# Computer Basics

~Shinjit Kamal Borah

**Definition:**

Computer is an electronic device that processes data according to a set of instructions to produce desired results. In this definition, we have seen some basic terminologies that define a computer system. A system must possess these characteristics or parts to be called as computer or computer like device. These are

1. Electronic device: This part is termed as hardware, in the study of computer. This part is visible and tangible. Hardware consists of electronic devices.
2. Data: The next important term found in the definition. Data is simply a value which is insufficient to give some knowledge, but collection of data becomes information, from which we can draw knowledge. (Think about a number 25, does it mean anything to you? Now consider Roll No 25, is it meaningful now? This is the difference between data and information. 25 is data but Roll No 25 is a piece of information.) If we do not provide the data computer can do nothing. We term data as an input in terms of computer. For example to print an application we must provide the alphabets using keyboard.
3. Set of instructions: It is known as the software. Computer can perform any task only if sufficient instructions are provided. Therefore, we need different software to perform different task in computer. For instance, to listen to music we need media player.
4. Desired Result: Computer is used as a tool to perform tasks to get some specific results. This result is known as output. Computer must be able to provide us the correct result.

**Components of Computer:**

- C.P.U.: A central processing unit (CPU), also called a central processor or main processor, is the electronic circuitry within a computer that executes instructions that make up a computer program (set of instruction). The CPU performs basic arithmetic, logic, controlling, and input/output (I/O) operations specified by the instructions in the program. It is also known as the brain of a computer.

    - Memory: Computer memory is any physical device capable of storing information temporarily or permanently. We can store and retrieve data and information to and from computer memory. To process data and information, we must place these data and information in memory.

    - Control Unit (CU): The control unit (CU) is a component of the CPU that directs the operation of the processor. It tells the computer's memory, arithmetic and logic unit and input and output devices how to respond to the instructions that have been sent to the processor.

- ALU(Arithmetic Logic Unit): The arithmetic logic unit (ALU) is a digital circuit within the processor that performs integer arithmetic and bitwise logic operations. The inputs to the ALU are the data words to be operated on (called operands), status information from previous operations, and a code from the control unit indicating which operation to perform. Depending on the instruction being executed, the operands may come from internal CPU registers or external memory, or they may be constants generated by the ALU itself.

- Input Unit: This unit is responsible for providing data and control signals to a computer system. As computer works only on binary data i.e. 0 and 1. This unit converts the input signal to binary or digital signal. The devices that take user input and provide to the CPU are known as Input Devices. Examples of input devices are keyboard, scanner, mouse etc.

- Output Unit: This unit is responsible for providing information to an user from a computer system. As computer works only on binary data i.e. 0 and 1. This unit converts binary or digital signal to human readable format. The devices that take user output from the CPU and provide to the users are known as Output Devices. Examples of output devices are monitor, projector, printer etc.

