Major Components of a computer system:

In general a computer system consist of four major components-

- CPU
- Input unit
- Output unit
- Storage unit

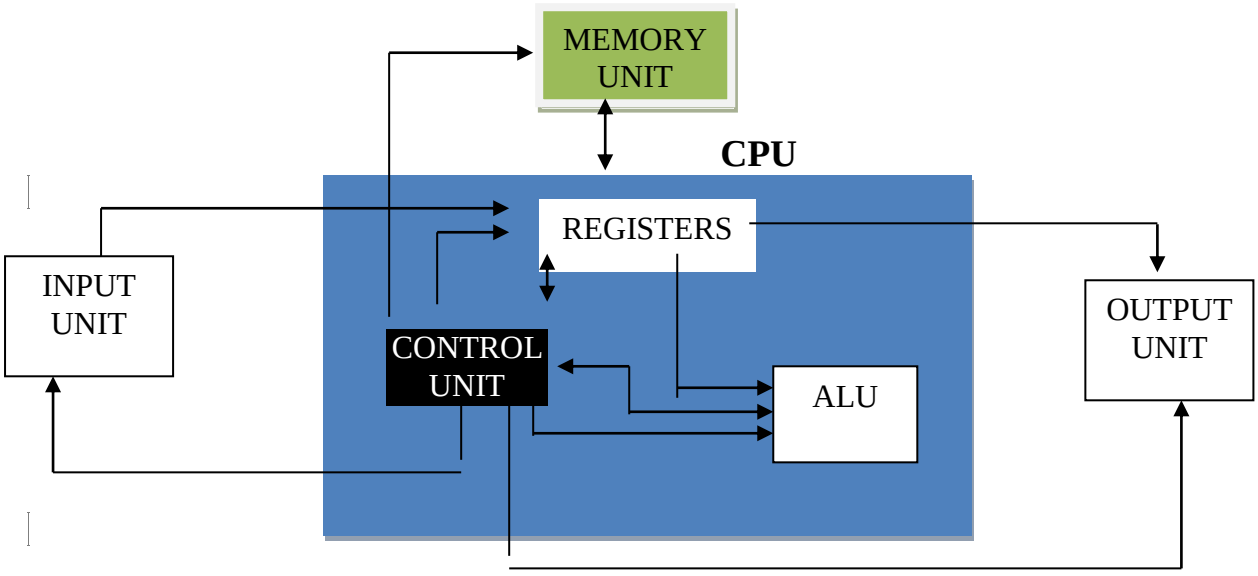


FIG: COMPONENTS OF A COMPUTER SYSTEM

Central Processing Unit (CPU): The CPU is also called the processor and is the brain of a computer system that processes data (input) and converts them into meaningful information as output. It generally interprets the data and instructions, Co-ordinates the operations and supervises the instructions. The CPU works with data in discrete form, i.e. either 1 or 0.

The CPU itself consists 3 parts-

Arithmetic and Logic unit (ALU): This unit performs the arithmetic operations like addition, subtraction etc and logical operations like AND, OR etc. on data available to it. For these kinds of operations the required data are transferred from the memory unit to the ALU and after the operation the result is returned to the memory unit. This kind of transfer of data may be needed many times during any operation between ALU and memory unit.

Control unit: The control unit controls the sequence of operations. It fetches the program instructions from the memory unit, decodes them and ensures correct execution of the program. It also controls the 1/0 devices and directs the over all functioning of the other units of the computer.

Registers: These are the special purpose, high speed temporary memory units that can hold different types of data, instructions, address and intermediate results of calculations. Mostly, they hold the information that the CPU is currently working on. We can also consider the registers as the working memory of the CPU.

Input-Output Unit: To perform any operation, the computer system must get any data or instruction from the user and this is possible through the input unit. On the other hand after processing any operation the computer system gives us the result through the out put unit.

In general, a computer system accepts the user instructions and data through the input devices like keyboard, mouse, light pen etc. The input unit also converts the different signals received from the different input devices into the form that the computer can understand.

