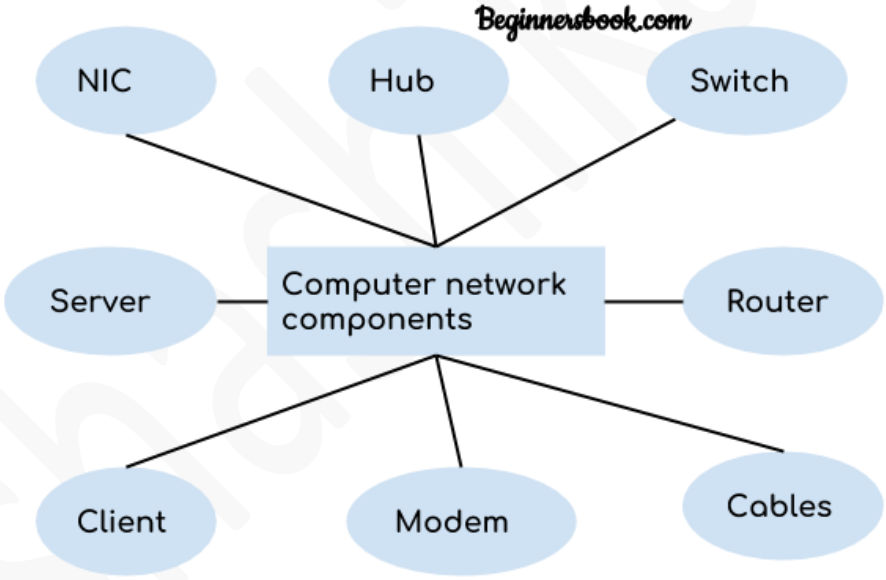
# UNIT 1. DATA COMMUNICATION

A **computer network** is a system in which multiple computers are connected to each other to share information and resources.

## 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.

## Major components of a computer network are:




**NIC:**

- NIC stands for network interface card.
- It is a hardware component used to connect a computer with another computer onto a network
- It can support a transfer rate of 10,100 to 1000 Mb/s.
- The MAC address or physical address is encoded on the network card chip which is assigned by the IEEE to identify a network card uniquely.

**Hub:**

A Hub is a hardware device that divides the network connection among multiple devices. When computer requests for some information from a network, it first sends the request to the Hub through cable. Hub will broadcast this request to the entire network.

**Switch**

A switch is a hardware device that connects multiple devices on a computer network. A Switch contains more advanced features than Hub. Switch delivers the message to the correct destination based on the physical address present in the incoming message. A Switch does not broadcast the message to the entire network like the Hub. It determines the device to whom the message is to be transmitted.

**Router**

- A router is a hardware device which is used to connect a LAN with an internet connection.
- It is used to receive, analyze and forward the incoming packets to another network.
- A router forwards the packet based on the information available in the routing table.
- It determines the best path from the available paths for the transmission of the packet.

**Modem**

- A modem is a hardware device that allows the computer to connect to the internet over the existing telephone line.
- A modem is not integrated with the motherboard rather than it is installed on the PCI slot found on the motherboard.
- It stands for Modulator/Demodulator. It converts the digital data into an analog signal over the telephone lines.

**Cables and Connectors**

Cable is a transmission media used for transmitting a signal.

There are three types of cables used in transmission:

- Twisted pair cable
- Coaxial cable
- Fibre-optic cable

**DATA COMMUNICATION**

- Data Communication is a process of exchanging data or information.
- In case of computer networks this exchange is done between two devices over a transmission medium. This process involves a communication system which is made up of hardware and software.
- The hardware part involves the sender and receiver devices and the intermediate devices through which the data passes. The software part involves certain rules which specify what is to be communicated, how it is to be communicated and when. It is also called as a Protocol.

**The following sections describes the fundamental characteristics**

**Characteristics of Data Communication**

The effectiveness of any data communications system depends upon the following four fundamental characteristics:

1. **Delivery**: The data should be delivered to the correct destination and correct user.

2. **Accuracy**: The communication system should deliver the data accurately, without introducing any errors. The data may get corrupted during transmission affecting the accuracy of the delivered data.

3. **Timeliness**: Audio and Video data has to be delivered in a timely manner without any delay; such a data delivery is called real time transmission of data.

4. **Jitter**: It is the variation in the packet arrival time. Uneven Jitter may affect the timeliness of data being transmitted.

