+ Computer Organization:

Main Components of Computer Hardware:

1. Processor:

- It is also called as CPU(Central Processing Unit).
- CPU contains CPU Registers, ALU, CU etc...
- CPU Registers: to store currently executing instructions and data temporarily
- ALU: Aritmetic & Logical operations
- CU: Control Unit: to control all operations in a system

+ "Bus":

- components of the computer can communicates with each other through conducting wires reffered as "bus", through the bus address, data & control signal can be transfered to each other.
- there are three types of buses:

1. data bus/data lines: data gets transfered
2. address bus/address lines: addresses gets transfered
3. control lines: control signals gets transferred

- bus is a "shared communication pathway": i.e. data which is sent by one device can be recieved by any other device which is connected to the bus.
- bus which connects core components of a computer system is reffered as a "system bus".

- each device has got its own dedicated processor which controls all its operations reffered as "controller".
e.g. hdd has got its own processor reffered as "disk controller", which controls all disk operations.
- As the Processor, controls all the operations in a computer system by means of communicating with controller's of devices centrally, and hence processor is also called as CPU.

2. Memory Devices:

- Computer memory follows a memory heirarchy:

Q. What is Primary Memory & Secondary Memory
Q. What is an Internal & External Memory?
Q. Why RAM is also called as Main Memory?

- Memory which is directly accessible by the CPU is reffered as a primary memory
e.g. CPU registers, L1 & L2 cache, Cache Memory & RAM
- Memory which is not directly accessible by the CPU is reffered as a secondary memory, if the CPU want to access data from secondary memory, then first those contents gets loaded into the main memory.
e.g. HDD, CD, DVD etc...
- Memory which is internal to the motherboard is reffered as an "internal memory", whereas memory which is connected to the motherboard externally through ports is reffered as an "external memory".

- For an execution of any program RAM Memory is must, i.e. without RAM memory execution of any program cannot be started, and hence RAM is also called as "Main Memory".

- RAM: Random Access Memory
as data can be accessed from this memory by using "random access" method.

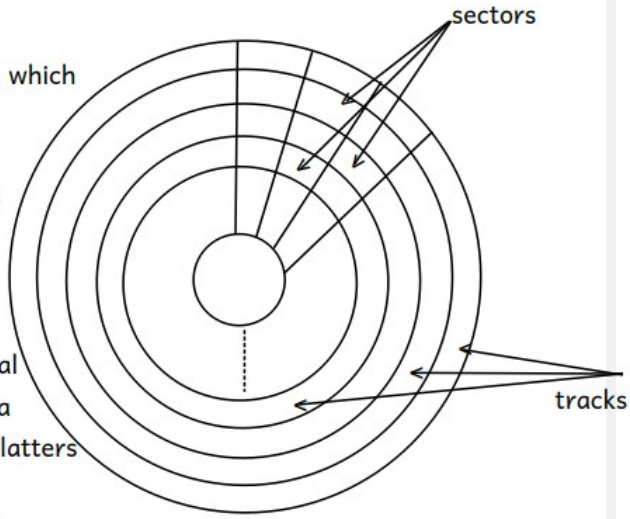
- there are four access methods by which data can be accessed from computer memory:
1. linear/sequential access: e.g. magnetic tape
2. direct access: e.g. magnetic disk/hard disk drive
3. random access: e.g. main memory
4. associative access: e.g. cache memory

addr = 50 + 550

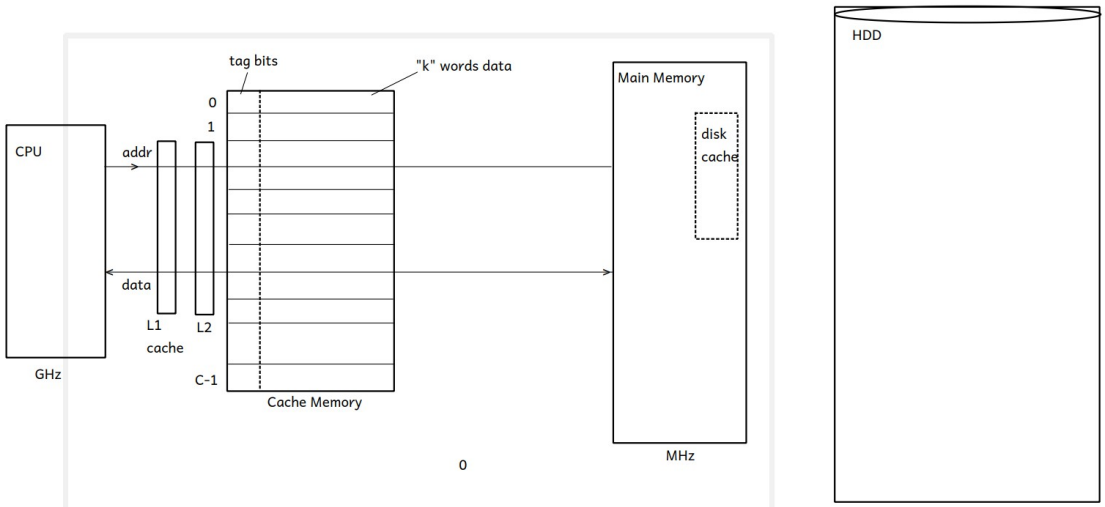
- disk controller to control all operations of the disk
- movement of head is also done by disk controller.

