Chapter 1: Introduction

1.1 Introduction of Computer System and Organization

1) What is a computer?

A computer is an electronic device that accepts data from the user, processes it, produces results, displays them to the users, and stores the results. It is a programmable and digital device, under the control of instructions stored in its memory that can accept data (input), process the data according to specified rules (Program), produces information (output), and store information for future use.

There are three major components of a computer system:

1. Hardware
2. Software
3. Human ware

While hardware and software components co-exist to make up the actual computer, the human ware component adds in the human face to bring the complete computer into a functional and productive existence. When installed separately, each may be useful to an extent but incapable of achieving complete computing potential. Hardware and software need the human factor in order to make input and connectivity possible.

1. Computer Hardware

The physical parts attached to a computer that forms a whole computer are called hardware or hardware components. There can be different types of hardware, depending on the structure.

Some most common examples of hardware:-

- Display monitor Keyboard
- Mouse Motherboard
- Memory modules &
- Disk drive

Basic components of Computer Hardware

Hardware is divided into 4 major components:

- **Input Unit:** Input Units or devices are used to input the data or instructions into the computers. Some most common input devices are mouse and keyword.
- **Output Unit:** Output Units or devices are used to provide output to the user in the desired format. The most popular examples of output devices are the monitor and the printer.
- **Central Processing Unit (CPU): The** CPU is also called the brain of the computer. It is also known as a processor. It is responsible for carrying out all activities in a computer. It is further divided into three parts:

  Control Unit (CU): This unit is responsible for flow of data and instructions between different units of computer. It decides whether data should go to ALU, registers, memory unit, secondary storage or output unit.

  Arithmetic Logic Unit (ALU): This unit is responsible for arithmetic calculations and comparison.

Registers: They are memory cells inside CPU to store data temporarily. They are mainly used to store frequently used data.

- **Memory Unit**: Memory unit is used to store data, instructions and output data. It stores data in machine language i.e. in the form of 0 and 1. The binary digits 0 and 1 are known as bits. Memory usually has two types: Primary Memory and Secondary Memory.

i. Primary Memory

Primary or main **Memory consists of three parts:**

A) RAM /Random Access Memory
B) ROM /Read Only Memory
C) Cache Memory

A) RAM (Random Access Memory)

It is used to store data and instructions temporarily. It retains data in it as long as the power is on. All the contents of RAM get cleared if power supply is turned off. Whenever software is opened, it automatically gets opened in RAM.RAM is of two types:

Dynamic RAM: It consists of capacitors and transistors. It uses electric charge to store the data.

Static RAM: It consists of flip-flops. It stores data in binary form. They have faster access time compared to dynamic RAM.

B) ROM (Read Only Memory)

ROM stands for Read Only Memory. Data is permanently stored in ROM. ROM contains instructions needed to start up the computer and load operating system into RAM.ROM is of three types:

PROM (Programmable Read Only Memory): It can be programmed once.

EPROM (Erasable Programmable Read Only Memory): It can be erased by keeping ROM chip using Ultraviolet light. It can be reprogrammed.

EEPROM (Electrically Erasable Read Only Memory): It can be erased by electrical signal. It can also be reprogrammed.

C) Cache Memory

It is special memory used to compensate the speed difference between CPU (very fast) and RAM (very slow). It stores the copies of frequently used data from RAM. Hence, it reduces the time required to access data from primary memory.

ii. Secondary Memory / Secondary Storage unit

Secondary storage unit is used to store data permanently. It consists of different types of storage devices. Most commonly used storage devices are:

- Hard Disk

- Compact Disk (CD), and Digital Versatile Disk (DVD):
- Blu Ray Disk: HD (High Definition)
- Pen Drive :Flash memory

These components of computer system are diagrammatically represented as:

