

Unit-1 Basics of Computer Networks

1.1 Definition and Need of networks

Interconnection of two or more computing devices (like mobile, tablet, computer, laptop etc) Such that they can communicate with each other and allow sharing of resources and information e.g. computer network, mobile network, internet etc.

Need of networks:

The following are the potential needs for computer networks.

- **File sharing:** Networking of computers helps the network users to share data files.
- **Information exchange:** To exchange data and information between different individual users, it is necessary to interconnect the individual users' computers.
- **Hardware sharing:** Users can share devices such as printers, scanners, CD-ROM drives, hard drives etc. Without computer networks, device sharing is not possible.
- **Application sharing:** Applications can be shared over the network, and this allows to implement client/server applications
- **User communication:** Networks allow users to communicate using e-mail, newsgroups, and video conferencing etc.

1.2 Categories of Computer Networks base on scope and connection

Types of Network

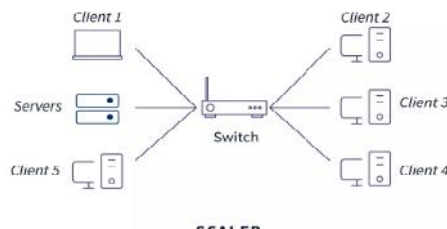
Based on Scope/Area

Depending on geographical area covered by network

1. LAN (Local Area Network)
2. MAN (Metropolitan Area Network)
3. WAN (Wide Area Network)

LAN (Local Area Network)

- A network is a group of two or more connected computers,
- LAN is a network contained within a small geographic area, usually within the same building.
- Home Wi-Fi networks and small business networks are common examples of LANs.
- The group of computers and devices are connected together by a switch, or stack of switches, using a private addressing scheme as defined by the TCP/IP protocol
- LANs had data rates in the 4 to 16 Mbps range
- A LAN typically relies mostly on wired connections for increased speed and security, but wireless connections can also be part of a LAN.



- Advantages:

1. Provides fast data transfer rates and high-speed communication.
2. Easy to set up and manage.
3. Can be used to share peripheral devices such as printers and scanners.
4. Provides increased security and fault tolerance compared to WANs.

- Disadvantages:

1. Limited geographical coverage.
 2. Limited scalability and may require significant infrastructure upgrades to accommodate growth.
- May experience congestion and network performance issues with increased usage

- Applications:

1. LAN is used for school environment, offices, hospitals etc as it allows sharing of resources like sharing data, scanners, printing and internet.
2. LAN serves users at home to access internet.
3. LAN's are widely used in manufacturing industries where a central server coordinates the activities of other machines.
4. High speed LANs are typically used to connect many slower networks together.

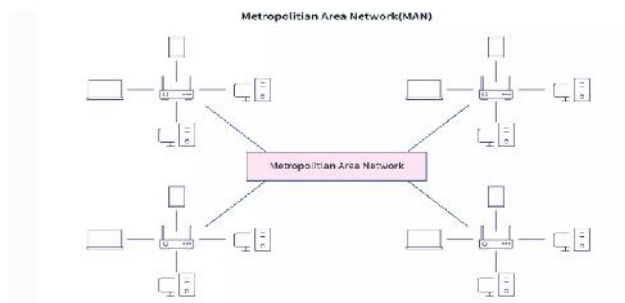
MAN (Metropolitan Area Network)

- MAN or Metropolitan area Network covers a larger area than that covered by a LAN and a smaller area as compared to WAN.
- MAN has a range of 5-50km.
- It connects two or more computers that are apart but reside in the same or different cities.
- It covers a large geographical area and may serve as an ISP (Internet Service Provider).
- MAN is designed for customers who need high-speed connectivity.
- Speeds of MAN range in terms of Mbps.
- It's hard to design and maintain a Metropolitan Area Network
- Advantages:

1. Provides high-speed connectivity over a larger geographical area than LAN.
2. Can be used as an ISP for multiple customers.
3. Offers higher data transfer rates than WAN in some cases.