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 alligned with desired sector is called as rotational latency.



 # Cache Memory:



Q. Why there is a need of cache memory?
- to reduce speed mis-match between the CPU & RAM, cache memory can be added in between them.

Q. What is Cache Memory?
- It is a type of RAM:
DRAM (Dynamic RAM): e.g. Main Memory - DRAM memory cells made up of capacitors
SRAM (Static RAM) : e.g. Cache Memory - flip-flop gates - digital device
- Cache memory is the faster memory which is the type RAM can be used to reduce speed mis-match between the CPU and main memory.
- In Cache Memory most recently accessed main memory contents can be kept in an associative manner i.e. in a key-value pairs.

- Cache memory contains C no. of lines, whereas each line is divided logically into two parts
1. first part: few "tag bits": main memory addresses of k words of data in that line.
2. second part: contains "k" words of data

- "word" is a unit of memory from system point of view.
- word length = 8 bits/16 bits/32 bits/64 bits
- on few processor, word length is fixed whereas on few word length may vary.

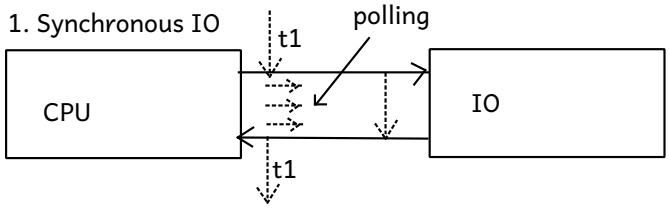
"cache hit": if the requested addr (and hence data) by the CPU is found in a cache memory, it is reffered a cache hit, if requested data is not found in a cache memory it is reffered "cache miss".

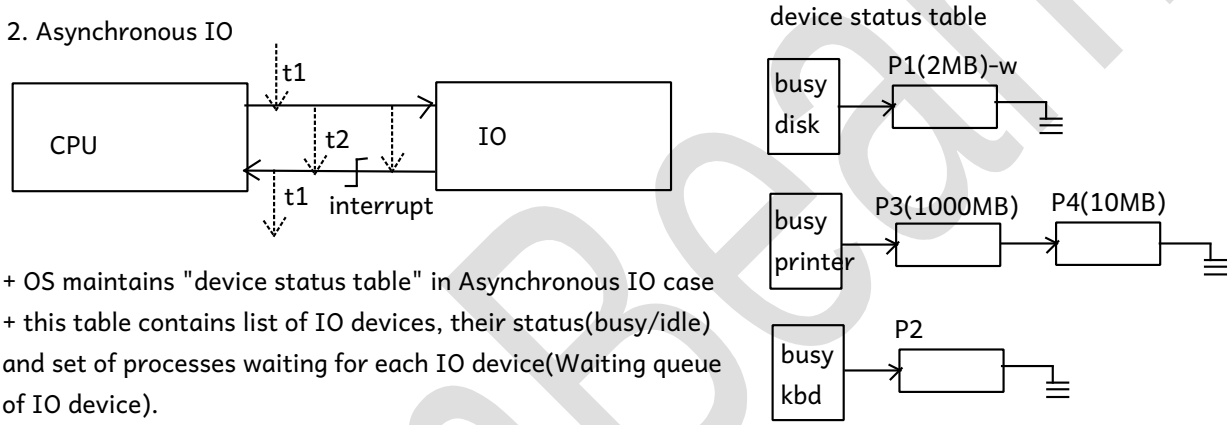
L1 cache & L2 cache - to reduce speed mis-match between the CPU and cache memory one or more levels of cache memory can be added in between them, size of L1 & L2

cache must be smaller than size cache memory.

- **"disk cache":** it is a purely softare a technique in which most recently accessed disk contents can be stored in an associative manner.
- this technique has been implemented at kernel level, and in kernel it is reffered "buffer cache" - to get max throughput in minimum h/w movement.

3. I/O Devices:
- IO techniques:





+ OS maintains "device status table" in Asynchronous IO case
+ this table contains list of IO devices, their status(busy/idle) and set of processes waiting for each IO device(Waiting queue of IO device).

"interrupt": it is a "signal" recieved by the CPU from any i/o device due to which it stops an execution of one process and starts executing another process.
- commands: signals sent by the CPU to peripherals.
CONTROL
READ
WRITE
TEST

+ What is a Program?
    - user view: program set of instructions given to the machine to do specific task.
    - system view: program is nothing an executable file (file having ELF file format) which has got elf header, bss section, data section, rodata section, code/text section, symbol table. etc...