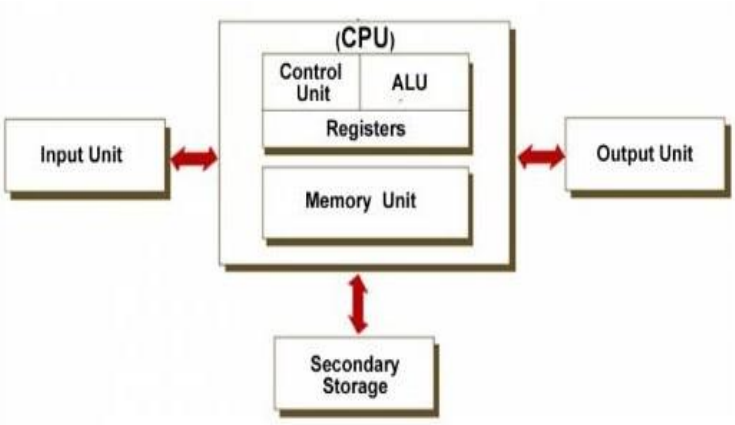

Figure 0-1.1 Computer system diagram

2. Computer Software

Software is defined as a collection of programs which are used for different purposes. The software component refers to the instructions, programs, data, and protocols which run on top of hardware. It is also retained temporarily and persistently in primary and secondary hardware media. The random access memory chip is an example of primary hardware while the hard disk drive is an example of secondary hardware.

There are three types of software:

A. Application Software
B. System Software
C. Utility Software

A. Application software

Application software is used to perform specific operation on computer. They are of two types:

- **General** Purpose software
  These softwares can be used by more than one type of user. Example: MS Word is general purpose software that can be used by students, teachers as well as clerks.
- Special Purpose / Customized Software
  These softwares can be used by only one type of user. Example: Banking Data Management software can be used only by bank employees.

B. System software:

System software is used to perform functions related to general operations of computer system. They are of two types:

- Operating System Software

It is an interface between user and computer. It takes instructions from user and further instructs hardware components to work. The results produced by hardware components are send back to the user.

Example: Windows 10, UNIX, Linux, Android etc.

- Language Translators:
  This software used to convert the High Level Language instructions into Machine Language instructions. They are of three types:

  Compiler: It converts High Level Language program into machine language in one go.

  Interpreter: It converts High Level Language program into machine language line by line.

  Assembler: It converts assembly language into machine language.

C. Utility Software

This software is used to take backup, remove outdated file, and recover data and other tasks that assist in smooth operation of computer.

Examples: Anti-Virus, Disk Defragmentation, Disk Clean, Backup, etc.

1.2 Architecture and Organization

Computer organization is concerned with the way the hardware components operate and the way they are connected together to form the computer system. The various components are assumed to be in place and the task is to investigate the organizational structure to verify that the computer parts operate as intended.

Computer Architecture is study of the system from hardware point of view and emphasis on how the system is implemented. Basically, throws light on the designer's point of view. It is concerned with the structure and behavior of the computer as seen by the user. It includes the information formats, the instruction set, and techniques for addressing memory. The architectural design of a computer system is concerned with the specifications of the various functional modules, such as processors and memories, and structuring them together into a computer system. In Computer Architecture, the attributes of the system that is visible to a programmer. Those attributes that have a direct impact on the execution of a program:-

- **Instruction sets**
- **Data representation – number of bits used to represent data**
- **Input/output mechanisms**
- **Memory addressing techniques**

Computer Architecture is the design of the computer at the hardware/software interface. Computer Architecture = Instruction Set Architecture + Machine Organization

Instruction set architecture is the attributes of a computing system as seen by the assembly language programmer or compiler. It deals with:

- **The Instruction Set (what operations can be perform?) and The Instruction Format (how instructions specified?)**
- **Data storage (where is data located?) and Addressing Modes (how data accessed?)**