- Disadvantages:

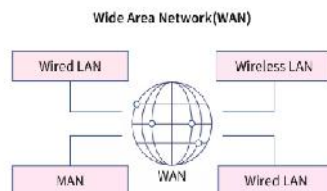
1. Can be expensive to set up and maintain.
2. May experience congestion and network performance issues with increased usage. May have limited fault tolerance and security compared to LANs



- Applications:
- Following are some of the uses of Metropolitan Area Network
 1. University Campus
 2. Airports
 3. Public libraries
 4. Hospitals
 5. Different branches of schools and colleges
 6. Cable Television

WAN (Wide Area Network)

- WAN or Wide Area Network is a computer network that extends over a large geographical area, although it might be confined within the bounds of a state or country.
- WAN has a range of above 50 km.
- A WAN could be a connection of LAN connecting to other LANs via telephone lines and radio waves and may be limited to an enterprise (a corporation or an organization) or accessible to the public.
- The technology is high-speed and relatively expensive
- There are two types of WAN: Switched WAN and Point-to-Point WAN.
- WAN is difficult to design and maintain.
- A Communication medium used for WAN is PSTN or Satellite Link. Due to long-distance transmission, the noise and error tend to be more in WAN.
- The speed of WAN ranges from a few kilobits per second (Kbps) to megabits per second (Mbps).
- Devices used for the transmission of data through WAN are Optic wires, Microwaves, and Satellites.
- An example of a Switched WAN is the asynchronous transfer mode (ATM) network and Point-to-Point WAN is a dial-up line that connects a home computer to the Internet
- Advantages:
 1. Covers large geographical areas and can connect remote locations.
 2. Provides connectivity to the internet.
 3. Offers remote access to resources and applications.
 4. Can be used to support multiple users and applications simultaneously.
- Disadvantages:
 1. Can be expensive to set up and maintain.
 2. Offers slower data transfer rates than LAN or MAN.
 3. May experience higher latency and longer propagation delays due to longer distances and multiple network hops.
 4. May have lower fault tolerance and security compared to LANs.



- Applications:
 1. Satellite systems
 2. Network providers
 3. Companies and offices

4. 4G mobile broadband systems
5. Internet
6. Telecommunication companies
7. A Network of bank cash dispensers
- **Comparisons of LAN ,MAN and WAN**

Parameters	LAN	MAN	WAN
Ownership of Network	Private	Private / Public	Private / Public
Geographical Area	1KM to 10 KM	10 KM to 100 KM	Beyond 100 KM
Design and maintenance	Easy	Difficult	Difficult
Propagation Delay	Short	Moderate	Long
Speed	High	Moderate	Low
Fault Tolerance	More Tolerant	Less Tolerant	Less Tolerant
Congestion	Less	More	More
Used for	College, School, Hospital.	Small towns, City.	Country/Continent.

1.3 Line configuration:

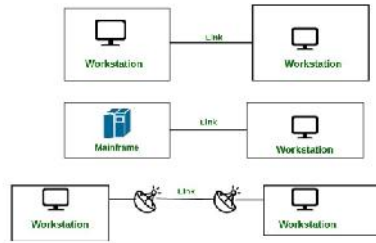
- A network is two or more devices connected through a link.
- A link is a communication pathway that transfers data from one device to another.
- Devices can be a computer, printer, or any other device that is capable to send and receive data. For visualization purposes, imagine any link as a line drawn between two points.
- For communication to occur, two devices must be connected in some way to the same link at the same time. There are two possible types of connections:

1. Point-to-Point Connection
2. Multipoint Connection

1. Point-to-Point Connection

- A point-to-point connection provides a dedicated link between two devices.
- The entire capacity of the link is reserved for transmission between those two devices.
- Most point-to-point connections use an actual length of wire or cable to connect the two ends, but other options such as microwave or satellite links are also possible.
- Point to point network topology is considered to be one of the easiest and most conventional networks topologies.
- It is also the simplest to establish and understand.

Example: Point-to-Point connection between the remote control and Television for changing the channels.



