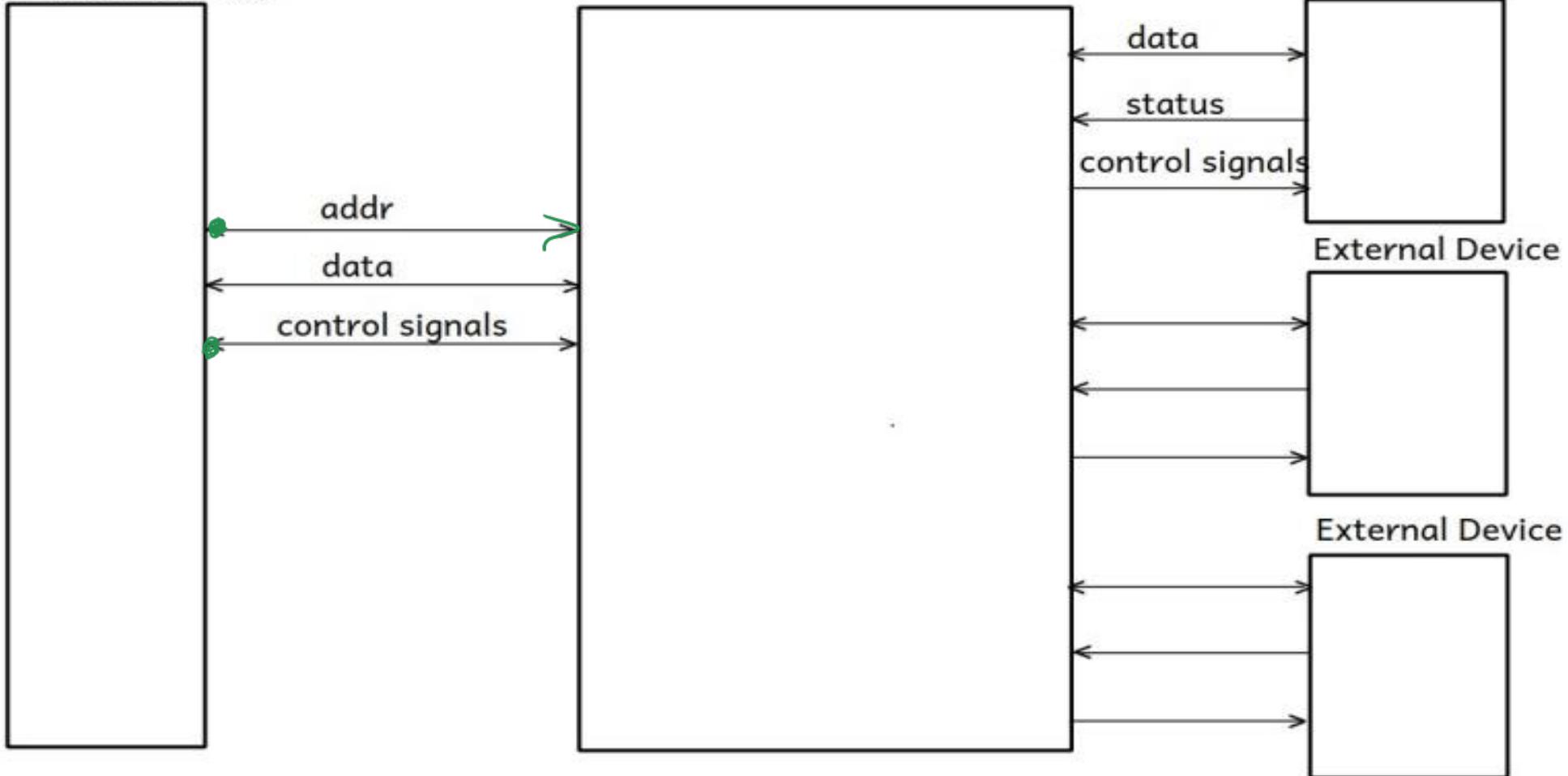
❖ IO Steps

1. CPU checks I/O module device status
2. I/O module returns status
3. If ready, CPU requests data transfer
4. I/O module gets data from device
5. I/O module transfers data to CPU.