Again the output unit performs just opposite to that of input unit. The output unit accepts the output produced by the computer (machine-coded form) and then converts them into the user understandable form. After then the result is supplied to the user through an output device like printer, monitor, plotter etc.

Storage unit: Another important unit of computer system is the memory unit. The storage unit of computer system consists of two type's memory- primary and secondary. The primary memory is also called the main memory, which holds the instructions and data currently being processed by the CPU. It also holds any intermediate results produced during any operation and the recently processed data. If the data needed by the CPU remains in the main memory it can be accessed directly and very quickly. However it is very expensive and limited storage capacity. Eg. RAM, ROM.

On the other hand the secondary memory is mainly used for storing data and instructions permanently. It is quiet slow compare with the primary memory. However secondary memory has very high storage capacity and less expensive. Some commonly used secondary storage devices are hard disk, tape devices, floppy disks etc.

The secondary memory is also called Auxiliary memory.

Memory Hierarchy: Depending upon the access speed and storage capacity the memory system in a computer has following types which is arranged according to the diagram shown below-

- Internal processor memory
- Primary memory
- Secondary memory

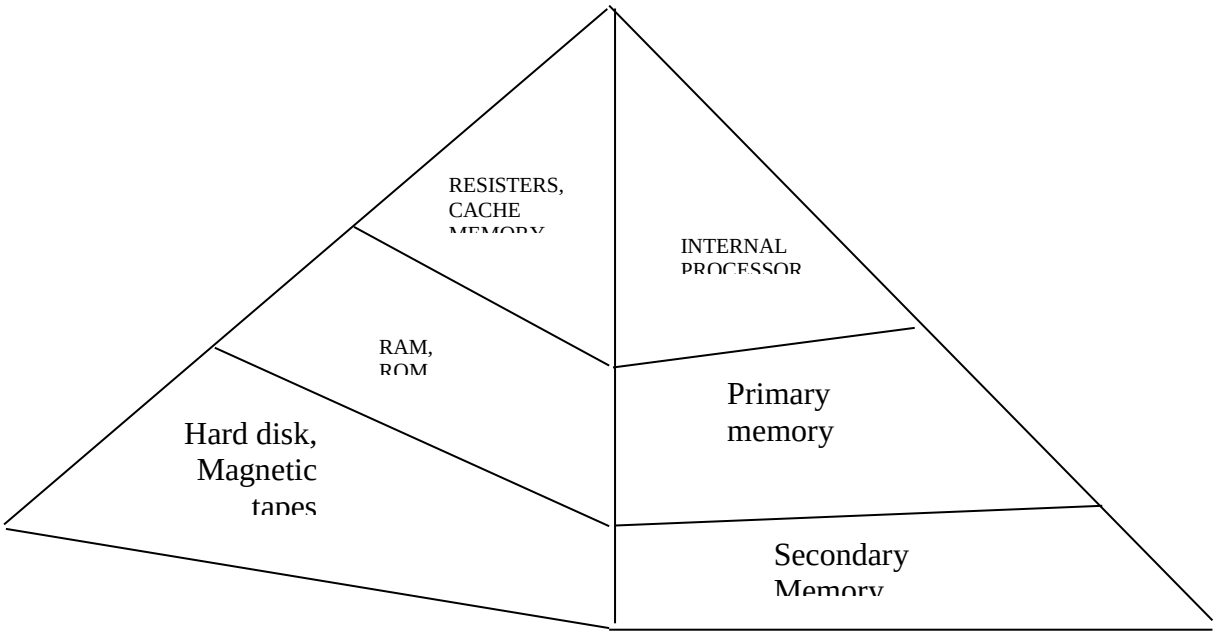


FIG: MEMORY HIERARCHY IN A COMPUTER SYSYEM

Random Access Memory (RAM): RAM is the physical memory of a computer system. It allows the computer to store data for immediate manipulation and keep track of what is currently being processed. It's the Primary place where the OS, application programs and data in current use are kept so that they can be accessed quickly by the CPU. RAM is a volatile memory, i.e. when

the computer is turned off, it losses all its contents. Once the data is loaded into the memory (RAM), the CPU is able to access them very quickly as because it is much faster than Secondary memory.