## Components of Data Communication

A Data Communication system has five components as shown in the diagram below:
**1. Message:** Message is the information to be communicated by the sender to the receiver.
**2. Sender:** The sender is any device that is capable of sending the data (message).
**3. Receiver:** The receiver is a device that the sender wants to communicate the data.
**4. Transmission Medium**: It is the path by which the message travels from sender to receiver. It can be wired or wireless and many subtypes in both.
**5. Protocol :** A protocol is a set of rules that governs data communication.
A Protocol is a necessity in data communications without which the communicating entities are like two persons trying to talk to each other in a different language without know the other language.

## Data representation in computer networks

Information can be in the form of text, numbers, images, audio, and video.
**1. Text:** Text includes combination of alphabets in small case as well as upper case. It is stored as a pattern of bits. Prevalent encoding system : ASCII, Unicode
**2. Numbers:** Numbers include combination of digits from 0 to 9.It is stored as a pattern of bits. Prevalent encoding system: ASCII, Unicode
**3. Images:** An image is worth a thousand words‖ is a very famous saying. In computers images are digitally stored. A Pixel is the smallest element of an image. To put it in simple terms, a picture or image is a matrix of pixel elements. The pixels are represented in the form of bits. Depending up on the type of image (black n white or color) each pixel would require different number of bits to represent the value of a pixel. The size of an image depends upon the number of pixels (also called resolution) and the bit pattern used to indicate the value of each pixel.
**4. Audio:** Data can also be in the form of sound which can be recorded and broadcasted. Example: What we hear on the radio is a source of data or information. Audio data is continuous, not discrete.
**5. Video:** Video refers to broadcasting of data in form of picture or movie.

## Need of Computer Network

- **Resource sharing:** Resource sharing is the sharing of resources such as programs, printers, and data among the users on the network without the requirement of the physical location of the resource and user.
- **Server-Client model:** Computer networking is used in the **server-client model**. A server is a central computer used to store the information and maintained by the system administrator. Clients are the machines used to access the information stored in the server remotely.
- **Communication medium:** Computer network behaves as a communication medium among the users. For example, a company contains more than one computer has an email system which the employees use for daily communication.
- **E-commerce:** Computer network is also important in businesses. We can do the business over the internet. For example, amazon.com is doing their business over the internet, i.e., they are doing their business over the internet.

## Network services

Computer systems and computerized systems help human beings to work efficiently and explore the unthinkable. When these devices are connected together to form a network, the capabilities are enhanced multiple-times. Some basic services computer network can offer are.

**Directory Services**

These services are mapping between name and its value, which can be variable value or fixed. This software system helps to store the information, organize it, and provides various means of accessing it.

- **Accounting**
  In an organization, a number of users have their user names and passwords mapped to them. Directory Services provide means of storing this information and make available when requested.
- **Authentication and Authorization**
  User credentials are checked to authenticate a user at the time of login and/or periodically.
- **Domain Name Services**
  DNS is widely used essential services on which internet works. This system maps IP addresses to domain names, which are easier to remember and recall than IP addresses. Because network operates with the help of IP addresses and humans tend to remember website names, the DNS provides website's IP address which is mapped to its name from the back-end on the request of a website name from the user.

**File Services**

File services include sharing and transferring files over the network.

- **File Sharing**
  File sharing enables its users to share their data with other users. User can upload the file to a specific server, which is accessible by all intended users. As an alternative, user can make its file shared on its own computer and provides access to others.
- **File Transfer**
  This is an activity to copy or move file from one computer to another computer or to multiple computers, with help of underlying network. Network enables its user to locate other users in the network and transfers files.

**Communication Services**

- **Email**
  Electronic mail is a communication method and something a computer user cannot work without. Email system has one or more email servers. All its users are provided with unique IDs. When a user sends email to other user, it is actually transferred between users with help of email server.
- **Social Networking**
  Recent technologies have made technical life social. People, can find other known peoples or friends, can connect with them, and can share thoughts, pictures, and videos.
- **Internet Chat**
  Internet chat provides instant text transfer services between two hosts. Two or more people can communicate with each other using text based Internet Relay Chat services. Voice chat and video chat are very common.
- **Discussion Boards**

Discussion boards provide a mechanism to connect multiple peoples with same interests. It enables the users to put queries, questions, suggestions etc. which can be seen by all other users. Other may respond as well.

- **Remote Access**
  This service enables user to access the data residing on the remote computer. This feature is known as Remote desktop. This can be done via some remote device, e.g. mobile phone or home computer.

## Application Services

These are nothing but providing network based services to the users such as web services, database managing, and resource sharing.