- **Exceptional Conditions (what happens if something goes wrong?)**

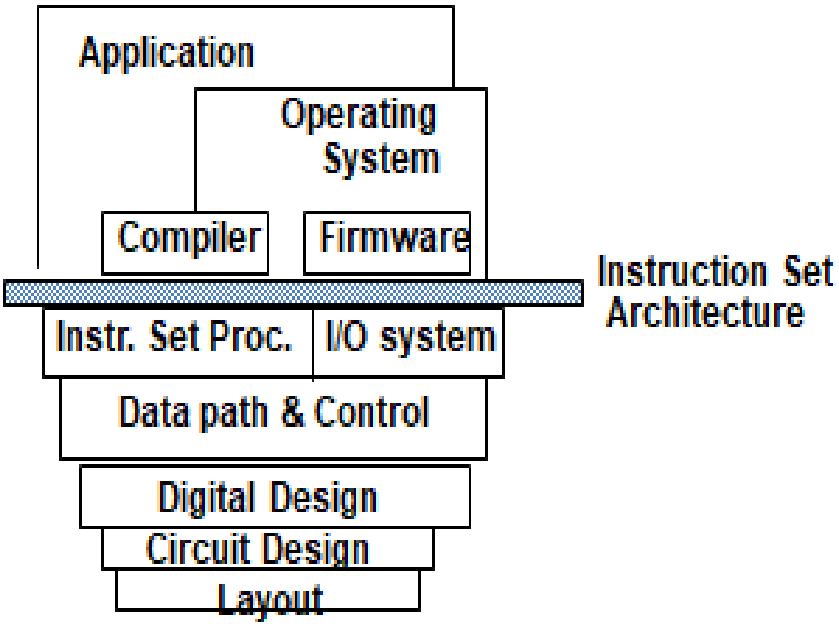

Figure 0-2: ISA layer

Machine organization is the view of the computer that seen by the logic designer. Typically, the machine organization is designing to meet a given instruction set architecture. It deals with:

- **Capabilities & performance characteristics of functional units (e.g., registers, ALU, shifters, etc.).**
- **Ways in which these components are interconnected**
- **How information flows between components**
- **Logic and means by which such information flow is controlled**
- **Coordination of functional units to realize the ISA**

