What is network:

In the world of computers, networking is the practice of linking two or more computing devices together for the purpose of sharing data/resources.

Networks are built with a mix of computer hardware and computer software.

The requirement of Networking / Advantages / Need of Networking:

Most of the benefits of networking can be divided into two generic categories: ***connectivity*** **and** ***sharing***. They also allow for the easy sharing of information and resources, and cooperation between the devices in other ways.

- Connectivity and Communication
- Data Sharing
- Intranets and extranets
- Hardware Sharing
- Internet Access Sharing
- Data Security and Management
- Performance Enhancement and Balancing
- Entertainment

Disadvantages of Networking:

- Purchasing the network cabling and file servers can be expensive.
- Managing a large network is complicated, requires training and a network manager usually needs to be employed.
- If the file server breaks down the files on the file server become inaccessible. Email might still work if it is on a separate server. The computers can still be used but are isolated.
- Viruses can spread to other computers throughout a computer network.
- There is a danger of hacking, particularly with wide area networks.

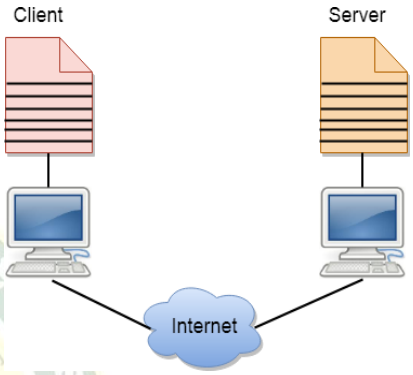
Network Types (based on their Role):

Based on the roles of the computers attached to them, networks are divided into three types:

- **Server-based (also called client-server),** containing clients and the servers that support them.
- **Peer (also called-peer-to-peer),** which have no servers and use the net-work to share resources among independent peers.
- **Hybrid network,** which is a client-server network that also has peers sharing resources. Most networks are actually hybrid networks.

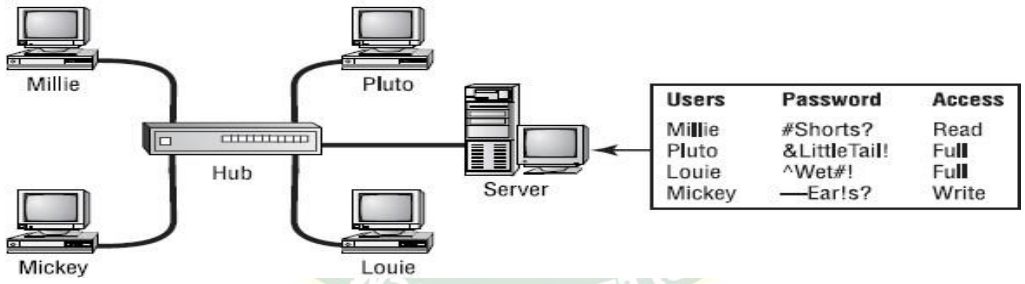
Client – Server Network Model

- **Client**
  - A client is a program that runs on the local machine requesting service from the server.
  - A client program is a finite program means that the service started by the user and terminates when the service is completed.
- **Server**
  - A server is a program that runs on the remote machine providing services to the clients. When the client requests for a service, then the server opens the door for the incoming requests, but it never initiates the service.



  - A server program is an infinite program means that when it starts, it runs infinitely unless the problem arises. The server waits for the incoming requests from the clients. When the request arrives at the server, then it responds to the request.
  - A client and server networking model is a model in which computers such as servers provide the network services to the other computers such as clients to perform a user based tasks. This model is known as client-server networking model.

A client/server network



  - An application program is known as a client program, running on the local machine that requests for a service from an application program known as a server program, running on the remote machine.
  - A client program runs only when it requests for a service from the server while the server program runs all time as it does not know when its service is required.
  - A server provides a service for many clients not just for a single client.
  - Therefore, we can say that client-server follows the many-to-one relationship. Many clients can use the service of one server.
  - Services are required frequently, and many users have a specific client-server application program.
  - For example, the client-server application program allows the user to access the files, send e-mail, and so on. If the services are more customized, then we should have one generic application program that allows the user to access the services available on the remote computer.