Computer Fundamentals and Operating Systems

Core Computer System:
[CPU, Main Memory]

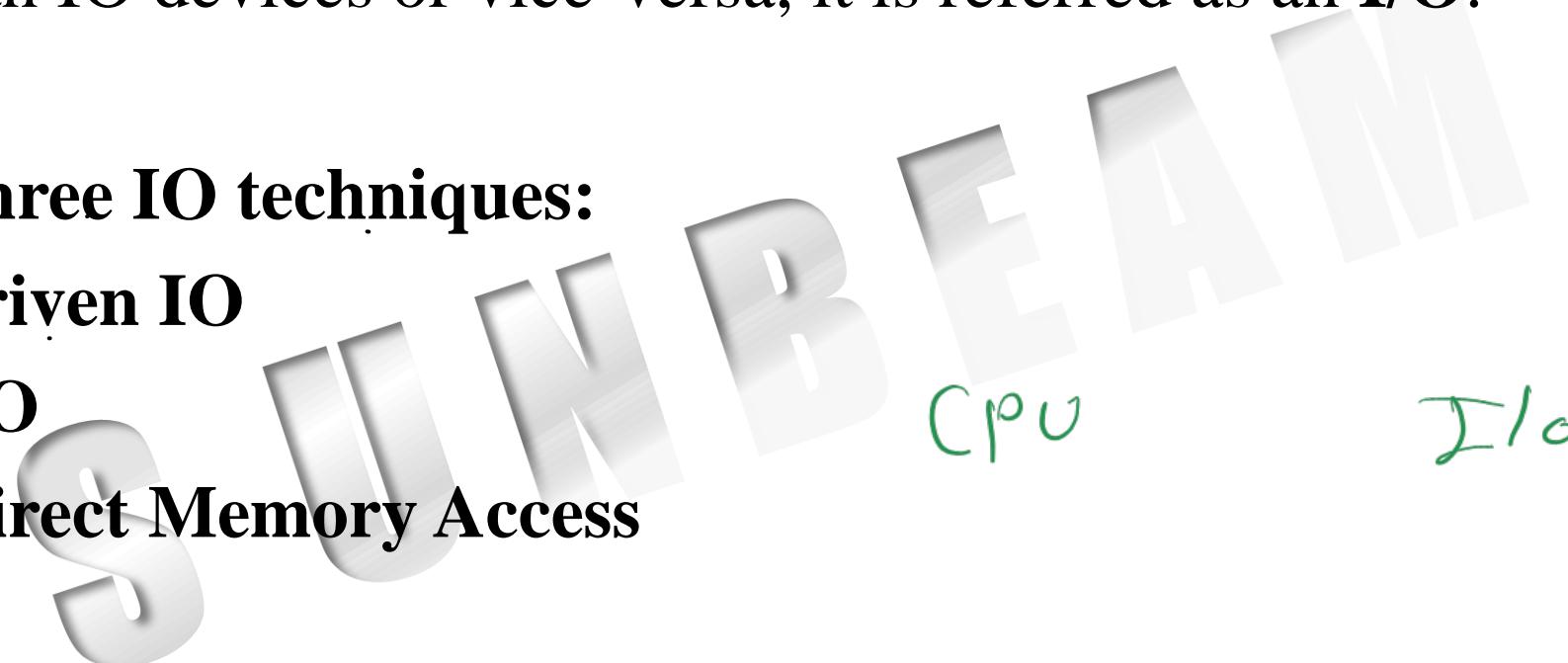


Computer Fundamentals and Operating Systems

➤ Whenever there is transfer of data either from core computer system (i.e. Bus) to an IO devices or vice-versa, it is referred as an I/O.

❖ There are three IO techniques:

1. Program driven IO
2. Interrupt IO
3. DMA i.e. Direct Memory Access



Computer Fundamentals and Operating Systems

1. Program driven IO:

- All the logic/steps required for an I/O is there into one program, and by means of executing that program by the CPU I/O can be done.
- CPU waits for IO operations to be completed. This is also called "**Polling**".
- When OS/program waits for the IO to be completed, it is called as "**Synchronous IO**".

❖ Advantages:

- Simple

❖ Disadvantages:

- As the CPU remains wholly involved in an IO, less CPU utilization, and hence system performance is low.



Computer Fundamentals and Operating Systems

2. Interrupt IO:

❖ What is an interrupt?