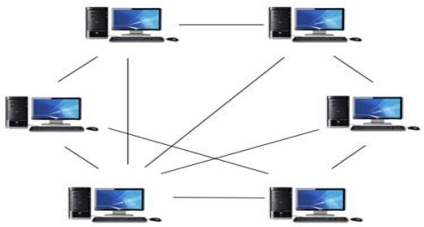
- **Resource Sharing**
  To use resources efficiently and economically, network provides a mean to share them. This may include Servers, Printers, and Storage Media etc.
- **Databases**
  This application service is one of the most important services. It stores data and information, processes it, and enables the users to retrieve it efficiently by using queries. Databases help organizations to make decisions based on statistics.
- **Web Services**
  World Wide Web has become the synonym for internet. It is used to connect to the internet, and access files and information services provided by the internet servers.

## Network models:

- Peer-To-Peer network
- Client/Server network
- Distributed/hybrid

**Peer-To-Peer network**

- Peer-To-Peer network is a network in which all the computers are linked together with equal privilege and responsibilities for processing the data.
- Peer-To-Peer network is useful for small environments, usually up to 10 computers.
- Peer-To-Peer network has no dedicated server.
- Special permissions are assigned to each computer for sharing the resources, but this can lead to a problem if the computer with the resource is down.



**Advantages of Peer-To-Peer Network:**

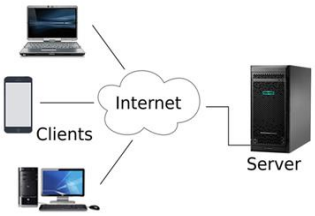
- It is less costly as it does not contain any dedicated server.
- If one computer stops working but, other computers will not stop working.
- It is easy to set up and maintain as each computer manages itself.

**Disadvantages of Peer-To-Peer Network:**

- In the case of Peer-To-Peer network, it does not contain the centralized system. Therefore, it cannot back up the data as the data is different in different locations.
- It has a security issue as the device is managed itself.

**Client/Server Network**

- Client/Server network is a network model designed for the end users called clients, to access the resources such as songs, video, etc. from a central computer known as Server.
- The central controller is known as a **server** while all other computers in the network are called **clients**.
- A server performs all the major operations such as security and network management.
- A server is responsible for managing all the resources such as files, directories, printer, etc.
- All the clients communicate with each other through a server. For example, if client1 wants to send some data to client 2, then it first sends the request to the server for the permission. The server sends the response to the client 1 to initiate its communication with the client 2.




**Advantages of Client/Server network:**

- A Client/Server network contains the centralized system. Therefore we can back up the data easily.
- A Client/Server network has a dedicated server that improves the overall performance of the whole system.
- Security is better in Client/Server network as a single server administers the shared resources.
- It also increases the speed of the sharing resources.

**Disadvantages of Client/Server network:**

- Client/Server network is expensive as it requires the server with large memory.
- A server has a Network Operating System(NOS) to provide the resources to the clients, but the cost of NOS is very high.
- It requires a dedicated network administrator to manage all the resources.

**Distributed/hybrid:** It is the combination of both client-server and peer to peer model.

# Network Applications

Computer systems and peripherals are connected to form a network. They provide numerous advantages:

- Resource sharing such as printers and storage devices
- Exchange of information by means of e-Mails and FTP
- Information sharing by using Web or Internet
- Interaction with other users using dynamic web pages
- Video conferences
- Parallel computing

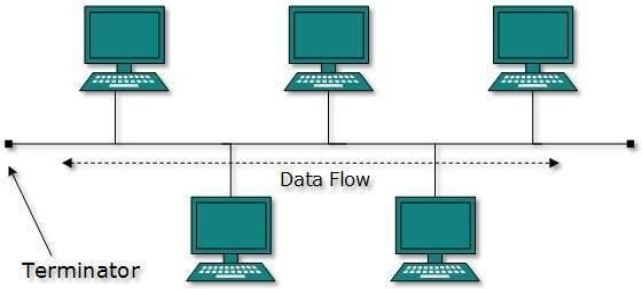
- Instant messaging

## Computer Network Topologies

A Network Topology is the arrangement with which computer systems or network devices are connected to each other. Topologies may define both physical and logical aspect of the network.

**Bus Topology**

In Bus topology, all devices share single communication line or cable. Bus topology may have problem while multiple hosts sending data at the same time. Therefore, Bus topology recognizes one host as Bus Master to solve the issue. It is one of the simple forms of networking where a failure of a device does not affect the other devices. But failure of the shared communication line can make all other devices stop functioning.