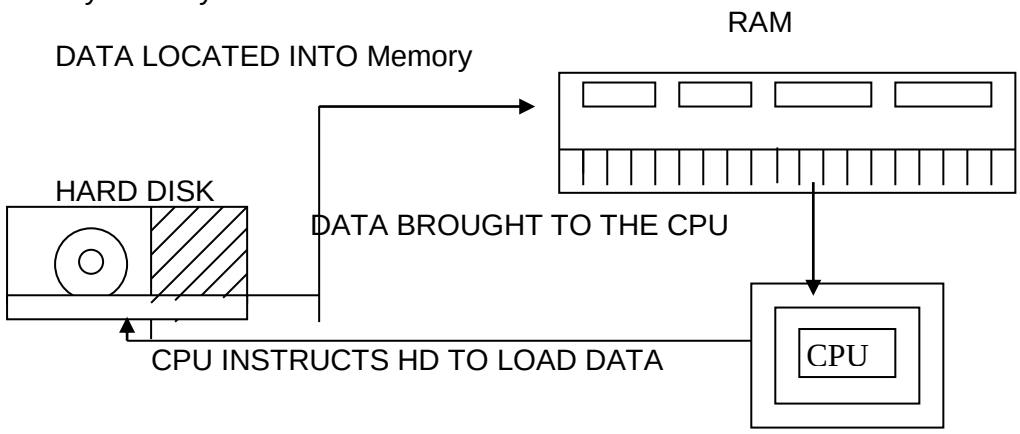


FIG: INTERACTION OF MEMORY AND STORAGE WITH CPU

Types of RAM: In general we have two types of RAM

1. Static RAM (S RAM)
2. Dynamic RAM (D RAM)

Static RAM: Static RAM does not need to be refreshed periodically, i.e. as long as the power is supplied to it, data remain in the memory cell. It is very fast and very much expensive then D RAM; hence it is often used as cache memory.

Dynamic RAM: D RAM is very unstable. Its memory must be continuously refreshed in order to maintain the data in it. This is done by rewriting the data several hundred times per second in the D RAM chip. D RAM is mainly used as system memory because of its small size and less expensive than S RAM.

Differences between Static RAM and Dynamic RAM:

SRAM	DRAM
1. SRAM does not need to be refreshed, so it can hold the data as long as the power is supplied to it. 2. SRAM chip are less dense and hence its size is larger 3. SRAM is more fast and has low latency.(time difference between Request and Response) 4. It is more expensive, requires more power to operate and produces more heat.	1. But in DRAM, it must be refreshed at a particular interval of time, even if power is continuously supplied to it. 2. But DRAM chip are high dense than SRAM. It has more memory cells. 3. But DRAM is less faster than SRAM and has longer latency time. 4. But DRAM is less expensive, needs less power to operate and also smaller in size.

Read Only Memory (ROM):

ROM is a special kind of memory where we can only read its contents but can not overwrite or delete. This is required because during the start up operation, the main memory of a computer is empty (as it is volatile in nature), so there have some instructions (called booting program)

stored in a special chip which enable the computer system to perform the start up operations and transfer the control to the OS . This kind of special chip where the start up instructions is stored is called ROM. The ROM is non-volatile in nature. ROM chip is not only used in computer system but also in other electronic items like washing machine, mobile phone, air conditions etc.

Generally, designers program a ROM chip at the time of manufacturing circuits. Once a ROM chip is programmed, it can not be reprogrammed or rewritten. A ROM chip consumes very little power and extremely reliable.

