

# Basics of Computer Network

## UNIT-1

**Course Outcome:** Classify various types of networks base on their construction, usage and scope

# Topic Covered in this Unit

1.1 Definition & history of networks

1.2 Usage of Computer Networks

1.3 Standard Organizations and Protocols

1.4 Line Configuration

1.5 Network Topology

1.6 Categories of network

- Based on scope

- Based on Connection

1.7 Applications and features of different types of servers: File server, Print Server,

- Mail Server, Web Server, Proxy Server

# COMPUTER NETWORK: Definition

- Computer network is defined as **two or more computers and other devices connected in such a way that they can share data, information and resources.**
- **connected** by **wired: cables, telephone** lines, **wireless: radio waves, satellites**, or **infrared** light beams.
- A **computer network** is a system in which **multiple computers are connected to each other to share information and resources.**
- In large networks, **thousands of computers and other devices may be connected** through different Network connecting devices such as **hub, switch, router etc.**

# Basic Components of Network

❑ Components of a network include:

- **Computer systems** (nodes or hosts or clients)
- **Servers** : computer or device that **provides a service to another computer** program and its **user**, also known as the **client**.
- **Transmission media**-a path for electrical signals between devices.
- **Network interfaces**-devices that send and receive electrical signals.
- **Protocols**- rules or standards describing host communication.
- **Networking** and **Internetworking devices**

.

# History

- In the 1960s computers were housed in computer rooms and were connected together in order to share printers and disk space.
- In 1967 ARPA (Advance Research Project Agency) developed small network.
- In 1969 ARPA was connected four nodes of diff universities via IMP(Interface Message Processor).
- In 1972 Vint Cerf and Bob Kahn developed Transmission control protocol and Internetworking protocol for end to end package delivery.
- In 1973 internetworking protocol became TCP/IP.

# Characteristics of Network

- **Resource sharing-** such as program information, hardware regardless where they are physically located.
- **High reliability-** reliable to ensure that data and resources are always available when needed. E.g. Google drive.
- **Saving money:** less hardware required, like printer is share between many computers
- **Communication Speed:** quick and efficient, like video conference, emails,etc.
- **Scalability:** network can grow and handle more users or devices without losing performance.

# Characteristics of Network

- **Time saving:** email service required less time than postal service
- **Fault Tolerance:** For example, if two devices are connected by both wired and wireless means, and the wireless connection fails, the data can still be sent through the wired connection.
- This ensures that communication continues smoothly even if part of the network is down or damaged.
- **Security:** network allows security by ensuring that the user has the right to access certain files and applications.
- **High Performance:** Using multiple processors can enhance performance as per our need at any time.

# Usage of networks

- Efficient and effective resource management: e.g. printer sharing
- Data sharing is faster
- Access to remote information
- Interactive entertainment
- Cost saving



# Advantages of Computer Networks

- Efficient Management of Resources
- Saving Money
- High Reliability
- Efficient Communication
- Scalability

# Disadvantages of computer network

- The **loss of data and resources** can be caused **by network faults**.
- **Application may be unavailable** if there is a **problem with server**.
- Poses **security difficulties**.: cyber attacks, **hacking** etc.
- Allows for more presence of computer **viruses and malware**.
- Requires an **expensive setup and efficient handler**.
- It is difficult to manage large network

# APPLICATIONS/ Usage of Computer Networks

- Financial Services
- Marketing and sales
- Electronic Messaging
- Cellular Telephone
- Manufacturing
- Cable TV
- Video Conference
- Directory services
- Information services
- Electronic data interchange

# Need of 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 videoconferencing etc.**

# Categories of Computer Networks base on scope and connection

## **1. Based on Scope: geographic area**

**a) Local Area Network (LAN):**

**b) Metropolitan Area Network (MAN):**

**c) Wide Area Network (WAN):**

## 2. Based on Connection Type

### a) Wired Networks:

- **Definition:** Devices are **connected via physical cables** (e.g., Ethernet).
- **Advantages:** Faster, stable, and secure.
- **Disadvantages:** Limited mobility, installation can be cumbersome.

### b) Wireless Networks:

- **Definition:** Devices are **connected using radio waves or infrared signals**.
- **Examples:** Wi-Fi, Bluetooth, Cellular networks.
- **Advantages:** Greater mobility and ease of installation.
- **Disadvantages:** Prone to interference and less secure.