- An interrupt is a signal received by the CPU due to which it stops an execution of one job and starts an execution of another job.
- CPU issues a command, and proceed for its work until interrupt by IO device
- Since OS does not wait for the IO completion, it is called as "Asynchronous IO".

❖ Advantages:

- In this IO, the CPU remains involved in an IO whenever gets interrupted, and hence its cpu utilization can be maximized.

❖ Disadvantages:

- When there is a data transfer between main memory & secondary memory unnecessary involvement of the CPU is there.



Computer Fundamentals and Operating Systems

❖ Interrupt Handling :

- Interrupt handling function is also called as **interrupt service routine(ISR)**.
- There are many IO devices in system , so there interrupt handling process also different like keyboard , mouse , disk etc..
- So there are Table maintain by OS that store all device interrupt function starting address . This table is called **as Interrupt Vector Table(IVT)**.

❖ Interrupt Types

• **Hardware Interrupt :**

- Interrupt received from hardware
- E.g. mouse , keyboard , storage devices ... etc.

• **Software Interrupt**

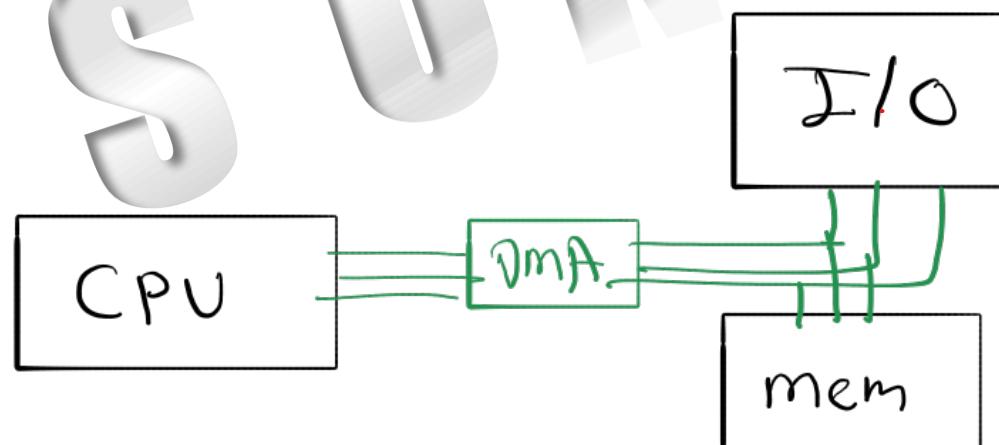
- Interrupt received from Software
- E.g. system call, antivirus ..



Computer Fundamentals and Operating Systems

3. DMA (Direct Memory Access):

- Whenever there is a transfer of data between core computer system and IO devices (e.g. main memory and secondary memory), the CPU initiates an IO and gives control of an IO process to the DMA controller, and hence onwards that IO process is controlled by the DMC. controller till the end i.e. the DMA controller will work on behalf of the CPU and after finishing an IO it sends acknowledgement to the CPU, and by the time the CPU can execute another jobs, and utilization of the CPU can be maximized further.
- e.g. 8237 DMA controller



Operating Systems Concepts

➤ Booting Process → (Starting Computer / loading o.s.)

■ Terminologies :

• **Bootstrap Program**

- It loads OS kernel into main memory
- Each OS has Its own Bootstrap program.
- Located in first sector of bootable storage device.

• **Bootable Device**

- Storage device whose first sector (512 bytes) contains a special program “Bootstrap Program”.
- Usually it is device that stores OS installation setup;
- E.g. Bootable CD/DVD ,Bootable Pendrive.