Types of ROM:

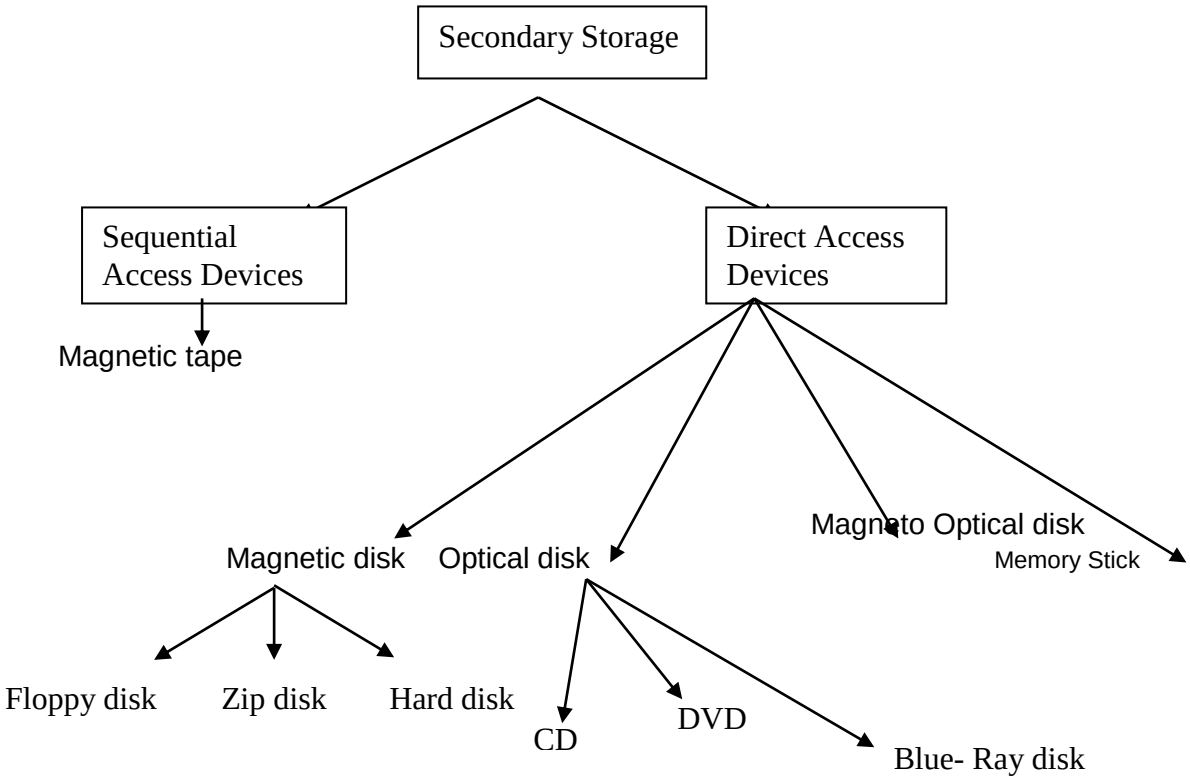
- Masked ROM
- Programmable ROM(PROM)
- Erasable Programmable ROM(EROM)
- Electrically Erasable Programmable ROM(EEROM)
- Flash ROM

Secondary Storage Devices:

A secondary storage device is used to store data and instructions permanently. The data stored on a secondary storage device can be accessed in two ways depending on how it is stored in it. The two ways are-

1. Sequential Access: In this type of access the computer system must search the storage device from the beginning until the desired data is found. E.g.- Magnetic tape
2. Direct Access: This type of access is also called the random access. Here the computer can go directly to the location where the data that the user want, is stored. E.g.- optical dick, hard disk.

Classification of secondary storage devices:



Hard disk:

The hard disk is the primary storage unit of a computer system. It consists of round flat disks (platters) made up of glass or metals which are coated on both sides with a special material to store information. Each platter is further divided into tracks, which are again broken into sectors. Special Read/ Write head is placed over the platter surface which slide over the tracks and sectors to either record data onto the disk or read data from it. The device which controls the movement of the head in each surface is called 'actuator'. Each platter has tow heads, one on each surface.

Generally, the 'actuator' moves the R/W head to the exact location of a hard disk accordingly to the command received from the OS. A hard disk can either be external or internal, which can hold large amount of data. Now a day a typical hard disk in a computer system comes with 80GB to 1TB.