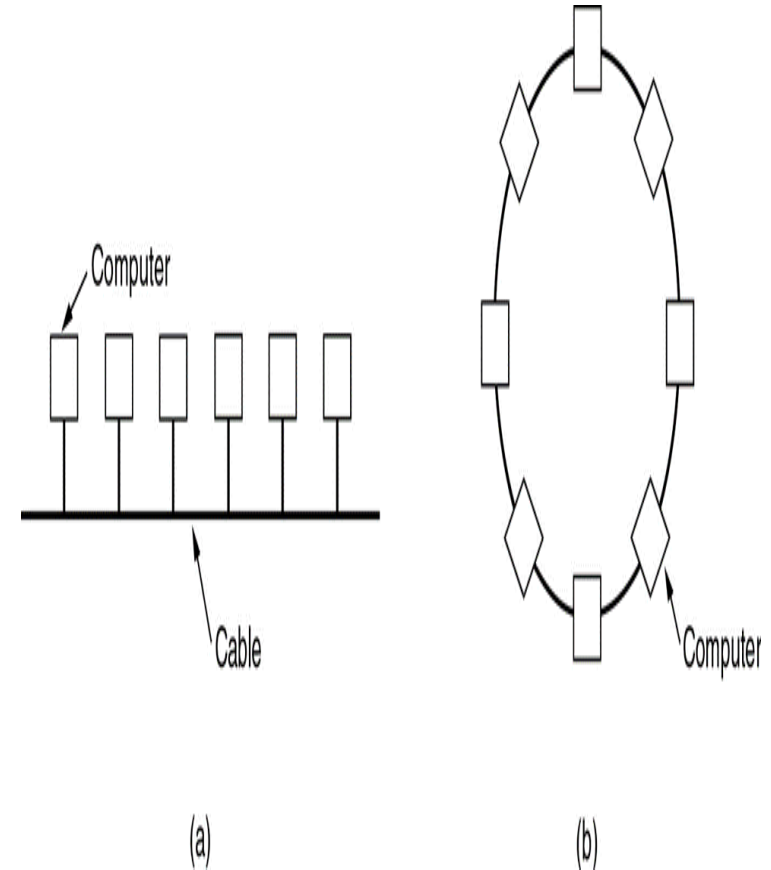
# Categories of Network

- There are three different categories based on geographical size.(based on scale)
- Local Area Network (LAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

# Local Area Network (LAN)

- A local area network (LAN) is a collection of devices connected together in one physical location, such as a building, office, or home.
- It is less expensive.
- A LAN can interconnect almost any type of computing device, such as mainframes, workstations, personal computers, file servers, and numerous peripheral devices.
- Data Transmission speed is more than 1 mbps.





# Components of LAN

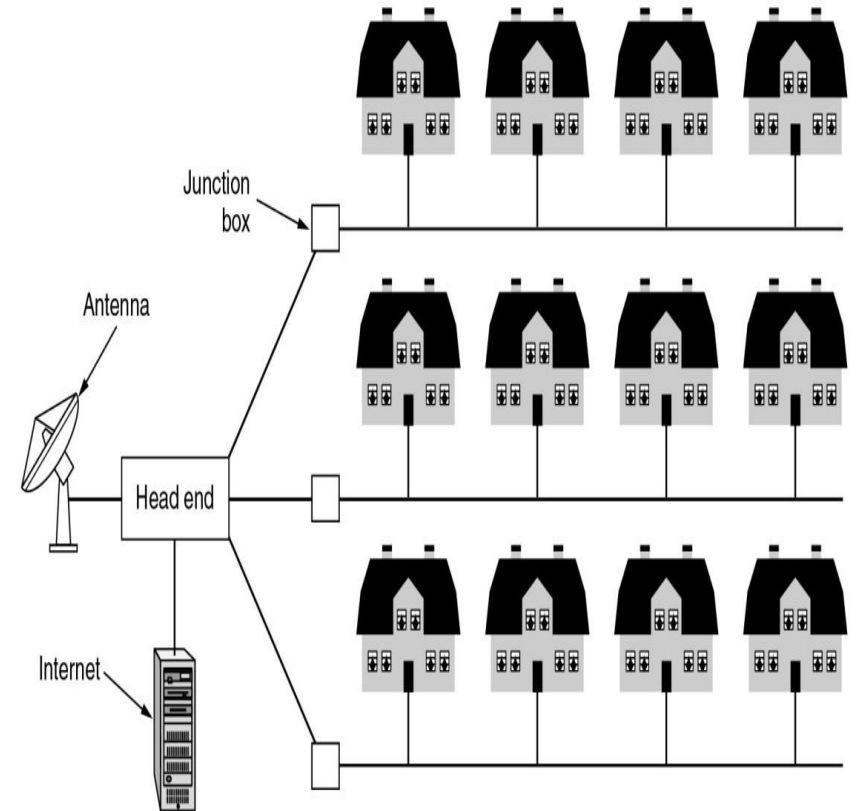
- Workstations and applications
- Network hardware which connects them (Network Interface Card)
- Network software which controls the system (Network OS)
- Local Area Networks (LANs) connect computers, minicomputers, mainframes, switches, and routers together. Basically a LAN extends as far as the LAN cable.