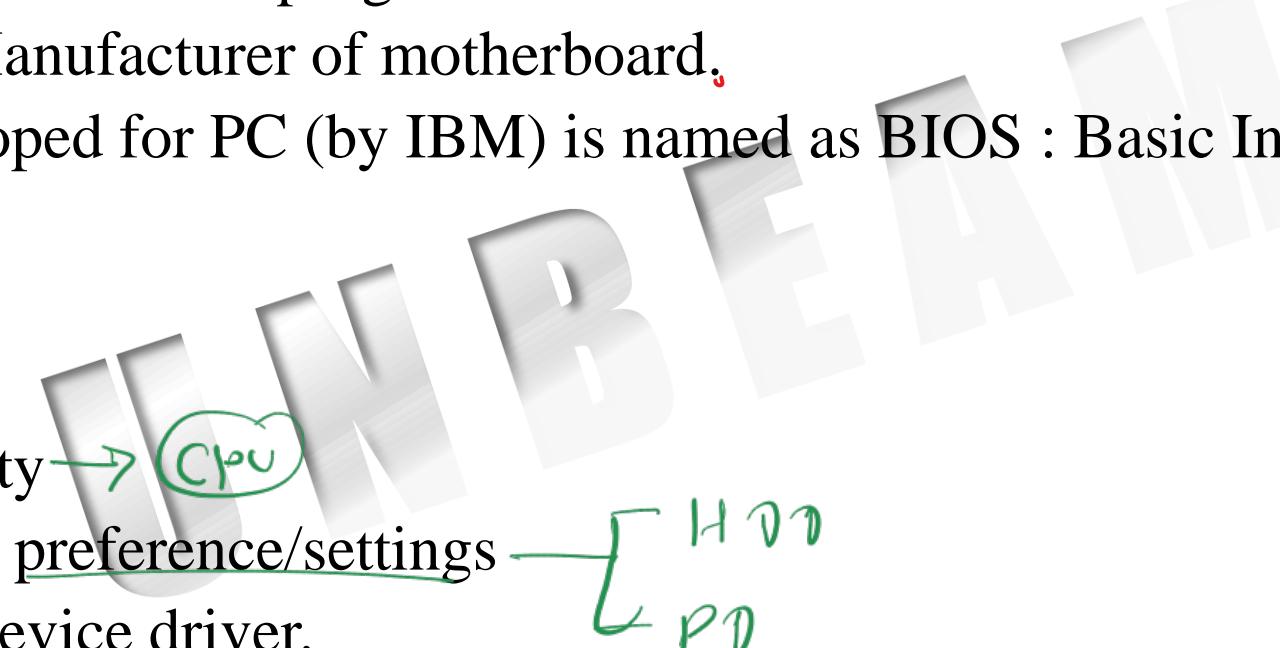
• **Bootloader**

- When multiple OS are installed on single computer, at the beginning one program asks end user about which OS boot.
- This task perform by bootloader program.
- Bootloader program bootstrap program of selected OS.
- Located in second sector of bootable storage device.



Operating Systems Concepts

• BIOS/ Firmwaer

- Firmware is a program/set of a program loaded into base ROM of motherboard.
 - It is developed by Manufacturer of motherboard.
 - The firmware developed for PC (by IBM) is named as BIOS : Basic Input Output System
 - BIOS Contain
 - POST/BIST
 - Bootstrap loader
 - Information utility
 - Bootable Device preference/settings
 - Basic/Minimal device driver.
- 

Operating Systems Concepts

- **POST/BIST**
 - **POST** - Power ON Self Test
 - **BIST** - Built In Self Test
 - Send signal to all peripheral(e.g. keyboard , mouse, monitor...)and test if they are functioning well.
 - Located in Base ROM(Part of Firmware)
- **Bootstrap Loader :**
 - Finds the bootable device in the computer and start it's Bootloader.
 - It check all devices in a order given in BIOS and start the first found bootable device.
 - Located in Base ROM (Part of Firmware).



Operating Systems Concepts

Booting:

- There are two steps of booting:

1. Machine Boot:

Step-1: when we switched on the power supply current gets passed to the motherboard on which from ROM memory one micro-program gets executes first called as **BIOS(Basic Input Output System)**.

Step-2: first step of BIOS is **POST(Power On Self Test)**, under POST it checks whether all peripheral devices are connected properly or not and their working status.

Step-3: After POST it invokes **Bootstrap Loader** programs, which searches for available **bootable devices** presents in the system, and it selects only one bootable device at a time as per the priority decided in BIOS settings.

2. System Boot:

Step-4: After selection of a bootable device (by default HDD), **Bootloader Program** in it gets invokes which displays list of names operating systems installed on the disk, from which user need to select any one OS.

Step-5: Upon selection of an OS, **Bootstrap Program** of that OS gets invokes, which locates the kernel and load into the main memory





Thank you!
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