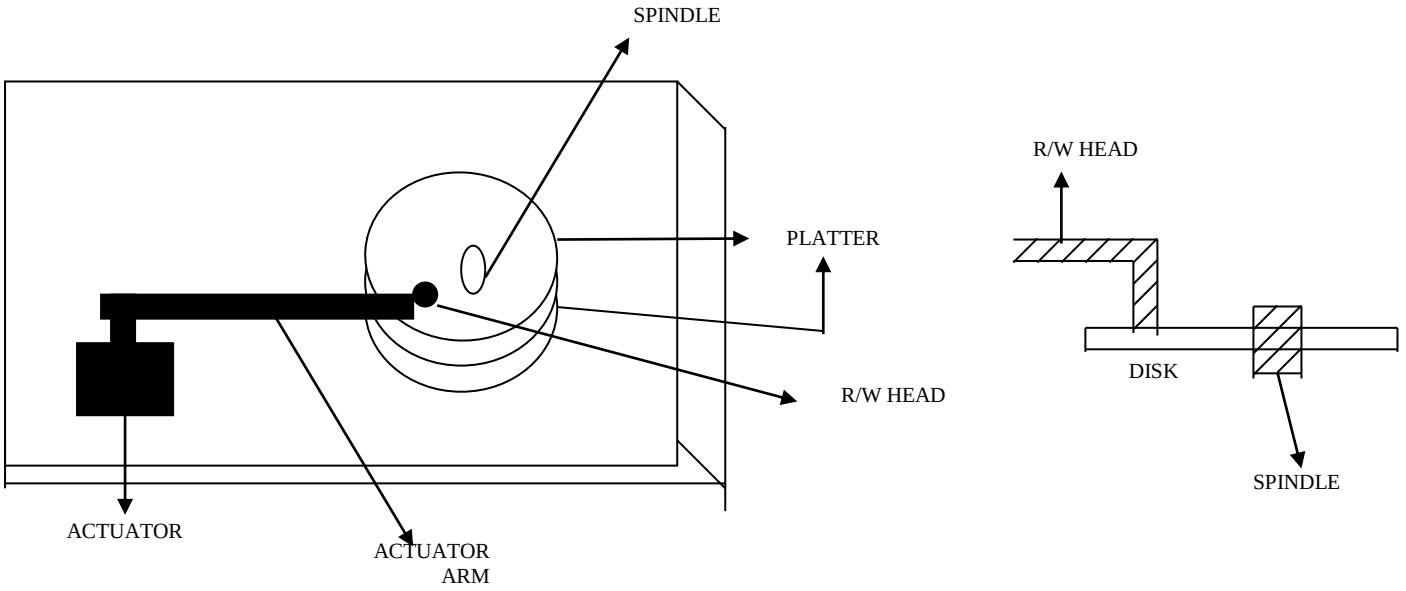


Fig: Typical parts of hard disk

Optical Disk:

An optical disk is a flat, circular, plastic disk coated with material like aluminum, gold or silver that acts as a reflective surface. A read/write head, which is a laser beam, is used for recording data onto it.

Optical disks come with various sizes and capacities. In general, a compact disk (CD) is a 12 cm diameter disk having capacity 700 MB is the most common means of optical storage. An optical disk consists of a single long track in spiral shape. This track is further divided into small sectors of the same length.

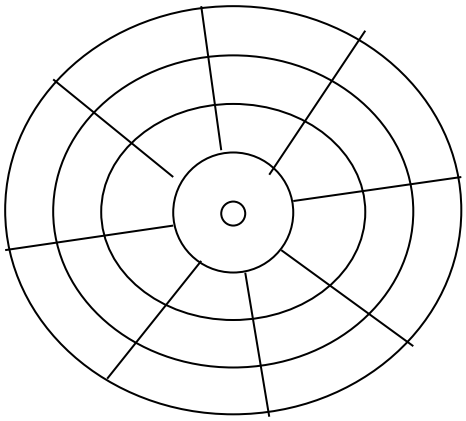


FIG: TRACKS ON A MAGNETIC DISK

Types of optical disks:
Now a day's optical disk comes with 3 varieties, which are made for some special purposes.