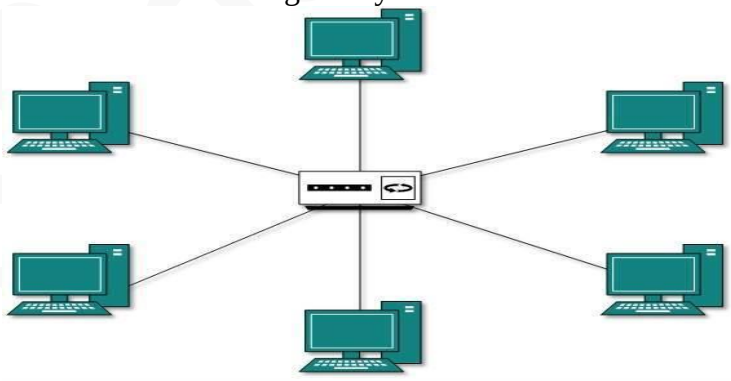



Both ends of the shared channel have line terminator. The data is sent in only one direction and as soon as it reaches the extreme end, the terminator removes the data from the line.

**Star Topology**

All hosts in Star topology are connected to a central device, known as hub device, using a point-to-point connection. That is, there exists a point to point connection between hosts and hub. The hub device can be any of the following:

- Layer-1 device such as hub or repeater
- Layer-2 device such as switch or bridge
- Layer-3 device such as router or gateway

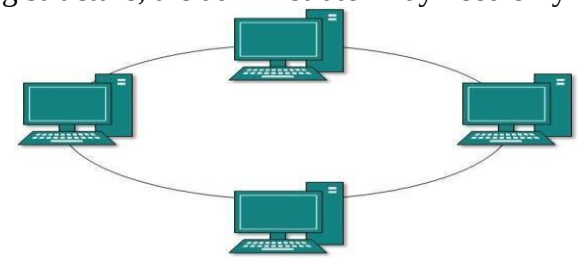


As in Bus topology, hub acts as single point of failure. If hub fails, connectivity of all hosts to all other hosts fails. Every communication between hosts, takes place through only the hub. Star topology is not expensive as to connect one more host, only one cable is required and configuration is simple.

**Ring Topology**

In ring topology, each host machine connects to exactly two other machines, creating a circular network structure. When one host tries to communicate or send message to a host

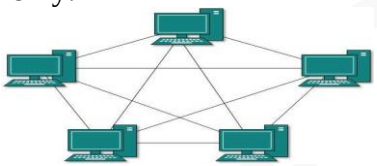
which is not adjacent to it, the data travels through all intermediate hosts. To connect one more host in the existing structure, the administrator may need only one more extra cable.



Failure of any host results in failure of the whole ring. Thus, every connection in the ring is a point of failure. There are methods which employ one more backup ring.

**Mesh Topology**

In mesh topology, a host is connected to one or multiple hosts. This topology has hosts in point-to-point connection with every other host or may also have hosts which are in point-to-point connection to few hosts only.

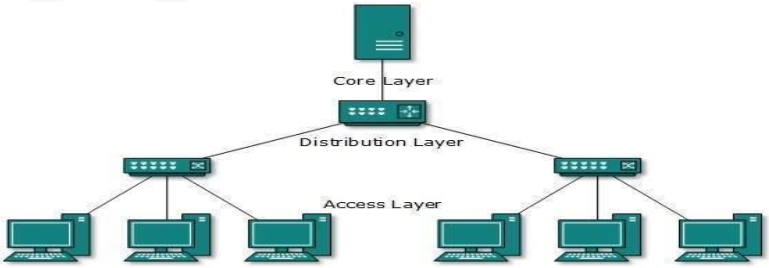


Hosts in Mesh topology also work as relay for other hosts which do not have direct point-to-point links.

**Tree Topology**

Also known as Hierarchical Topology, this is the most common form of network topology in use presently. This topology imitates as extended Star topology and inherits properties of bus topology. This topology divides the network in to multiple levels/layers of network. Mainly in LANs, a network is bifurcated into three types of network devices.

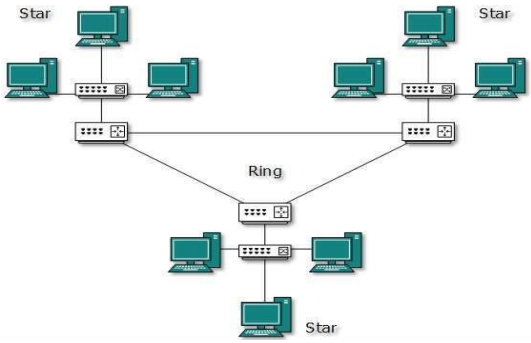
- The lowermost is access-layer where computers are attached.
- The middle layer is known as distribution layer, which works as mediator between upper layer and lower layer.
- The highest layer is known as core layer, and is central point of the network, i.e. root of the tree from which all nodes fork.