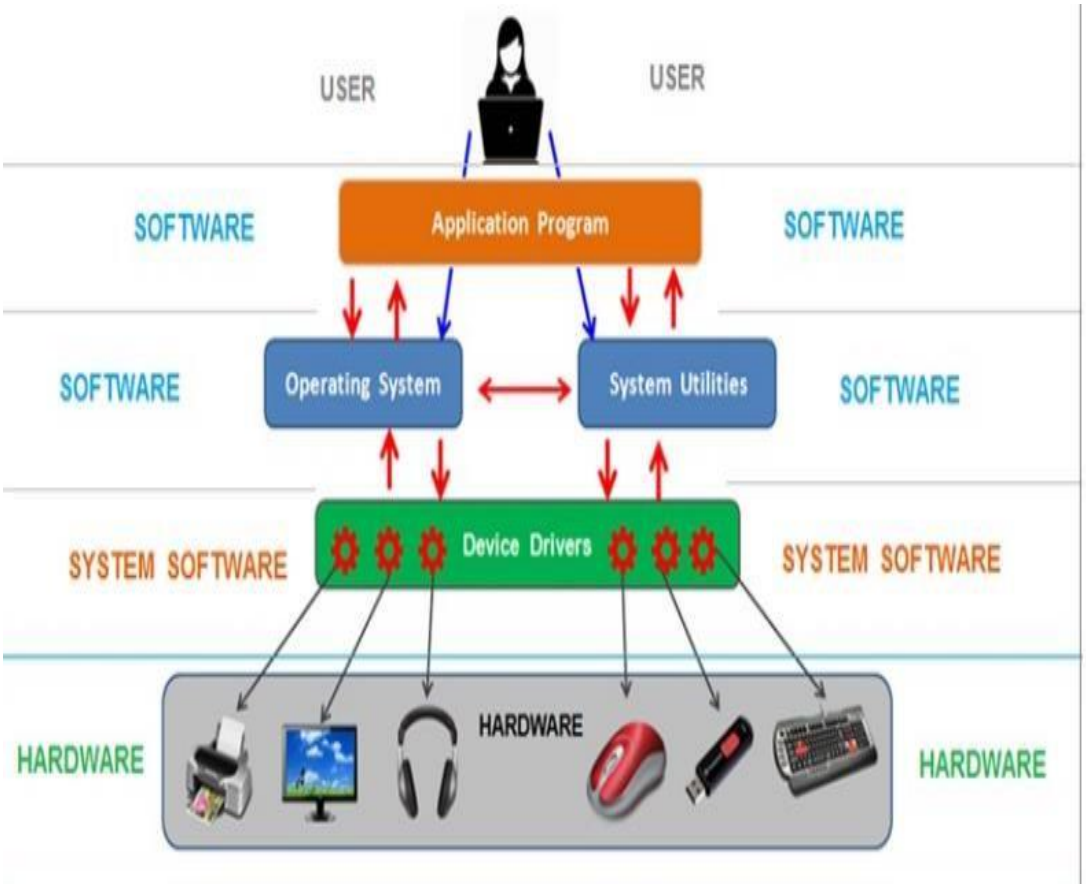

Figure 0-3: System Architecture layer

Table 1.1: Compare& contrast computer architecture Vs. computer organization

Computer Architecture	Computer Organization
Computer Architecture is concerned with the structure and behavior of a computer system as seen by the user.	Computer Organization is concerned with the way hardware components are connected together to form a computer system.
It acts as the interface between hardware and software.	It deals with the components of a connection in a system.
Computer Architecture helps us to understand the functionalities of a system.	Computer Organization tells us how exactly all the units in the system are arranged and interconnected.
A programmer can view architecture in terms of instructions, addressing modes and registers.	Whereas Organization expresses the realization of architecture.
While designing a computer system architecture is considered first.	An organization is done on the basis of architecture.
Computer Architecture deals with high-level design issues.	Computer Organization deals with low-level design issues.
Architecture involves Logic (Instruction sets, Addressing modes, Data types, Cache optimization)	Organization involves Physical Components (Circuit design, Adders, Signals, Peripherals)

1.3 Structure and Function

- Structure in computer

  Computer architecture, structure of a digital computer, encompassing the design and layout of its instruction set and storage registers**.** Its principal components or subsystems, each of which could be said to have an architecture of its own, are input/output, storage, communication, control, and processing.

- Functions of Computer

  There are four main functions of a computer system: Input, Processing, Storage, Output and Controlling

  The operations of computer components given below:

  Inputting: It is the process of entering raw data, instructions and information into the computer. It is perform with the help of input devices.

  Storing: The computer has primary memory and secondary storage to store data and instructions. It stores the data before sending it to CPU for processing and stores the processed data before displaying it as output.

  Processing: It is the process of converting the raw data into useful information. This process is performed by the CPU of the computer. It takes the raw data

From storage, processes it and then sends back the processed data to storage. Typically, the following operations are performed on the data during the processing:

- Arithmetic Operations, such as addition, subtraction, multiplication, differentials, square root, etc.
- Logical Operations, such as equal to, not equal to, greater than, less than, opposite, etc.

***Outputting*:** It is the process of presenting the processed data through output devices like monitor, printer and speakers.

Controlling: This operation performed by the control unit that is part of CPU. The control unit ensures that all basic operations are executed in a right manner and sequence.

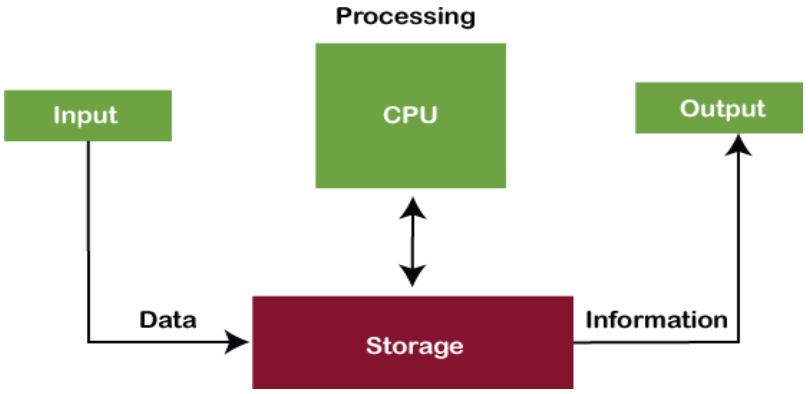

Figure 1.4: Function of computer

1.4 Interconnection Structures

A computer consists of a set of components (CPU, MEMORY, I/O Module) that communicate with each other. The collection of paths connecting the various modules is called an interconnection structure.