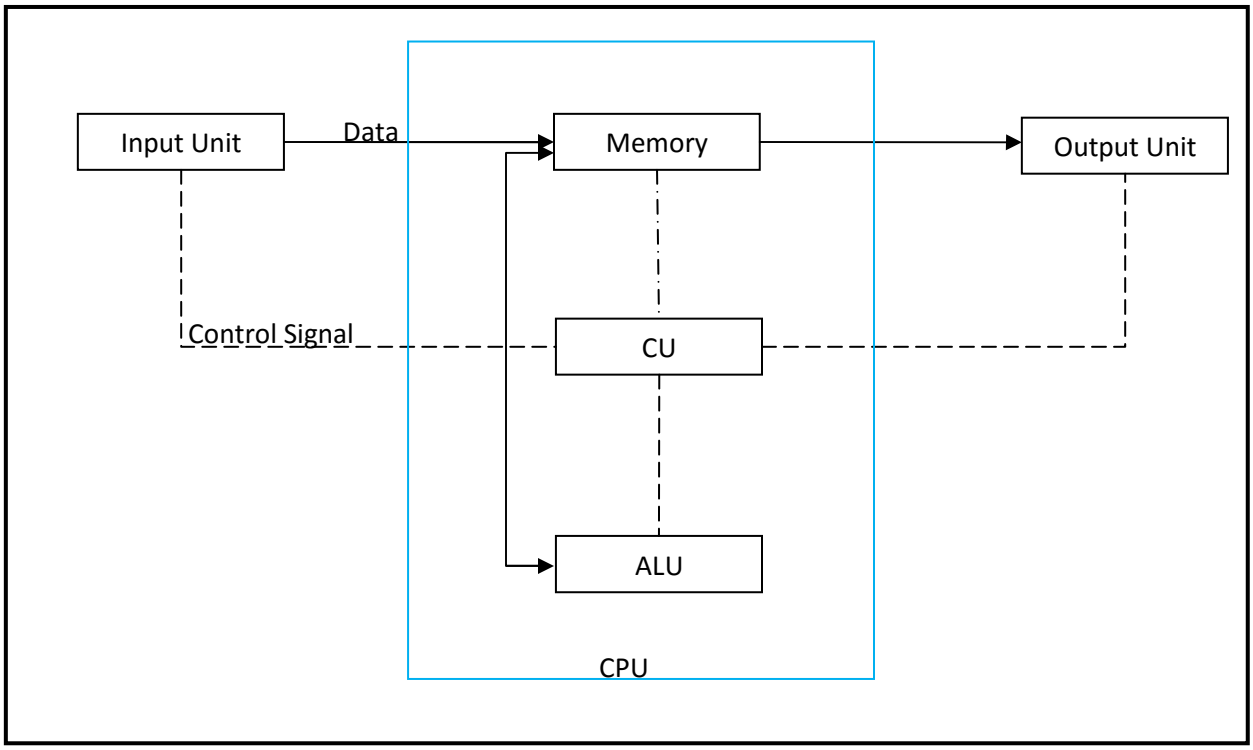
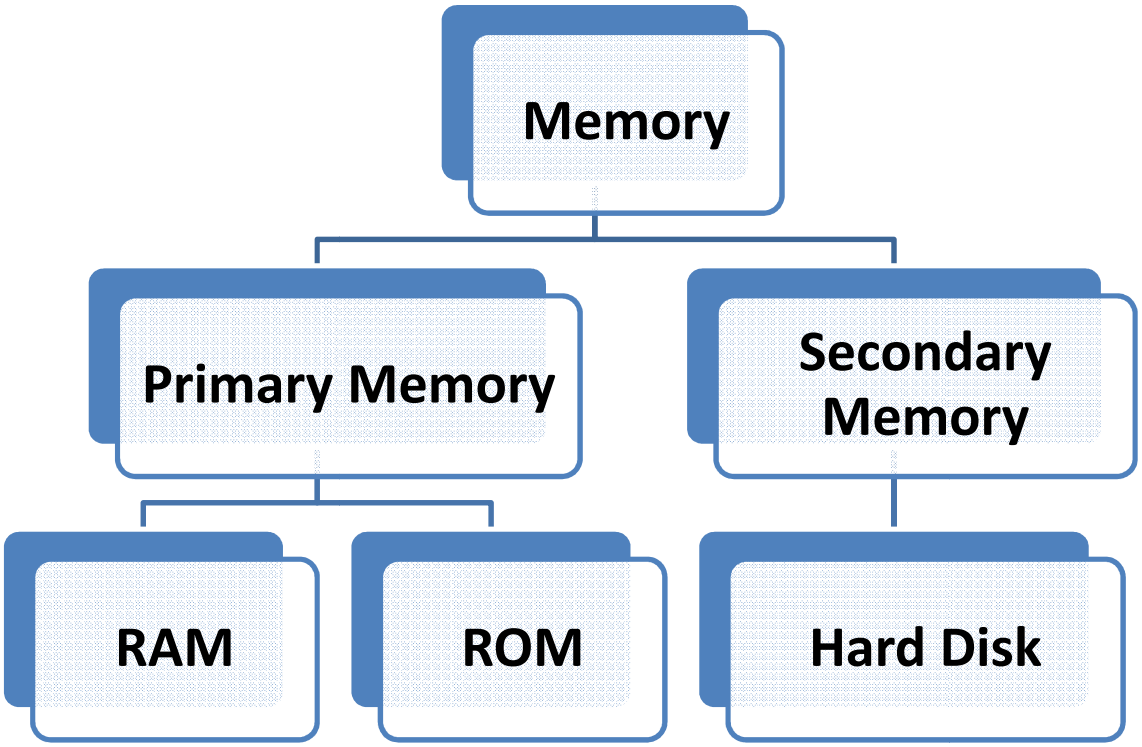



Fig: Block Diagram of a Computer

**Types of Memory:**




Primary memory: Primary memory is computer memory that is accessed directly by the CPU. This includes several types of memory, such as the processor cache, Random Access Memory (RAM) and Read Only Memory (ROM).