Advantages of Client-server networks:

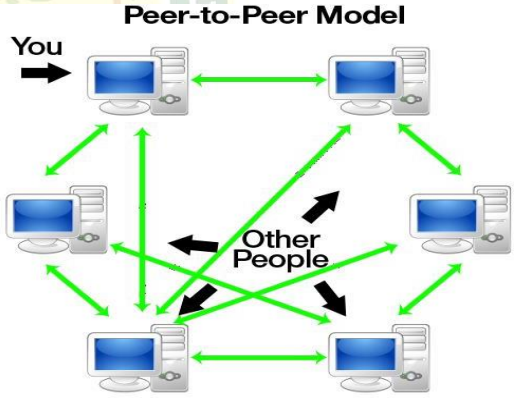
- Centralized: Centralized back-up is possible in client-server networks, i.e., all the data is stored in a server.
- Security: These networks are more secure as all the shared resources are centrally
- administered.
- Performance: The use of the dedicated server increases the speed of sharing resources. This increases the performance of the overall system.
- Scalability: We can increase the number of clients and servers separately, i.e., the new element can be added, or we can add a new node in a network at any time.

Disadvantages of Client-Server network:

- Traffic Congestion is a big problem in Client/Server networks. When a large number of clients send requests to the same server may cause the problem of Traffic congestion.
- It does not have a robustness of a network, i.e., when the server is down, then the client requests cannot be met.

Peer-to-Peer Network

- The Peer-to-Peer network is also called P2P or computer-to-computer network.
- 'Peers' are the nodes or computer system which is connected to each other.
- In this kind of network, each node is connected to each other node in the network.
- The nodes can share printers or CDROM drives, and allow other devices to read or write to its hard disk, allowing sharing of files, access to its internet connection, and other resources.
- Files or resources can be shared directly between the systems on the network, without the need of any central server.
- Such kind of network, where we allow nodes to become a server and share things in this manner, can be referred to as a peer-to-peer network.



- In a peer-to-peer network, each node can work as either a server as well as a client.
- This network does not distinguish between the client or server. Each of the nodes can act as both client/servers depending on whether the node is requesting or providing the service. All the nodes are functionally equal and can send or receive data directly with one another.

Advantages of using a peer-to-peer network:

- Easy to implement and manage.
- Nodes or workstations are independent of one another. Also, no access permissions are needed.
- The network is reliable in nature. If a peer fails, it will not affect the working of others.
- There is no need for any professional software in such kind of networks.
- The cost of implementation of such networks is very less.

Disadvantages of using a peer-to-peer network

- Storage is decentralized, and also not so efficiently managed.
- No data backup options are available in peer-to-peer networks.
- These kinds of networks are not so secure.

Hybrid Network:

- Hybrid networks are the networks that are based on both peer-to-peer & client-server relationship.
- Hybrid networks incorporate the best features of workgroups in peer-to-peer networks with the performance, security and reliability of server-based networks.
- Hybrid networks still provide all of the centralized services of servers, but they also allow users to share and manage their own resources within the workgroup.

Advantages of Hybrid Network

- Client Server application are still centrally located and managed.
- Users can assign local access to resources in their computers.

Disadvantages of Hybrid Network

- Users may need to remember multiple passwords.
- Files can be duplicated and changes overwritten between the computers with the shared folder and the Server.
- Files saved on the workstation are not backed up.