# LAN characteristics

- LANs are capable of **transmitting data at very fast rates because of limited distance** and limit on number of devices that can be attached to a single LAN.
- It is local (works within a finite distance in a limited geographic area such as an office, building or complex of closely-spaced buildings).
- **LANs can be wired or wireless. Twisted Pair, Co-axial or Fiber optic** cable can be used in wired LAN's. **Radio waves, infrared or micro waves** used in wireless LAN.
- It is used by a single organization

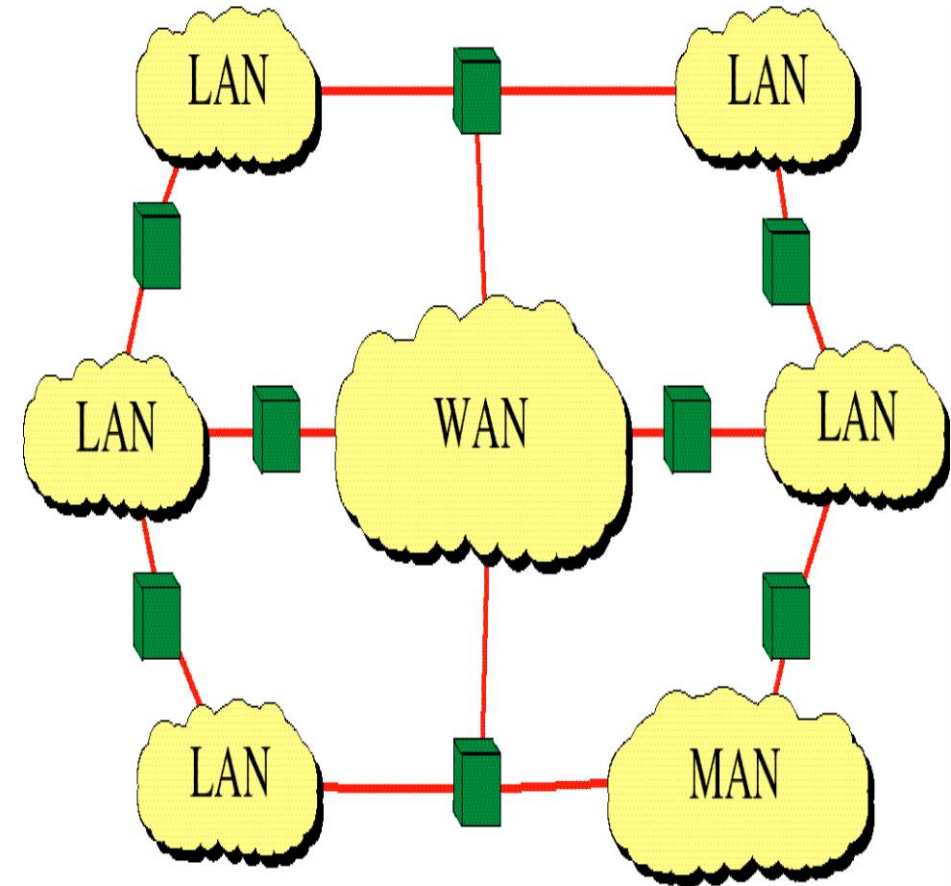
# Metropolitan Area Networks (MAN)

- A MAN (metropolitan area network) is a large network that usually **spans several buildings in the same city or town**
- The MAN network usually provides service to **ISPs, cable TV providers, or large corporations.**
- It is larger than a LAN, but smaller than a WAN
- **Covers area upto 5km to 50km in diameter.**



# Wide Area Network (WAN)

- communication among computers which are located far from each other and at a large distance. E.g. Among the countries or continent.
- Internet is one classic example of WAN.
- It is the collection of large number of computers connecting together to share information with each other and accessible from every where.