Random-access memory (RAM): It is a form of computer memory that can be read and changed in any order, typically used to store working data and machine code. This type of memory is volatile in nature. Data and information cannot be stored permanently here. As it is volatile when power supply is stopped, all data and information get erased automatically.

Read Only Memory (ROM): Read-only memory is a type of non-volatile memory used in computers and other electronic devices. Computer can only read this type of memory and cannot change the stored information. Read-only memory is useful for storing software that is rarely changed during the life of the system, also known as firmware.

Secondary memory: Secondary memory refers to the external storage device which can be used to store data or information permanently. Example Hard Disk, floppy disks, magnetic tape, paper tape, punched cards etc.

**Programming Language:** The process of writing instruction is known as programming. The language in which computer instructions are written is known as programming language and a set of instructions written in programming language is known as a program.

**Types of programming language:**

1. Machine Level Language: As computer is an electronic device, here data and information are represented as voltage or current. Therefore, computer works only on binary or digital signal that represents high voltage and low voltage. If high voltage represents 1 and low voltage represents 0 we call it positive logic and if high voltage represents 0 and low voltage represents 1 we call it negative logic. To instruct the computer if we write the instructions in the binary format i.e. 0 and 1 we called this programming language as *machine level language*. But these types of instructions are very much difficult for human to understand and remember. At the time, these instructions were machine dependent.
2. Assembly Level Language: Instead of writing whole the instruction in machine code or binary format, in *assembly level language* operators are written as mnemonics and operands are written in binary. Assembler is used to convert the *assembly level language* to *machine level language*.
3. High Level Language: *High level language*s can be easily converted to *machine level language* as well these languages can be easily understood by human also. High-level languages are like English-like language, with fewer words also known as keywords and fewer ambiguities. Each high level language will have its own syntax and keywords. The meaning of the word syntax is grammar.
   There are two types of translators for high level language programs to convert to *machine level language*. They are **interpreter** and **compiler**.
   Examples of high level language are C, C++, Java, Pascal, Fortran etc.

# Network Fundamentals

## Definition:

Computer network is a collection of computing devices that are connected in various ways in order to communicate and share resources. A computer network or data network is a digital telecommunications network. In computer networks, networked computing devices exchange data with each other using a data link. The generic term node or host refers to any device on a network. The connections between nodes are established using cable media, most commonly the Ethernet cable or wireless media like radio waves. Nodes can include hosts such as personal computers, phones, servers as well as networking hardware. Two such devices can be said to be networked together when one device is able to exchange information with the other device, whether or not they have a direct connection to each other. A network is a multipurpose connection, which allows a single computer to do more.

**Characteristics of a Computer Network**

- Share resources from one computer to another.
- Create files and store them in one computer, access those files from the other computer(s) connected over the network.
- Connect a printer, scanner, or a fax machine to one computer within the network and let other computers of the network use the machines available over the network.

## Architecture and Requirement of Network:

**Network architecture** is the design of a communication network. It is a framework for the specification of a network's physical components and their functional organization and configuration, its operational principles and procedures, as well as data formats use.

1. **Client/Server Network:** A client/server network is a network in which the shared files and applications are stored in the server but network users (clients) can still store files on their individual PCs. A server is a computer that shares information and resources with other computers on a network. A client is a computer which requests services or files from a server computer.

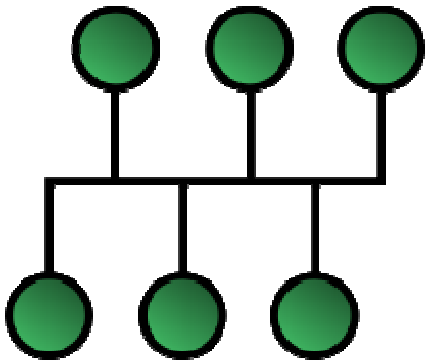
2. **Peer-to-Peer or P2P:** It is a network with all the nodes acting as both servers and clients. A PC can access files located on another PC and can also provide files to other PCs. All computers in the peer-to-peer network have equal responsibilities and capabilities to use the resources available on the network. With peer-to-peer network, no server is needed; each computer in the network is called a peer.