- All the units must be connected
- Different types of connections for a different types of unit

  Memory

  Input/output

  CPU

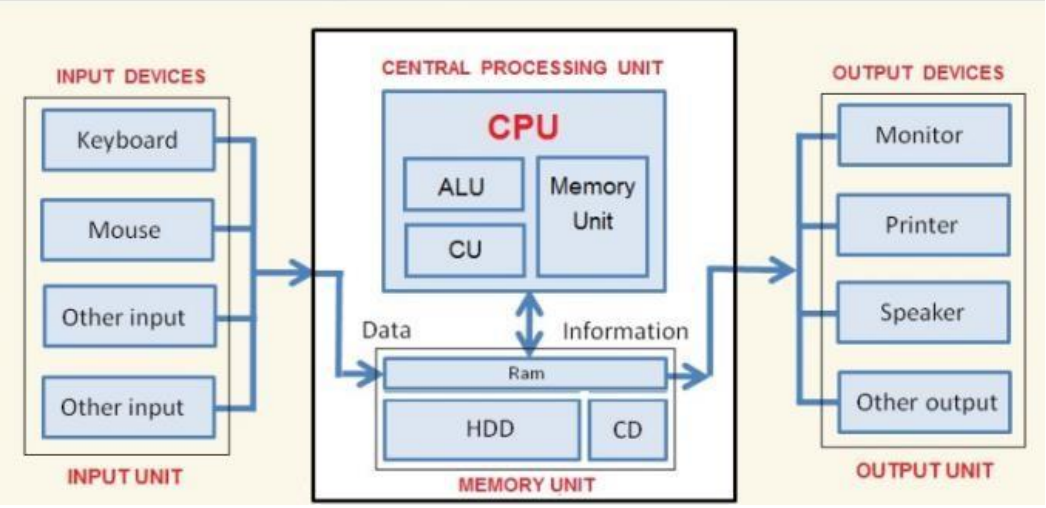

Figure 1.5: Personal computer block diagram

Types of interconnections

- Memory to Processor:- the processor read an instruction or unit of data from memory
- Processor to memory:- the processor writes unit of data to memory
- I/O to Processor:- the data reads from I/O device through I/O module
- Processor to I/O:- the processor sends data to I/O device.

1. Memory Connection

- **Receives and sends data , Receives addresses (of locations), and Receives control signals (Read , Write and Timing)**