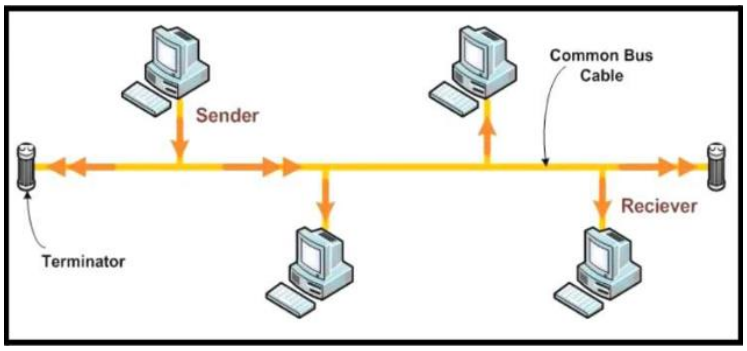
Network Topologies:

- A Network Topology is the pattern in which nodes (I.e. computers, printers, routers or the devices) are connected to a local area network (LAN) or other networks.
- There are two basic categories of network topologies:
  - **Physical topology:** It defines how the nodes of the network are physically connected. The shape of the cabling layout used to link devices is called the physical topology of the network.
  - **Logical topology:** It defines how the data is transmitted between the nodes. It refers to the nature of the paths that the signals follow from one node to another node.
- There are 6 types of topologies:
  - Bus, Ring, Star, Mesh, Tree, Hybrid

Bus Topology:

- In bus topology there is a main cable and all the devices are connected to this main cable through drop lines.
- Here one long cable act as a backbone to link all the devices that are connected to the backbone.
- It transmits the data from one end to another in single direction.
- No bi-directional feature is in bus topology.

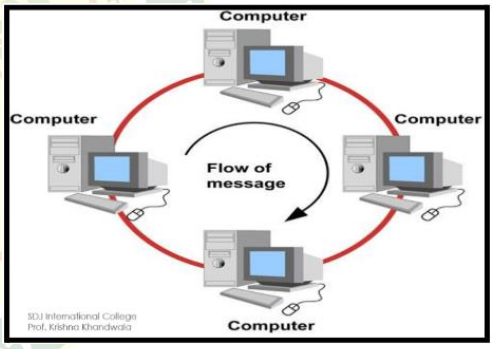
- A bus topology with shared backbone cable. The nodes are connected to the channel via drop lines.
- When a device sends a message, it is broadcasted down on the cable in both the directions and the terminators at the end of the cable prevent the signal from reflecting back to the sender.



- **Advantages:**
  - Ease of installation.
  - Less cabling.
  - Less expensive.
- **Disadvantages:**
  - Difficult reconfiguration and fault isolation.
  - Difficult to add new devices.
  - If any fault occurs in backbone, then it stops all transmission.
  - Collision occurs when 2 nodes send messages simultaneously.
  - Bad connection of the cable can bring down the entire network.

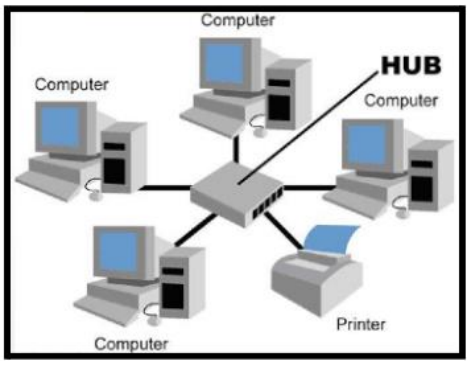
Ring Topology:

- In this topology, each device has a dedicated connection with two devices on either side.
- The signal is passed in one direction from device to device until it reaches the destination and each device have repeater.
- When one device received signals instead of intended another device, its repeater then regenerates the data and passes them along.