**Network topology:** Network topology is the arrangement of the various elements (links, nodes, etc.) of a communication network. Network topology is the topological structure of a network and may be depicted physically or logically. *Physical topology* is the placement of the various components of a network, including device location and cable installation, while *logical*

*topology* illustrates how data flows within a network. Distances between nodes, physical interconnections, transmission rates, or signal types may differ between two networks, yet their topologies may be identical.

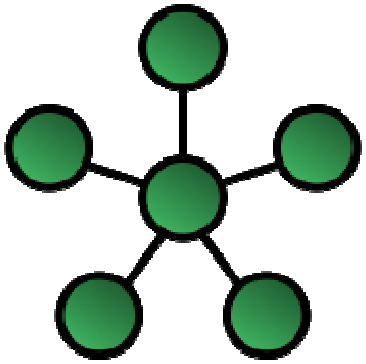
Classification of topology:

1. **Bus Topology**



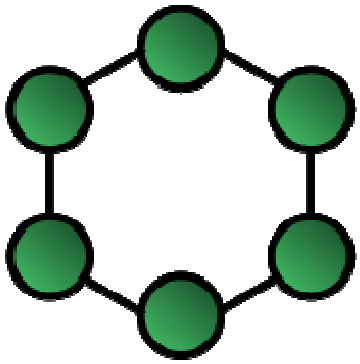
In local area networks where bus topology is used, each node is connected to a single cable, by the help of interface connectors. This central cable is the backbone of the network and is known as the bus. A signal from the source travels in both directions to all machines connected on the bus cable until it finds the intended recipient. If the machine address does not match the intended address for the data, the machine ignores the data. Alternatively, if the data matches the machine address, the data is accepted. Because the bus topology consists of only one wire, it is rather inexpensive to implement when compared to other topologies. However, the low cost of implementing the technology is offset by the high cost of managing the network. Additionally, because only one cable is utilized, it can be the single point of failure. In this topology data being transferred may be accessed by any workstation.

2. **Star Topology**



In local area networks with a star topology, each network host is connected to a central hub with a point-to-point connection. So it can be said that every computer is indirectly connected to every other node with the help of the hub. In Star topology, every node is connected to a central node called hub, router or switch. The switch is the server and the peripherals are the clients. The network does not necessarily have to resemble a star to be classified as a star network, but all of the nodes on the network must be connected to one central device. All traffic that traverses the network passes through the central hub. The hub acts as a signal repeater. The star topology is considered the easiest topology to design and implement.

### 3. Ring Topology



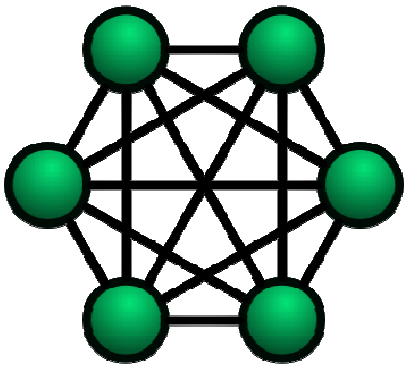
A ring topology is a bus topology in a closed loop. Data travels around the ring in one direction. When one node sends data to another, the data passes through each intermediate node on the ring until it reaches its destination. The intermediate nodes repeat (re transmit) the data to keep the signal strong. Every node is a peer; there is no hierarchical relationship of clients and servers. If one node is unable to re transmit data, it severs communication between the nodes before and after it in the bus.

Advantages:

- When the load on the network increases, its performance is better than bus topology.
- There is no need of network server to control the connectivity between workstations.

Disadvantages: Aggregate network bandwidth is bottlenecked by the weakest link between two nodes.

### 4. Mesh Topology



In fully connected network each node is connected with each other nodes. All nodes are interconnected. This kind of topology does not trip and affect other nodes in the network. The value of fully meshed networks is proportional to the exponent of the number of subscribers. This makes it impractical for large networks.