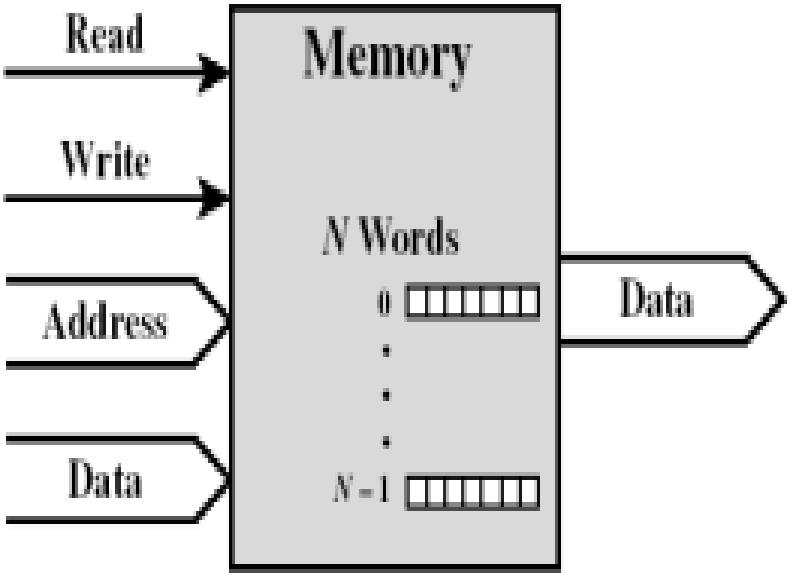

Figure 1.6: Memory to Processor

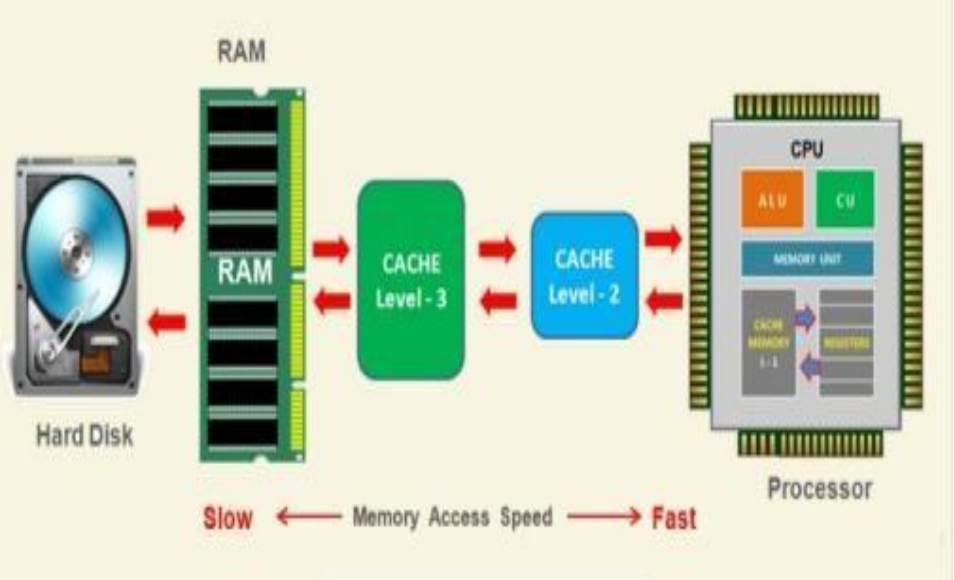

Figure 1.7: Memory to Processor

2. I/O Connection
   - **Similar to memory from computer's viewpoint**
   - **Output**
     - Receive data from computer
     - Send data to peripheral
   - **Input**
     - Receive data from peripheral
     - Send data to computer
   - **Receive control signals from computer**
   - **Send control signals to peripherals**
     - e.g. spin disk
   - **Receive addresses from computer**
     - e.g. port number to identify peripheral
   - **Send interrupt signals (control)**

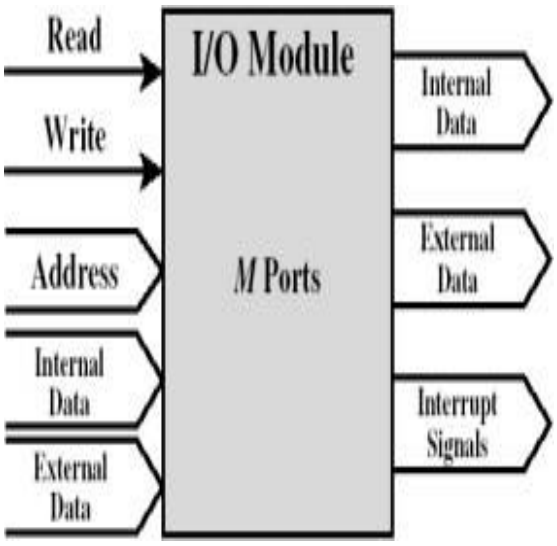

Figure 1.8: I/O Module

3. CPU Connection

- Reads instruction and data , Writes out data (after processing) ,Sends control signals to other units and Receives (& acts on) interrupts
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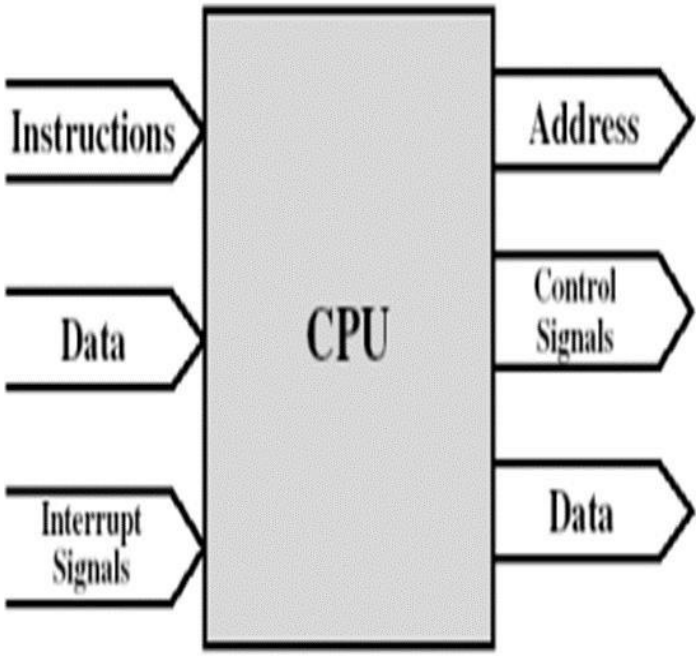