    - when we give command $./program.out, when we double click on an executable or if run program, loader first verifies file format of an executable file, if it is matches then its check magic mumber which is exists in an elf header, and if both file format and magic macthes then only it loads program from secondary memory into the main memory -> an execution of a program has been started or

process has been submitted.

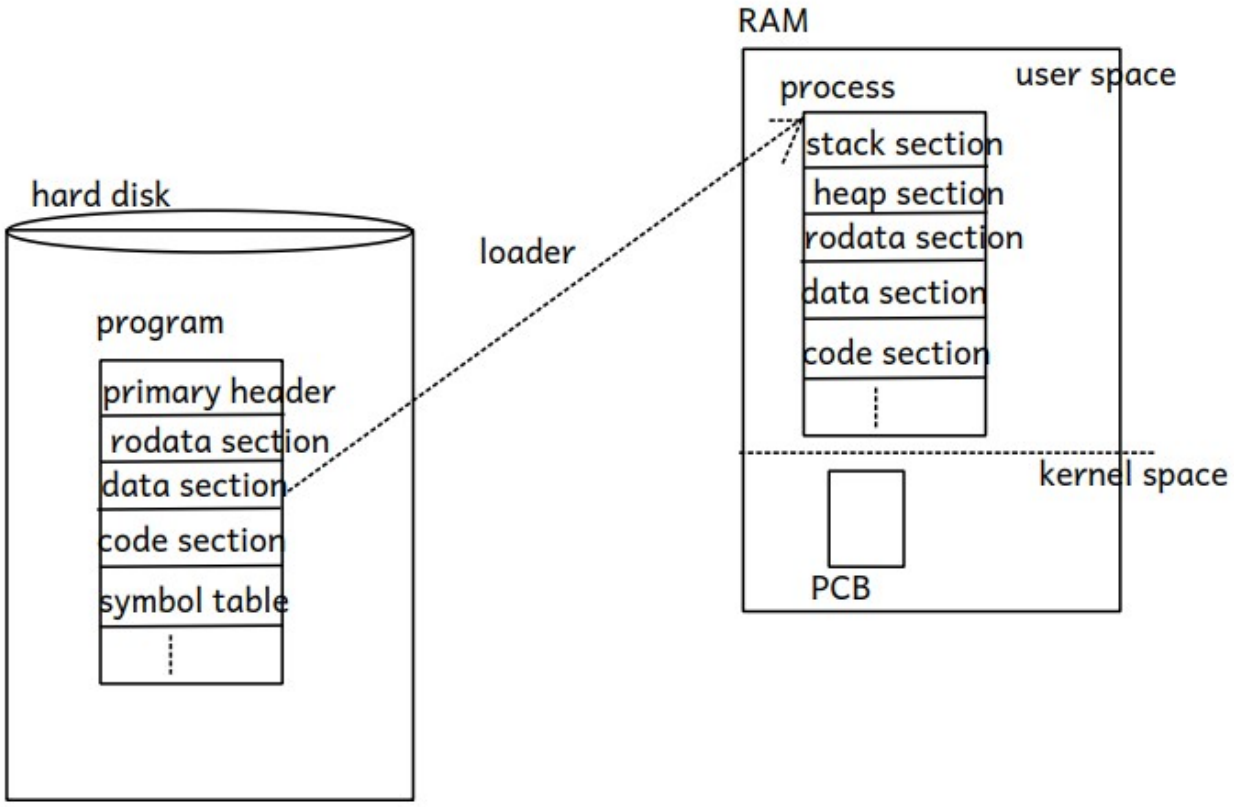
- the part of main memory which is occupied by the kernel is reffered as "kernel space", and whichever part is left is reffered as "user space".
- main memory is divided logically into two parts:
1. kernel space: kernel data structure
2. user space: user processes

- loader adds two new sections for the program:
1. stack section: contains function activation records of called functions
2. heap section: dynamically allocated memory

- process has satck section, heap section, bss section, data section, rodata section, code/text section.

- an OS/kernel creates one structure per process into the kernel space in which al info which is required to control an execution of that can be kept, this structure is reffered as "PCB": Process Control Block.
PCB contains info like:
- pid: process id --> an unique identifier of a process for an OS
- ppid: parent's process id
- PC: program counter: it contains addr of next instruction to be executed
- mem mgmt information: e.g. base & limit values
- cpu sched information: e.g. priority
- information about resources allocated for a process
- execution context
etc....

- PCB gets created upon submission of a process, it gets removed from the main memory after process termination/exit.


RAM
process
user space
stack section
heap section
rodata section
data section
code section
hard disk
loader
program
primary header
rodata section
data section
code section
symbol table
kernel space
PCB