**5. Hybrid Topology**

Hybrid networks combine two or more topologies in such a way that the resulting network does not exhibit one of the standard topologies (e.g., bus, star, ring, etc.). For example, a tree network (or star-bus network) is a hybrid topology in which star networks are interconnected via bus networks.

**OSI model:** The Open Systems Interconnection model (OSI model) is a conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system without regard to their underlying internal structure and technology. Its goal is the interoperability of diverse communication systems with standard protocols. The model partitions a communication system into abstraction layers. The original version of the model defined seven layers.

- **Layer 1: Physical Layer**:
  The layer defines the electrical and physical specifications of the data connection. It defines the relationship between a device and a physical transmission medium (for example, an electrical cable, an optical fiber cable, or a radio frequency link).
- **Layer 2: Data Link Layer**
  The data link layer provides node-to-node data transfer—a link between two directly connected nodes. It detects and possibly corrects errors that may occur in the physical layer.
- **Layer 3: Network Layer**

The network layer provides the functional and procedural means of transferring variable length data sequences called datagrams from one node to another connected in different networks.

- **Layer 4: Transport Layer**
  The transport layer provides the functional and procedural means of transferring variable-length data sequences from a source to a destination host via one or more networks, while maintaining the quality of service functions..
- **Layer 5: Session Layer**
  The session layer controls the dialogues (connections) between computers. It establishes, manages and terminates the connections between the local and remote application.
- **Layer 6: Presentation Layer**
  The presentation layer establishes context between application-layer entities, in which the application-layer entities may use different syntax and semantics if the presentation service provides a mapping between them. If a mapping is available, presentation service data units are encapsulated into session protocol data units and passed down the protocol stack.
  This layer provides independence from data representation by translating between application and network formats. The presentation layer transforms data into the form that the application accepts. This layer formats data to be sent across a network.
- **Layer 7: Application Layer**
  The application layer is the OSI layer closest to the end user, which means both the OSI application layer and the user interact directly with the software application. This layer interacts with software applications that implement a communicating component.

**Internet protocol suite:** The Internet protocol suite is the conceptual model and set of communications protocols used on the Internet and similar computer networks. It is commonly known as **TCP/IP** because the foundational protocols in the suite are the Transmission Control Protocol (TCP) and the Internet Protocol (IP). The Internet protocol suite provides end-to-end data communication specifying how data should be packetized, addressed, transmitted, routed, and received. This functionality is organized into four abstraction layers which classify all related protocols according to the scope of networking involved. The four layers are

- **Link Layer**: It is the lowest layer, containing communication methods for data that remains within a single network segment (link).
- **Internet Layer**: This layer provides internetworking between independent networks.
- **Transport Layer:** This layer handles host-to-host communication.

- **Application Layer**: This layer provides process-to-process data exchange for applications.

## Types of Networks:

1. **Local Area Network** (LAN): Smallest network compared to the other two networks. The simplest form of LAN is to connect two computers together. LAN is operated within a limited physical area, such as at home, school, a single building or several buildings. A network which consists of less than 500 interconnected devices across several buildings, is still recognized as a LAN.

2. **Metropolitan Area Network** (MAN): MAN can be defined as a group of computers and network devices connected together within a large physical area. It can be a collection of several LANs within the same city. Metropolitan - describes important cities like New Delhi, Mumbai, Kolkata, Bangaluru, Chennai etc. Companies that have several branches within the Mumbai city such as banks, use a MAN.

3. **Wide Area Network** (WAN): The largest network of all network types. Internet is the largest WAN in the world. WAN generally covers large distances such as states, countries or continents. Eg: Local banks have always maintained their business online by connecting all computers of their branches in the countries. International banks also use WAN to connect their computers all over the world. WAN is a group of MANs or LANs or the mixture of both networks.

## Application of Computer Network:

1. **Resource sharing**: It allows all programs, equipments and data available to anyone on the network irrespective of the physical location of the resource and the user. File Transfer Protocol (FTP) facilities transfer of files from one computer to another e.g. from a client to a server. There are 2 common processes involved in FTP

    a. **Downloading: -** This is the process of obtaining files from a server to a workstation or a client.

    b. **Uploading: -** This is obtaining of files from a workstation to a server.

Terminal Emulation (TELNET): It allows a workstation to access the server for an application program. This enables you to control the server and communicate with other servers on the network. The workstation appears as a down terminal that is directly attached to the server. The user feels like he/she is using the server directly. TELNET enables PCs and workstations to function as dumb terminals in sessions with hosts on inter-networks.