Figure 1.9: CPU Module

Common System Bus Interconnection

- A bus is a communication pathway connecting two or more devices
- Point-to-point interconnection structures with packetized data transfer
- Usually broadcast (all components see signal)
- Often grouped
- A number of channels in one bus
  e.g. 32 bit data bus is 32 separate single bit channels
- Power lines may not be shown
- There are a number of possible interconnection systems
- Single and multiple BUS structures are most common
- e.g. Control/Address/Data bus (PC)
- e.g. Unibus (DEC-PDP)
- Lots of devices on one bus leads to:
  Propagation delays
  Long data paths mean that co-ordination of bus use can adversely affect performance
  If aggregate data transfer approaches bus capacity

- **Most systems use multiple buses to overcome these problems**

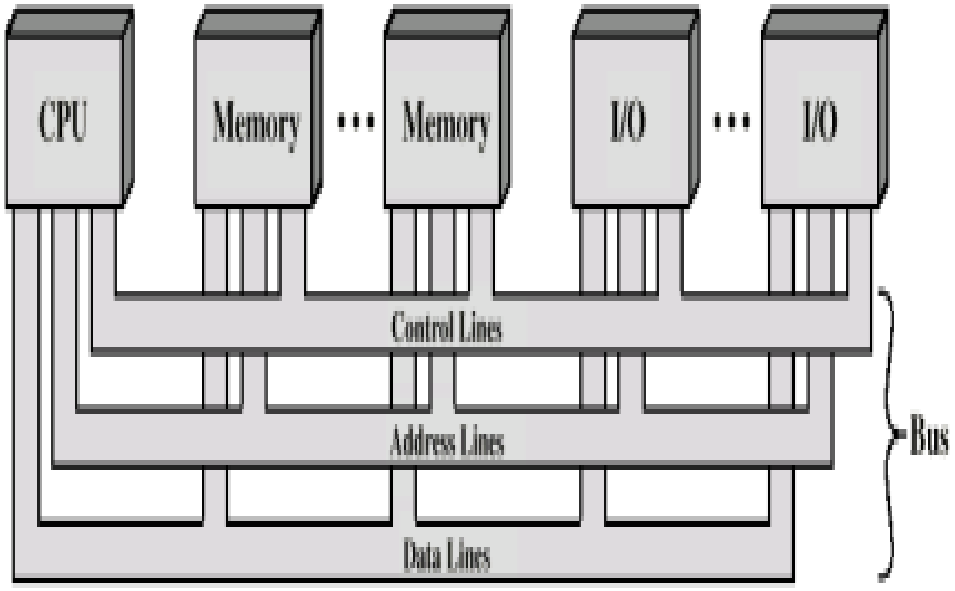

Figure 1.10: Bus

Interconnection Scheme

Table 1.2: Type of bus

Type of Bus	Description
Data Bus	▪ **Carries data** Remember that there is no difference between "data" and "instruction" at this level Width is a key determinant of performance • 8, 16, 32, 64 bit
Address Bus	▪ **Identify the source or destination of data** ▪ **CPU needs to read an instruction (data) from a given location in memory** ▪ **Bus width determines maximum memory capacity of system** ▪ **8080 has 16 bit address bus giving 64k address space**
Control Bus	▪ **Control and timing information** Memory read and Memory write I/O read and I/O write