Advantages of Point-to-Point Connection:

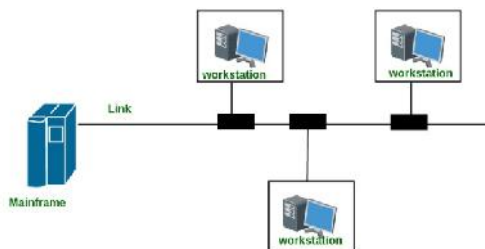
1. High Bandwidth.
2. Security
3. Reliability
4. Reduced Latency
5. Increased Control
6. Improved Performance.
7. Distance
8. Cost-Effective
9. Easy to Manage.

Disadvantages of Point-to-Point Connection:

1. Cost
2. Scalability
3. Maintenance
4. Limited Flexibility
5. Time-consuming Installation
6. Vulnerability to Failure
7. Limited Redundancy: .
8. Limited Collaboration
9. Limited Interoperability

2. Multipoint Connection

- It is also called Multidrop configuration. In this connection, two or more devices share a single link.
- If more than two devices share the link then the channel is considered a 'shared channel'. With shared capacity, there can be two possibilities in a Multipoint Line configuration:
- Spatial Sharing: If several devices can share the link simultaneously, it's called spatially shared line configuration.
- Temporal (Time) Sharing: If users must take turns using the link, then it's called Temporally shared or Time Shared Line configuration.



Advantages

1. Cost-Effective
2. Scalability

3. Flexibility
4. Increased Efficiency
5. Simplified Management
6. Enhanced Collaboration
7. Improved Reliability:
8. Greater Access
9. Improved Security

Disadvantages

1. Limited Bandwidth
2. Security
3. Reliability
4. Latency
5. Complexity
6. Network Congestion
7. Limited Control
8. Interference
9. Limited Distance

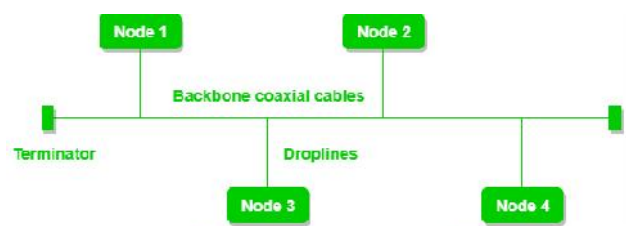
1.4 Network Topology

Types of network topology

1. Bus Topology
2. Star Topology
3. Ring Topology
4. Mesh Topology
5. Tree Topology

1. Bus Topology

- Bus Topology is a network type in which every computer and network device is connected to a single cable.
- It is bi-directional.
- It is a multi-point connection and a non-robust topology because if the backbone fails the topology crashes.
- In Bus Topology, various MAC (Media Access Control) protocols are followed by LAN ethernet connections like TDMA, Pure Aloha, CDMA, Slotted Aloha, etc

**Advantages:**

- It is the easiest network topology for connecting peripherals or computers in a linear fashion.
- It works very efficiently well when there is a small network.

- The length of cable required is less than a star topology.
- It is easy to connect or remove devices in this network without affecting any other device.
- Very cost-effective as compared to other network topology i.e. mesh and star
- It is easy to understand topology.
- Easy to expand by joining the two cables together.

Disadvantages:

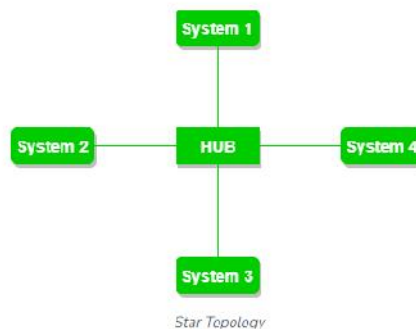
- Bus topology is not great for large networks.
- Identification of problems becomes difficult if the whole network goes down.
- Troubleshooting individual device issues is very hard.
- Need terminators are required at both ends of the main cable.
- Additional devices slow the network down.
- If the main cable is damaged, the whole network fails or splits into two.
- Packet loss is high.
- This network topology is very slow as compared to other topologies.

Applications

A common example of bus topology is the Ethernet LAN, where all devices are connected to a single coaxial cable or twisted pair cable. This topology is also used in cable television networks

2. Star Topology

- In Star Topology, all the devices are connected to a single hub through a cable.
- This hub is the central node and all other nodes are connected to the central node.
- The hub can be passive in nature i.e., not an intelligent hub such as broadcasting devices, at the same time the hub can be intelligent known as an active hub.
- Active hubs have repeaters in them. Coaxial cables or RJ-45 cables are used to connect the computers.
- In Star Topology, many popular Ethernet LAN protocols are used as CD (Collision Detection), CSMA (Carrier Sense Multiple Access), etc.