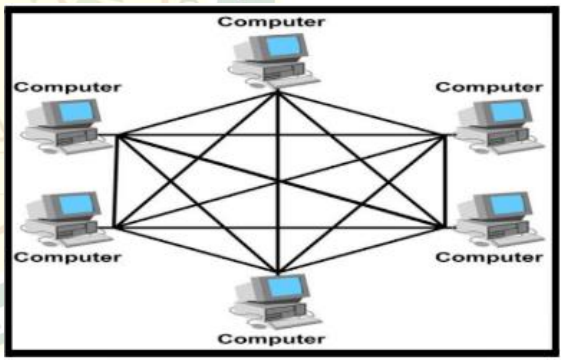
- This structure forms a ring thus it is known as ring topology. If a device wants to send data to another device, then it sends the data in one direction.
- Each device in ring topology has a repeater, if the received data is intended for other device, then repeater forwards this data until the intended device receives it.
- **Advantages:**
  - Easy to install.
  - Easy to reconfigure.
  - Managing is easier as to add or remove a device from the topology only two links are required to be changed.
  - Fault identification is easy.
- **Disadvantages:**
  - Unidirectional traffic. Data traffic issues, since all the data is circulating in a ring.
  - Break in a single ring can break entire network.

Star Topology:



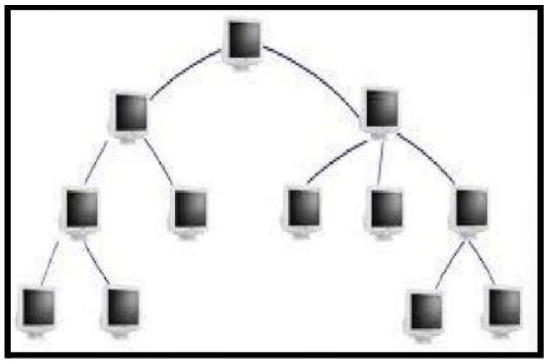
- In this type of topology, each device has a dedicated point-to-point link to the central controller called "HUB".
- The hub acts as an exchanger.
- There is no direct traffic between devices.
- The transmission occurs only through the central "hub".
- **Advantages:**
  - Robustness (If one link fails, only that links is affected. All other links remain active).
  - Easy fault identification & to remove parts.
  - No disturbance to the network while connecting or removing devices.
- **Disadvantages:**
  - Dependency: [whole network depends on one single point (i.e. hub)]. When it goes down, the whole system is dead.
  - The communications in the network will stop if the host computer stops functioning.
  - More cabling is required as compared to bus and ring topology.

Mesh Topology:



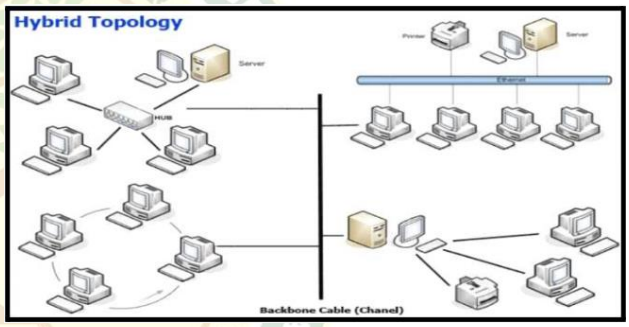
- In this type of topology, every device has a point-to-point link to every other device.
- When we say dedicated, it means that the link only carries data for the two connected devices only.
- Let's say we have n devices in the network then each device must be connected with (n-1) devices of the network. Number of links in a mesh topology of n devices would be n(n-1)/2.
- **Advantages:**
  - They use dedicated links so each link can only carry its own data load. So traffic problem can be avoided.
  - It is robust. If one link gets damaged it does not affect others.
  - It gives privacy and security. (Message travels through the dedicated link)
  - Fault identification and fault isolation are easy.
  - Data is reliable because data is transferred among the devices through dedicated channels or links.
- **Disadvantages:**
  - The amount of cabling required are very large.
  - Hardware required to connect each device is highly expensive.

Tree Topology:



- Also known as star bus topology.
- Tree topology is one of the most common network setups which combines bus topology and star topology.
- A tree topology connects multiple star networks to other star networks using bus network as central connection.
- **Advantages:**
  - Other hierarchical networks are not affected if one of them gets damaged.
  - Easier maintenance and fault finding.
- **Disadvantages:**
  - Huge cabling is needed.
  - If backbone is damaged then it reflects for the failure of whole network.