	Transfer ACK Bus request Bus grant Interrupt request Interrupt ACK Clock Reset

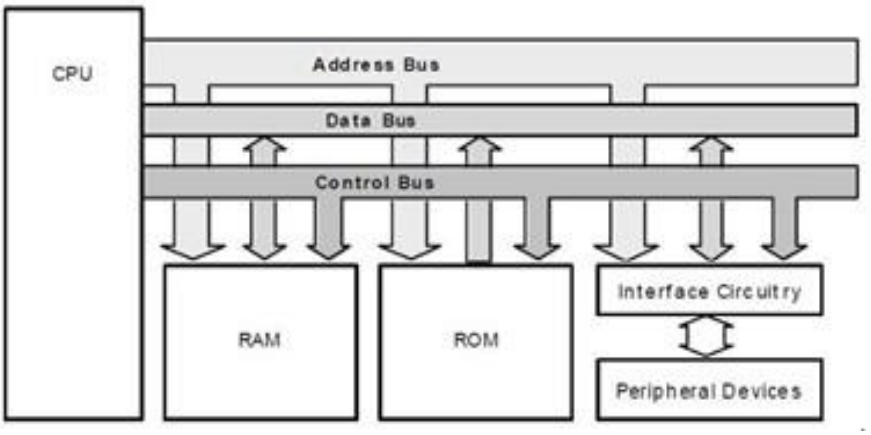

Figure 1.11: Microprocessor block Diagram

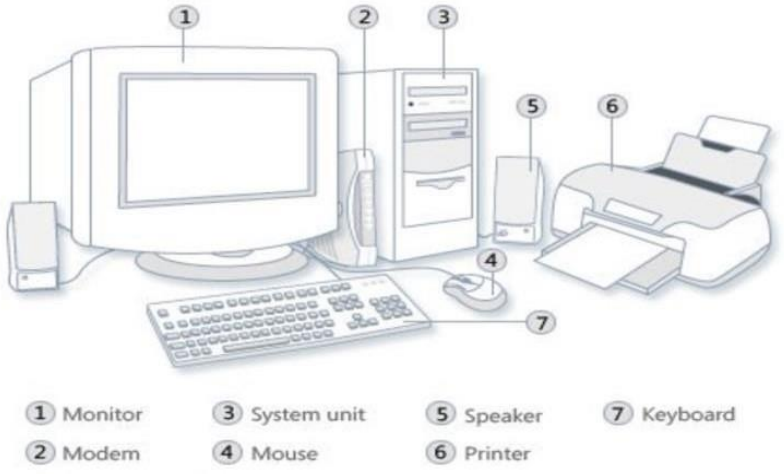

Figure 1.12: Computer hardware System and peripheral devices

How to Disassemble a Computer?

Step 1 – Unplug your computer and peripheral items
Step 2 – Remove side covers
Step 3 – Disconnect connectors
Step 4 – Remove standalone fans
Step 5 – Remove the storage drive
Step 6 – Remove memory (RAM) modules
Step 7 – Remove power supply unit

How to Assemble a Computer?

Step 1: Open Case.
Step 2: Mount Motherboard.
Step 3: Mount Processor (CPU)
Step 4: Install CPU Cooler
Step 5: Install Power Supply (PSU)
Step 6: Mount Memory (RAM)
Step 7: Install Graphics Card
Step 8: Mount Storage Drives

- Byte

  A group of 8 bits is called byte. A byte is the smallest unit, which can represent a data item or a character.
- Word

  A computer word, like a byte, is a group of fixed number of bits processed as a unit, which varies from computer to computer but is fixed for each computer.

Table 1.3: Computer Data Storage Memory Unit

No.	Unit	Description
1	Kilobyte (KB)	1 KB = 1024 B
2	Megabyte (MB)	1 MB = 1024 KB
3	Gigabyte (GB)	1 GB = 1024 MB
4	Terabyte (TB)	1 TB = 1024 GB
5	Petabyte (PB)	1 PB = 1024 TB
6	Exabyte (EB)	1 EB = 1024 PB
7	Zettabyte (ZB)	1 ZB = 1024 EB
8	Yottabyte (YB)	1 YB = 1024 ZB