All neighbouring hosts have point-to-point connection between them. Similar to the Bus topology, if the root goes down, then the entire network suffers even. though it is not the single point of failure. Every connection serves as point of failure, failing of which divides the network into unreachable segment.

**Hybrid Topology**

A network structure whose design contains more than one topology is said to be hybrid topology. Hybrid topology inherits merits and demerits of all the incorporating topologies.

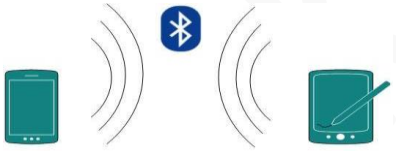



The above picture represents an arbitrarily hybrid topology. The combining topologies may contain attributes of Star, Ring, Bus, and Daisy-chain topologies. Most WANs are connected by means of Dual-Ring topology and networks connected to them are mostly Star topology networks. Internet is the best example of largest Hybrid topology

## Computer Network Types

### Personal Area Network

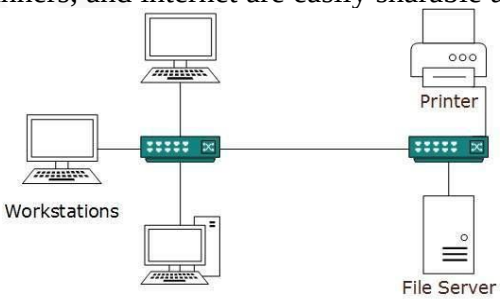
A Personal Area Network (PAN) is smallest network which is very personal to a user. This may include Bluetooth enabled devices or infra-red enabled devices. PAN has connectivity range up to 10 meters. PAN may include wireless computer keyboard and mouse, Bluetooth enabled headphones, wireless printers and TV remotes.



### Local Area Network

A computer network spanned inside a building and operated under single administrative system is generally termed as Local Area Network (LAN). Usually, LAN covers an organization' offices, schools, colleges or universities. Number of systems connected in LAN may vary from as least as two to as much as 16 million.

LAN provides a useful way of sharing the resources between end users. The resources such as printers, file servers, scanners, and internet are easily sharable among computers.

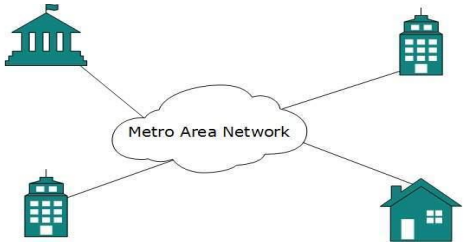



LANs are composed of inexpensive networking and routing equipment. It may contains local servers serving file storage and other locally shared applications. LAN can be wired, wireless, or in both forms at once.

### Metropolitan Area Network

The Metropolitan Area Network (MAN) generally expands throughout a city such as cable TV network. It can be in the form of Ethernet, Token-ring, ATM, or Fiber Distributed Data Interface (FDDI).

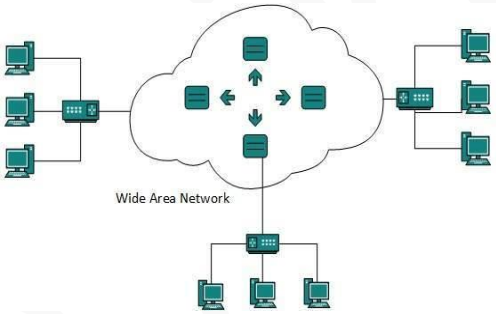
Metro Ethernet is a service which is provided by ISPs. This service enables its users to expand their Local Area Networks. For example, MAN can help an organization to connect all of its offices in a city.




Backbone of MAN is high-capacity and high-speed fiber optics. MAN works in between Local Area Network and Wide Area Network. MAN provides uplink for LANs to WANs or internet.

**Wide Area Network**

As the name suggests, the Wide Area Network (WAN) covers a wide area which may span across provinces and even a whole country. Generally, telecommunication networks are Wide Area Network. These networks provide connectivity to MANs and LANs. Since they are equipped with very high speed backbone, WANs use very expensive network equipment.




**Questions:**

**(1 Mark )**

1. What is computer network?
2. Expand LAN/WLAN/MAN/WAN.
3. Mention the components of a computer network.
4. Mention the Components of Data Communication.
5. what is Hub?
6. what is topology?
7. What is PAN

**(3 marks)**

1. How will be the Data representation in computer networks?
2. What are the applications of Computer Network

**(5 marks)**

1. which are the Network models? Explain.
2. Mention and explain Network services
3. With neat diagram explain any 3 network topologies
4. Explain different Computer Network Types.