2. **High reliability due to alternative sources of data:** It provides high reliability by having alternative sources of data. For e.g. all files could be replicated on more than one machines, so if one of them is unavailable due to hardware failure or any other reason, the other copies can be used. The aspect of high reliability is very important for military, banking, air traffic control, nuclear reactor safety and many other applications where continuous operations is a must even if there are hardware or software failures.
3. **Money saving:** Computer networking has an important financial aspect for organizations because it saves money. Organizations can use separate personal computer one per user instead of using mainframe computer which are expensive. The organizations can use the workgroup model (peer to peer) in which all the PCs are networked together and each one can have the access to the other for communicating or sharing purpose.
4. **Communication medium:** A computer network provides a powerful communication medium among widely separated employees. They allow users to type messages at their local nodes and then send to someone on the network. It is a fast and easy way of transferring mail from one computer to another.

## Network Devices:

### Network interfaces:

A **Network Interface Controller** (NIC) is computer hardware that provides a computer with the ability to access the transmission media, and has the ability to process low-level network information. For example, the NIC may have a connector for accepting a cable, or an aerial for wireless transmission and reception, and the associated circuitry.

The NIC responds to traffic addressed to a network address for either the NIC or the computer as a whole.

In Ethernet networks, each network interface controller has a unique Media Access Control (MAC) address—usually stored in the controller's permanent memory. To avoid address conflicts between network devices, the Institute of Electrical and Electronics Engineers (IEEE) maintains and administers MAC address uniqueness. The size of an Ethernet MAC address is six octets. The three most significant octets are reserved to identify NIC manufacturers. These manufacturers, using only their assigned prefixes, uniquely assign the three least-significant octets of every Ethernet interface they produce.

**Repeaters and Hubs:**

A **repeater** is an electronic device that receives a network signal, cleans it of unnecessary noise and regenerates it. The signal is retransmitted at a higher power level, or to the other side of an obstruction, so that the signal can cover longer distances without degradation. In most twisted pair Ethernet configurations, repeaters are required for cable that runs longer than 100 meters. With fiber optics, repeaters can be tens or even hundreds of kilometers apart.

A **hub**, also called a network hub, is a common connection point for devices in a network. Hubs are devices commonly used to connect segments of a LAN. The hub contains multiple ports. When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets. Hubs serve as a central connection for all of your network equipment and handle a data type known as frames. Frames carry the data. When a frame is received, it is amplified and then transmitted on to the port of the destination PC.

**Bridges:**

A network bridge connects and filters traffic between two network segments at the data link layer (layer 2) of the OSI model to form a single network. This breaks the network's collision domain but maintains a unified broadcast domain. Network segmentation breaks down a large, congested network into an aggregation of smaller, more efficient networks.

Bridges come in three basic types:

- Local bridges: Directly connect LANs
- Remote bridges: Can be used to create a wide area network (WAN) link between LANs. Remote bridges, where the connecting link is slower than the end networks, largely have been replaced with routers.
- Wireless bridges: Can be used to join LANs or connect remote devices to LANs.

**Switches:**

A network switch is a device that forwards and filters OSI layer 2 datagrams (frames) between ports based on the destination MAC address in each frame. A switch is distinct from a hub in that it only forwards the frames to the physical ports involved in the communication rather than all ports connected. It can be thought of as a multi-port bridge. It learns to associate physical

ports to MAC addresses by examining the source addresses of received frames. If an unknown destination is targeted, the switch broadcasts to all ports but the source. Switches normally have numerous ports, facilitating a star topology for devices, and cascading additional switches.

Multi-layer switches are capable of routing based on layer 3 addressing or additional logical levels. The term *switch* is often used loosely to include devices such as routers and bridges, as well as devices that may distribute traffic based on load or based on application content (e.g., a Web URL identifier).

**Routers:**

A router is an internetworking device that forwards packets between networks by processing the routing information included in the packet or datagram (Internet protocol information from layer 3). The routing information is often processed in conjunction with the routing table (or forwarding table). A router uses its routing table to determine where to forward packets. A destination in a routing table can include a "null" interface, also known as the "black hole" interface because data can go into it; however, no further processing is done for said data i.e. the packets are dropped.