1. Compact disk (CD): It is the most popular and least expensive type of optical disk. It can record about 80 minute of playing time. The various formatives of CD are CD-ROM, CD-R, and CD-RW.
2. Digital Versatile Disk (DVD): DVD is also called the digital video disk, which has high storage capacity than a CD. DVD is available in many formats-

    - Single sided single layer (4.7 GB)
    - Double sided single layer (9.4 GB)
    - Single sided double layer (8.5 GB)
    - Double sided double layer (17 GB)

3. Blue–ray disk: It is used to record high definition (HD) video and high equality audio as well as pictures. It is the latest technology developed by many companies like Apple, Sony, Samsung, Panasonic, etc. It has high capacity of storage (10 times more than DVD). A single layer Blue-ray can store 25 GB and double layer can store 50 GB of data.

Keyboard:

Keyboard is one of the most common input devices of a computer system. It is generally used to input of textual information. Keyboard is initially introduced by IBM which was having 101 keys arranged in four groups. They are

- Numeric keys (digits 0 to 9 & operators +,-,*,/)
- Alphanumeric keys (A to Z, 0-9 and some function marks)
- Function keys (F1 to F12)
- Cursor movement keys.

Cache Memory:

Cache memory is a high speed semi conductor memory. It consists of static RAM s. It is very faster than main memory and is placed between the CPU and the main memory. Its access time is about 10 ns which is much less than that of main memory. The capacity of cache memory is 2 to 3 percent of that of main memory.

Since the CPU is very much factor than main memory, during any data processing there is a speed mismatch occurs between both of them while data transfer is needed. For this reason a high speed cache memory is used to supply currently needed data and instructions to the CPU. This reduces the speed mismatch of CPU and main memory. The main memory stores the program and data which is to be processed by the CPU and the cache memory contains the data and instructions that is currently needed by the CPU which is loaded from main memory.

There are two types of cache scheme is used

- WRITE THROUGH
- WRITE BACK

In WRITE THROUGH cache the main memory is updated each time the CPU writes into cache. In this method advantage is that the main memory contains always the same data as the cache.

Again in WRITE BACK scheme, only the cache memory is updated during a write operation. The updated locations in the cache are marked by a flag so that later on when the word is

removed from the cache, it is copied into the main memory. In general, set-associative cache memory is used in a computer system.

Various types of Resisters in the CPU:

1. Accumulator: It is the most frequently used resister in a CPU. Depending on the CPU structure number of accumulator may be different. It generally in side the ALU and store the results of all arithmetic and Logic operations.
2. General purpose Register: A CPU contains a number of general purpose registers which are used to store data and intermediate results temporarily during the execution of a program. Accumulator is also one of its kinds. Number of these resisters may vary processor to processor.
3. Special purpose resister: A CPU also contains a number of special purpose resisters which are used for some specific tasks. Generally following special purpose resisters are used-

- Program counter (PC): This resister contains the address of the memory location from where the next instruction is to be taken for execution.
- Memory Address Resisters (MAR): It contains the address of the memory location from where the instruction or data are to be taken.
- Memory Data Resister (MDR): It contains the data which is to be written into or read from the location specified by the MDR.
- Instruction Resisters (IR): It contains the instruction that is currently being executed.
- Stack Pointer (SP): It is a pointer which indicates the present status of the memory locations, i.e. up to which the Stack of memory location is filled up.

Computer Hardware and Software:

Every computer consists of two basic parts-

- Hardware
- Software

Computer hardware is the physical components which we can see or touch. It may be electronic, electrical, mechanical or optical. For example-Microprocessor, hard disk, Motherboard, Floppy disk, Mouse, Keyboard, printer etc.

On the other hand the sequence of instructions given to a computer to perform a particular task is called a program. Where as a set of programs grouped together are called software. Software consists of set of instructions which enable the computer hardware to perform various arithmetic and logical operations. So software tells the computer what to do and how to do it.