Hybrid Topology:

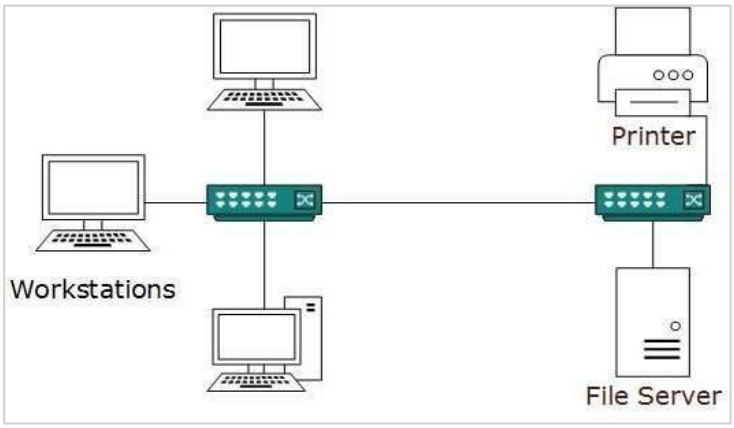


- A network which connects different types of networks (i.e., bus, ring and star or any other) under a single backbone channel is known as hybrid topology.
- **Advantages:**
  - Reliable: It has far better fault tolerance. The section where fault is found could possibly be removed out from rest of the network and required restoring steps could be taken, without impacting the working of rest of the network.
  - Effective: The weakness of the different connected topologies are disregarded and only the strengths are taken into considerations.
- **Disadvantages:**
  - Complexity: Due to the fact that different topologies connected in a hybrid topology, managing the topology gets challenging. It is not easy to design this type of architecture and it's a difficult job for designers. Configuration and installation process becomes very complex.
  - Expensive: The network hubs needed for hybrid topology are costly to purchase and maintain.

Network Types (based on their Geographical Coverage or Scale):

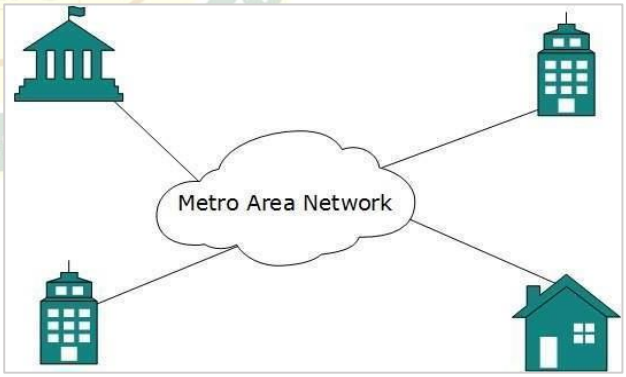
LAN (Local Area Network):

- A network that serves users within a confined area such as a building or a campus.
- Designed to allow resources to be shared between personal computers or workstations.



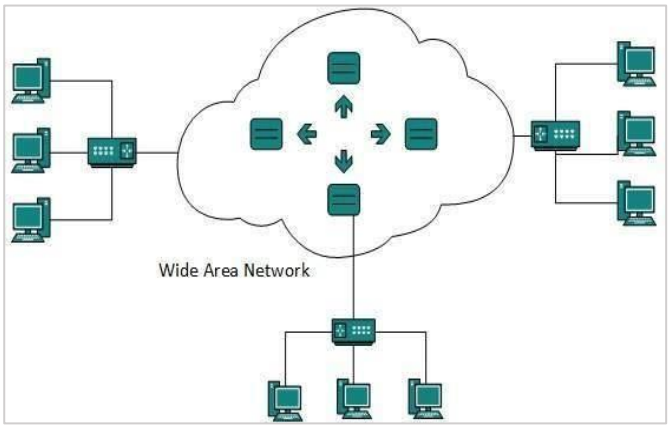
- The resources to be shared can include hardware (ex: a printer), software (ex: an application program) or data.
- Had data rates in the 4 to 16 megabits per second (Mbps) range.
- Today, however, speeds are normally 100 or 1000 Mbps.
- LANs are composed of inexpensive networking and routing equipment. It may contain local servers serving file storage and other locally shared applications. It mostly operates on private IP addresses and does not involve heavy routing. LAN works under its own local domain and controlled centrally.
- LAN uses either Ethernet or Token-ring technology.
- LAN can be wired, wireless, or in both forms at once.
- **Advantages:**
  - Provides fast data transfer rates and high-speed communication.
  - Easy to set up and manage.
  - Can be used to share peripheral devices such as printers and scanners.
- **Disadvantages:**
  - Limited geographical coverage.
  - Limited scalability and may require significant infrastructure upgrades to accommodate growth