**Advantages**

- If N devices are connected to each other in a star topology, then the number of cables required to connect them is N. So, it is easy to set up.
- Each device requires only 1 port i.e. to connect to the hub, therefore the total number of ports required is N.
- It is Robust. If one link fails only that link will affect and not other than that.
- Easy to fault identification and fault isolation.

- Star topology is cost-effective as it uses inexpensive coaxial cable.

Disadvantages

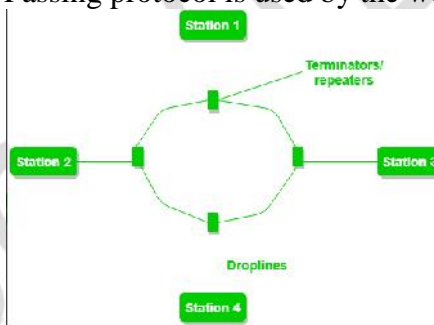
- If the concentrator (hub) on which the whole topology relies fails, the whole system will crash down.
- The cost of installation is high.
- Performance is based on the single concentrator i.e. hub.

Application:

A common example of star topology is a local area network (LAN) in an office where all computers are connected to a central hub. This topology is also used in wireless networks where all devices are connected to a wireless access point

3. Ring Topology

- In a Ring Topology, it forms a ring connecting devices with exactly two neighbouring devices.
- A number of repeaters are used for Ring topology with a large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node.
- Hence to prevent data loss repeaters are used in the network.
- The data flows in one direction, i.e. it is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called Dual Ring Topology.
- In-Ring Topology, the Token Ring Passing protocol is used by the workstations to transmit the data

**Advantages**

- The data transmission is high-speed.
- The possibility of collision is minimum in this type of topology.
- Cheap to install and expand.
- It is less costly than a star topology.

Disadvantages

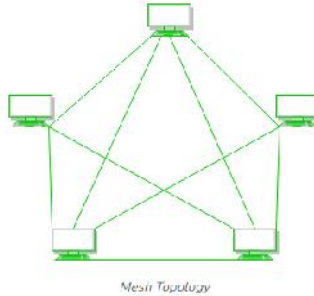
- The failure of a single node in the network can cause the entire network to fail.
- Troubleshooting is difficult in this topology.
- The addition of stations in between or the removal of stations can disturb the whole topology.
- Less secure.

Applications:

- The most common access method of ring topology is token passing.
- Token passing: It is a network access method in which a token is passed from one node to another node.
- Token: It is a frame that circulates around the network

4. Mesh Topology

- In a mesh topology, every device is connected to another device via a particular channel.
- In Mesh Topology, the protocols used are AHCP (Ad Hoc Configuration Protocols), DHCP (Dynamic Host Configuration Protocol), etc.



Advantages:

- Communication is very fast between the nodes.
- Mesh Topology is robust.
- The fault is diagnosed easily. Data is reliable because data is transferred among the devices through dedicated channels or links.
- Provides security and privacy.

Disadvantages:

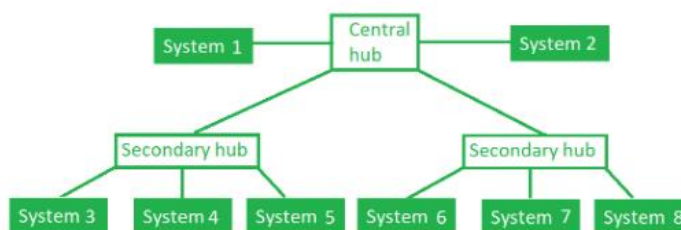
- Installation and configuration are difficult.
- The cost of cables is high as bulk wiring is required, hence suitable for less number of devices.
- The cost of maintenance is high.

Applications:

- A common example of mesh topology is the internet backbone, where various internet service providers are connected to each other via dedicated channels.
- This topology is also used in military communication systems and aircraft navigation systems.