Classification of computer software:

- System software
- Application software

System software consists of set of instructions which directly controls the hardware and also interpret and execute the application software.
E.g.- Assembler, compiler, operating system (OS).

Generally System software is responsible for controlling, integrating and managing the hardware components of a computer. System software acts as an interface between the hardware of the computer and the software applications. Here we can say it makes a computer functional. It provides basic functionality like file management, visual display, keyboard, input etc.

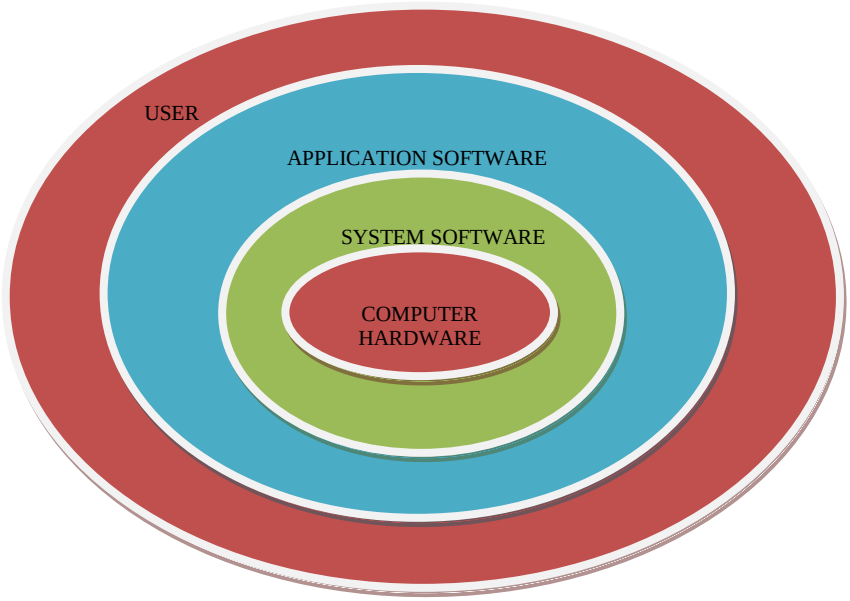
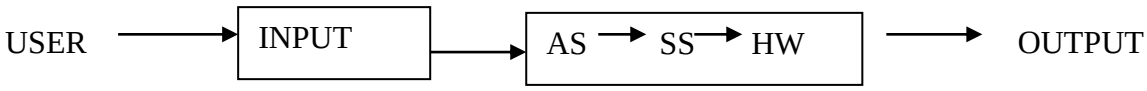


FIG: INTERACTION of SS, AS, HW and the USER

Again Application software is deigned to fulfill the needs of a user. It acts as an interface between the operating system and the user. It is most common to a user as it is used to perform specific tasks rather than just managing a computer system. That means a computer system will not be useful for a user without the application software.
E.g. - Microsoft notepad, point, MS office package etc.



Levels of processing

Difference between system software & Application software:

- AS is dependent on OS, SS is the interface between the user and the HW.
- AS performs tasks for the user, SS is deigned to help the computer to operate perfectly.
- Without of AS, the computer will not be helpful in meeting user requirements, where as SS directly controls the hardware, so without of it, computer system will not run.

Assembler: It is system software which translates the source programs written in assembly language into machine code (or object code). Assembly language program are machine dependent, i.e. assembly language program written in one machine may not run in another machine.

Compiler and Interpreter: These are system software which translates the source programs written high level language like C, C++, COBOL, java etc, into object code (Machine Code). These two system software are machine independent.
The main different between computer and interpreter is that----
While translating a source program in to object code by a compiler, it reads the entire source code and convents it to machine code taking all the statements at a time.
On the other hand , an interpreter convents only one statement of the program into object code and then execute it and again goes on to the next statement convent it , execute it and so on till the end of the program or an error occurred.
Hence we can say, an interpreter is an efficient tool for error checking then a compiler. But the over all execution time of a compiler is much faster then the interpreter.