**Modems:**

Modems (MOdulator-DEModulator) are used to connect network nodes via wire not originally designed for digital network traffic, or for wireless. To do this one or more carrier signals are modulated by the digital signal to produce an analog signal that can be tailored to give the required properties for transmission. Modems are commonly used for telephone lines, using a Digital Subscriber Line technology.

## Internet:

The **Internet** is the global system of interconnected computer networks that use the Internet protocol suite (TCP/IP) to link devices worldwide. It is a *network of networks* that consists of private, public, academic, business, and government networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies. The Internet carries a vast range of information resources and services, such as the inter-linked hypertext documents and applications of the World Wide Web (WWW), electronic mail, telephony, and file sharing.

The Internet has no centralized governance in either technological implementation or policies for access and usage; each constituent network sets its own policies. Only the overreaching

definitions of the two principal name spaces in the Internet, the Internet Protocol address (IP address) space and the Domain Name System (DNS), are directed by a maintainer organization. The terms *Internet* and *World Wide Web* are often used interchangeably in everyday speech. However, the World Wide Web or *the Web* is only one of a large number of Internet services.

**World Wide Web (**WWW**):** The WWW is an information space where documents and other web resources are identified by **Uniform Resource Locators** (URLs), interlinked by hypertext links, and can be accessed via the Internet. Embedded hyperlinks permit users to navigate between web pages. Web pages are primarily text documents formatted and annotated with **Hypertext Markup Language** (HTML). In addition to formatted text, web pages may contain images, video, audio, and software components that are rendered in the user's web browser as coherent pages of multimedia content. Multiple web pages with a common theme, a common domain name, or both, make up a **website**. Website content can largely be provided by the publisher, or interactively where users contribute content or the content depends upon the users or their actions. Websites may be mostly informative, primarily for entertainment, or largely for commercial, governmental, or non-governmental organizational purposes. Web resources are usually accessed using **Hyper Text Transfer Protocol** (HTTP), which is one of many Internet communication protocols. Viewing a web page on the World Wide Web normally begins either by typing the URL of the page into a web browser, or by following a hyperlink to that page or resource.

**Internet Protocol address** (**IP address**): An IP address is a numerical label assigned to each device connected to a computer network that uses the Internet Protocol for communication. An IP address serves two principal functions: host or network interface identification and location addressing. Internet Protocol version 4 (IPv4) defines an IP address as a 32-bit number. However, because of the growth of the Internet and the depletion of available IPv4 addresses, a new version of IP (IPv6), using 128 bits for the IP address, was developed in 1995, and standardized as RFC 2460 in 1998. IPv6 deployment has been ongoing since the mid-2000s.

IP addresses are usually written and displayed in human-readable notations, such as 172.16.254.1 in IPv4, and 2001:db8:0:1234:0:567:8:1 in IPv6. The IP address space is managed globally by the Internet Assigned Numbers Authority (IANA).

**Domain Name System** (**DNS**): The DNS is a hierarchical decentralized naming system for computers, services, or other resources connected to the Internet or a private network. It associates various information with domain names assigned to each of the participating entities. Most prominently, it translates more readily memorized domain names to the numerical IP addresses needed for locating and identifying computer services and devices with the underlying network protocols. By providing a worldwide, distributed directory service, the Domain Name

System is an essential component of the functionality on the Internet that has been in use since 1985.

**Electronic Mail** (**email** or **e-mail**): Email is a method of exchanging messages between people using electronic devices. Email servers accept, forward, deliver, and store messages. Neither the users nor their computers are required to be online simultaneously; they need to connect only briefly, typically to a mail server or a webmail interface, for as long as it takes to send or receive messages. Internet email messages consist of two major sections, the message header and the message body, collectively known as content.

The message header includes the following fields:

- *From*: The email address, and optionally the name of the author(s).
- *Date*: The local time and date when the message was written.
- *To*: The email address(es), and optionally name(s) of the message's recipient(s).
- *Subject*: A brief summary of the topic of the message.
- *Cc*: Carbon copy; A copy of the mail is sent the address provided in this space.
- *Bcc*: Blind carbon copy; addresses are usually only specified during SMTP delivery, and not usually listed in the message header.
- *Reply-To*: Address that should be used to reply to the message.