5. Tree Topology

- This topology is the variation of the Star topology.
- This topology has a hierarchical flow of data.
- In Tree Topology, protocols like DHCP and SAC (Standard Automatic Configuration) are used.
- In this, the various secondary hubs are connected to the central hub which contains the repeater.
- This data flow from top to bottom i.e. from the central hub to the secondary and then to the devices or from bottom to top i.e. devices to the secondary hub and then to the central hub.
- It is a multi-point connection and a non-robust topology because if the backbone fails the topology crashes.



Advantages

- It allows more devices to be attached to a single central hub thus it decreases the distance that is travelled by the signal to come to the devices.
- It allows the network to get isolated and also prioritize from different computers.
- We can add new devices to the existing network.
- Error detection and error correction are very easy in a tree topology.

Disadvantages

- If the central hub gets fails the entire system fails.
- The cost is high because of the cabling.
- If new devices are added, it becomes difficult to reconfigure.

Applications

- A common example of a tree topology is the hierarchy in a large organization.
- At the top of the tree is the CEO, who is connected to the different departments or divisions (child nodes) of the company.
- Each department has its own hierarchy, with managers overseeing different teams (grandchild nodes).
- The team members (leaf nodes) are at the bottom of the hierarchy, connected to their respective managers and departments.

1.5 Standard Organizations and Protocols

Standard Organizations for Data Communication:

1) International Standard Organization (ISO) –

ISO is the International Organization for Standardization. It creates set of rules and standards for graphics, document exchange, data communication etc.

2) Consultative Committee for International Telephony and Telegraphy (CCITT) –

CCITT is now standard organization for the United States. CCITT developers recommended set of rules and standards for telephone and telegraph communication.

3) American National Standard Institute (ANSI) –

ANSI is primary organization for fostering the development of technology standards in the United States and providing various set of rules and standard for Data Communication.

4) Institute of Electrical and Electronic Engineering (IEEE) –

It is US based professional organization of electronic, computer and communication engineering. It provides various set of rules and standard in communication and networking field.

5) Electronic Industries Association (EIA) –

This organization establishes and recommends industrial standards. EIA has developed the RS (Recommended Standards) series of Standards for data and telecommunication.

6) International Telecommunication Union (ITU)

The ITU Telecommunication Standardization Sector is one of the three Sectors of the International Telecommunication

7) Internet Engineering Task Force (IETF)

The Internet Engineering Task Force (IETF), founded in 1986, is the premier standards development organization (SDO) for the Internet.

8) Internet Society (ISOC)

The Internet Society (ISOC) is an American non profit advocacy organization founded in 1992 with local chapters around the world. Its mission is "to promote the open development, evolution, and use of the Internet for the benefit of all people throughout the world." It has offices in Reston, Virginia, U.S., and Geneva, Switzerland.

1.6 Applications and features of different types of servers:**What is Server?**

- Server is a computer or device on a network that manages network sources.
- Server is main computer in which network operating system is loaded.
- Two types of server
 1. Dedicated server
 2. Non dedicated server

Dedicated server

- A Dedicated server is a server that is hosted by a company and only allows one client company to access the server.
- The word "dedicated" comes from it being "dedicated" to the one client.
- No other clients are allowed to use it. A dedicated server is used to host applications and services.
- Advantages:
 1. Response time is very fast
 2. It cannot be used as individual computer
 3. More reliable, more efficient and more secure.
- Disadvantages:
 1. All data is stored on a single server, if server fails all data becomes unavailable.
 2. Design, proper management and backup is essential

Non dedicated server

- If users interact directly with server then it is known as a non dedicated server.
- Non-dedicated servers are not dedicated to any one website or client.
- Do double duty by requesting and providing service.
- It is computer which is made as a server to control network and acts as an individual computer also.
- If computer system consists of a network operating system it can be used as a workstation.

Comparisons between dedicated server and non dedicated server

Dedicated server	Non-dedicated server
It hosts a single website.	It hosts multiple websites.
It is expensive as a single website owner bears the cost.	It is an inexpensive option since multiple website owners share the total server maintenance cost.
The server resources and power are available for a single website.	Multiple websites share the server resources and power.
This server type positively impacts your website's loading time.	This server type negatively impacts your website's loading time.
It offers ample storage or disc space for your website.	It offers less storage or disc space for your website.
All the server bandwidth is available for your website.	The server bandwidth is shared among multiple websites hosted on the server.