MAN (Metropolitan Area Network):



- A network with a size between a LAN and a WAN. It normally covers the area inside a town or a city.
- The inter connection of networks in a city into a single larger network can be said to be a MAN network.
- A good example of MAN is part of Telephone company network that can provide a high-speed line to customers.
- **Advantages:**
  - Provides high-speed connectivity over a larger geographical area than LAN.
  - Can be used as an ISP for multiple customers.
- **Disadvantages:**
  - Can be expensive to set up and maintain.
  - May experience congestion and network performance issues with increased usage.

WAN (Wide Area Network):



- It provides long-distance transmission of data, image, audio, and video information over large geographic areas that may comprise a country, a continent, or even the whole world.
- The network allows multiple users to access a variety of host computers simultaneously through the same medium (i.e., Wireless [WiFi]).
- No wire is used but radio signals are the medium for communication.
- **Advantages:**
  - Covers large geographical areas and can connect remote locations.
  - Provides connectivity to the internet.
  - Offers remote access to resources and applications.
- **Disadvantages:**
  - Can be expensive to set up and maintain.
  - Offers slower data transfer rates than LAN or MAN.

Terminologies [Intranet, Internet, Unicast, Broadcast, Multicast]

Intranet

- An intranet is a private network contained within an enterprise that is used to securely share company information and computing resources among employees.
- An intranet can also be used for working in groups and teleconferences. Intranets encourage communication within an organization.

Internet

- Internet is a world-wide global system of interconnected computer networks. Internet uses the standard Internet Protocol (TCP/IP).
- Every computer in internet is identified by a unique IP address. IP Address is a unique set of numbers (such as 110.22).

Unicast

- In computer networking, unicast is a one-to-one transmission from one point in the network to another point; that is, one sender and one receiver, each identified by a network address.

Broadcast

- Broadcasting in computer network is a group communication, where a sender sends data to multiple receivers simultaneously.
- This is an all–to–all communication model where each sending device transmits data to all other devices in the network domain.

Multicast

- In computer networking, multicast is group communication where data transmission is addressed to a group of destination computers simultaneously.
- Multicast can be one-to-many or many-to-many distribution.
- Multicast should not be confused with physical layer point-to-multipoint communication.

Question Bank:

1. Define and explain the types of networks based on their roles.
2. Differentiate between Client-Server and Peer-to-Peer networks with at least three points.
3. Write advantages and disadvantages of Peer-to-Peer networks.
4. Explain with diagram how a Hybrid network works.
5. In what situations would you prefer a Client-Server network over Peer-to-Peer?
6. Define network topology. Why is it important in network design?
7. Draw and explain the structure of:
    a) Bus topology
    b) Ring topology
    c) Star topology
    d) Mesh topology
    e) Tree topology
8. Compare Star and Ring topologies.
9. List advantages and disadvantages of Mesh topology.
10. Which topology is best suited for large networks and why?
11. Explain with differences between LAN, MAN, and WAN
12. Define the following terms:
    a) Intranet
    b) Internet
    c) Unicast
    d) Broadcast
    e) Multicast
13. Differentiate between:
    a) Internet and Intranet
    b) Unicast and Broadcast
    c) Broadcast and Multicast