Cache Memory:

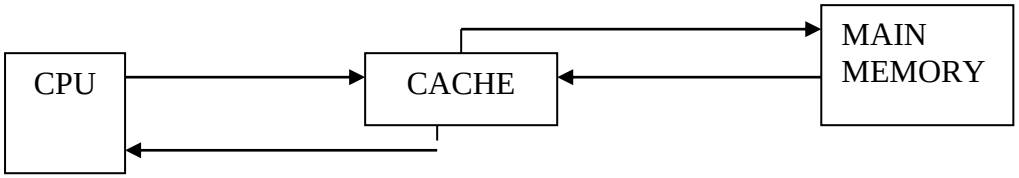


FIG: INTERACTION OF CPU, CACHE& MAIN MEMORY

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There are two types of cache scheme is used-

- Write-through
- Write –back

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Again in write-back scheme, only the cache memory is updated during a write operation. The updated location in the cache is marked by a flag so that later on when the word is removed from the cache, it is copied into the main memory. In general, set-association cache memory is used in a computer system.

What is Flash Memory?

Flash memory is a non-volatile memory chip used for storage and for transfering data between a personal computer (PC) and digital devices. It has the ability to be electronically reprogrammed and erased. It is often found in USB flash drives, MP3 players, digital cameras and solid-state drives.

Flash memory is a type of electronically erasable programmable read only memory (EEPROM), but may also be a standalone memory storage device such as a USB drive. EEPROM is a type of data memory device using an electronic device to erase or write digital data. Flash memory is a distinct type of EEPROM, which is programmed and erased in large blocks.

Binary Codes:

A code is a symbol or group of symbols that are mean for something. Various types of codes are used to communicate information to the digital computer correctly and properly. Using various coding system an operator can feed data into the computer directly in decimal numbers, alphabets and special characters. Certain binary codes are also used for arithmetic operation.

Binary coding system is divided into following groups-

- Weighted binary codes
- Non-weighted codes
- Error detecting codes
- Error correcting codes
- Alphanumeric codes

Weighted Binary codes:

Here each position of a number represents a specific weight.
Eg: 8421 BCD code.

BCD (Binary Coded Decimal): It is composed of 4 bit, representing decimal digits 0 to 9. In standard BCD, each decimal digit is represented by a binary code of 4 bits. It does not us the numbers 1010, 1011,1100,1101,1110 and 1111.
Eg: Decimal number 901 is converted to BCD as

$$901_{10} = 1001\ 0000\ 0001_{BCD}$$

Non-weighted codes:

In this type of code each position is not assigned a fixed value. That means they are not positional weighted.
Eg: Gray code, Excess 3 etc.

Excess-3 code (XS-3):

In XS-3 code, each decimal is increased by 3 and then converting the result into 4 bit binary. It is like BCD representation.
Eg: 261 can be represented as-

BCD Representation

2	6	1
0010	0110	0001

Excess-3 Representation

2	6	1
+3	+3	+3
5	9	4
0101	1001	0100

It is also written as **XS3**

GRAY CODE:

The Gray code belongs to a class of code known as “minimum change code”, in which only one bit in the code group changes on one step to the next. It is not an arithmetic code and is mainly used to reduce errors.

Eg.

Decimal	Gray
0	0000
1	0001
2	0011
3	0010
4	0110
5	0111
6	0101
7	0100
8	1100
9	1101
10	1111
11	1110
12	1010
13	1011
14	1001
15	1000

Alphanumeric codes:

This type of codes that represents alphabetic characters (A-Z, a-z), numeric digits (0-9), punctuation marks and other special characters.
Eg. ASCII code, EBCDIC code.

ASCII CODE (American Standard Code for Information Interchange):

It is a 7-bit code used in transferring coded information from keyboards and to computer displays and also printers. Micro computers having 8-bit word length use seven bit code to represent the basic codes. The 8^{th} bit is used for parity.

EBCDIC CODE (Extended Binary Coded Decimal Interchange Code):

It is a standard character code for large computers. It is an 8-bit code, which provides a more extensive character set than ASCII. Here no parity bit is available.