1. File server:

- The central server in a computer network that is responsible for the storage and management of data files is called a File Server.
- In a File Server, users access a central storage space that acts as a medium to store the internal data
- The users can share information over a network without having to physically transfer files.
- The server administrator has given strict rules that which users have the access to the files. These rules include opening, closing, adding, deleting, and editing a file.

Features of File Server:

1. Multiple users can access files simultaneously.
2. Protocols are set for authorization.
3. FTP (File Transfer Protocol) and SFTP (Secure File Transfer Protocol) are used over the internet for accessing files.
4. Blocking multiple users from editing the same file at the same time is called File Locking.
5. One can use a download server for ease.

Advantages:

- Helps in resource and information sharing.
- Helps in central storage of data.
- Helps in connecting with multiple computers for sending and receiving information when accessing the network.
- Faster-problem-solving.
- Highly flexible and reliable.

Disadvantages:

- Costly setup.

- The risk from viruses and malware.
- It lacks independence.
- Requires time for constant administration.
- It lacks Robustness.

2. Print server

- A print server is a software application, network device or computer that manages print requests and makes printer queue status information available to end users and network administrators.
- Print servers are used in both large enterprise and small or home office (SOHO) networks
- Print servers accept print requests from computers, queue the requests, and then send the requests to specific printers. Print servers can also be physical or cloud-based.
- **Advantages:**
 1. Makes maximum use of a high-performance, expensive printer
 2. Everyone can share the networked printer
 3. Less maintenance as there is no need for each person or area to have a printer
 4. Once the print job is sent to the print server the client computer can get on with other things

Disadvantages:

1. If it fails then everyone is affected compared to individual printers
2. May be over-kill for a simple office set up
3. Requires some administration by someone

3. Mail server

- Email today is a fundamental part of most organizations.
- The simplest approach is to use an online service for email services. This will work, but an alternative is to deploy an email server on the network.
- This will manage all aspects of email - sending, receiving and storing emails
- It is similar to post office where mail is stored and sorted before being sent its final destination.
- Commonly used mail server include Microsoft exchange, Qmail, Exim and send mail

Advantages:

- 1. Each person can have their own business related inbox
- 2. Only authorized people can send or receive email
- 3. Spam can be filtered before cluttering up their inbox
- 4. Emails can be archived / stored to meet legal requirements that some companies have to adhere to.
- 5. Each inbox can be allocated a quota limit
- 6. Shared calendars can be set up

Disadvantages:

- 1. Email servers require technical expertise to manage
- 2. For a small organization, a remote email service may be more cost-effective

4. Proxy server

- A 'proxy' is a word meaning substitute or stand-in.
- Proxy server is computer that acts as a gateway between local network and internet within company
- Server receives clients requests and forwards them to other server

- Main function of proxy server are caching ,firewalling ,filtering and logging
- Security and performance are increases by proxy server.

Advantages:

1. Provides a fast internet experience
2. Reduces the bandwidth consumed over the internet link
3. Firewall can be set up to block unauthorized data packets

Disadvantages:

1. Can be tricky to set up
2. Not cost-effective for low bandwidth internet use
3. Must have an effective method of updating cached web pages otherwise clients are viewing out of date pages.

5. Web server

- Web server is a type of hosting where Hyper Text Transfer Protocol (HTTP) is used to respond requests made by the clients
- The response is shown in the form of a webpage.
- It is a must for the computers to have a web server programs whenever they are hosting websites
- Microsoft internet information server, Google web server, Apache are the popular examples for the web servers

Advantages:

- It also delivers best insight in way HTTP communication.
- It is more control able and flexible.
- It is hold in protective infrastructure.
- Easy to handle all applications
- You have to permission to set up of customizes server as per your needs.

Disadvantages:

- It may be more expensive compare to use of electronic website hosting.
- Harder to customize hosting service
- Due to overwhelm of server at any time, it can get down your website.