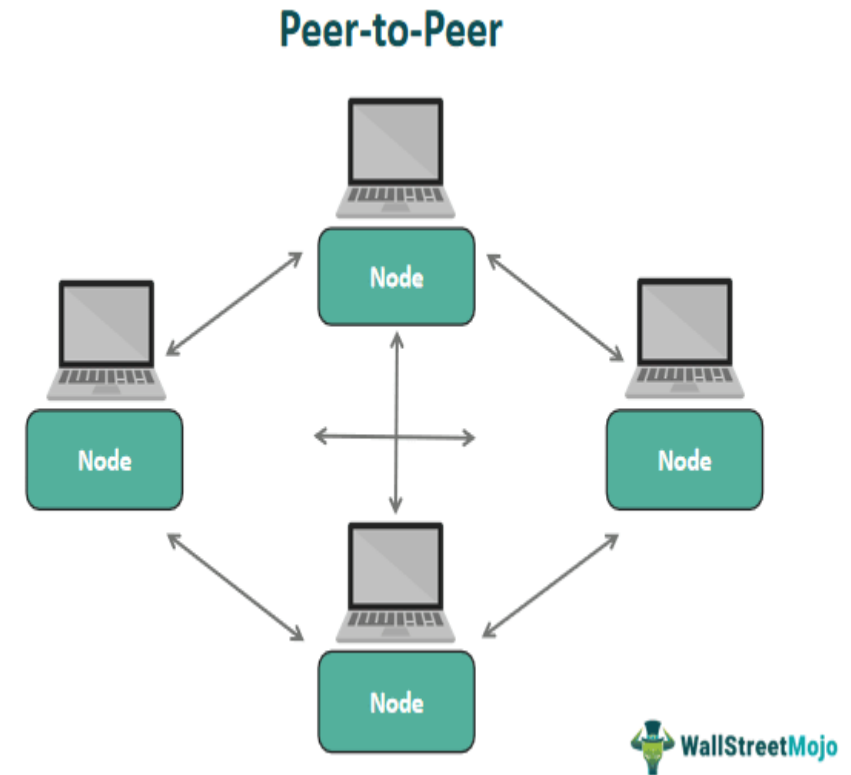


# Types of Networks:Based on Connection Type

- P2P: PEER TO PEER
- Client Server network

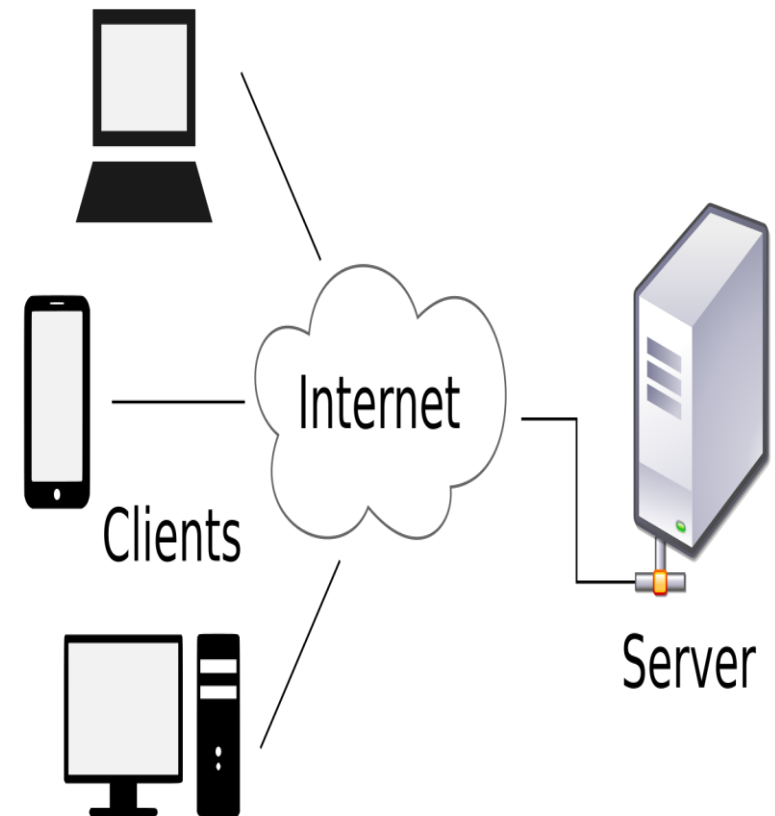
# Peer to Peer

- There are **no dedicated servers** or **hierarchy among the computers**.
- All of the **computers are equal** and act as both a client and a server, therefore known as **peers**.
- P2P networks are **decentralized, there is no central authority** or organization **that controls the network or its resources**.
- **Good choices** for needs of small organizations.
- Where the users are **allocated in the same general area, security** is not an issue.



# Client and Server networks

- A client-server network is a computing model where **multiple clients connect to a central server to access resources.**
- The **server manages and provides services to the clients, such as files, applications, and data**



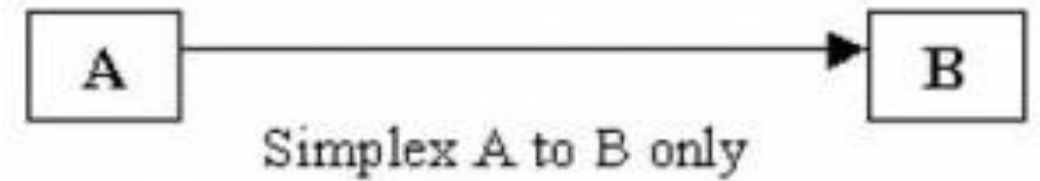
# Features of a client-server network:

- **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.**

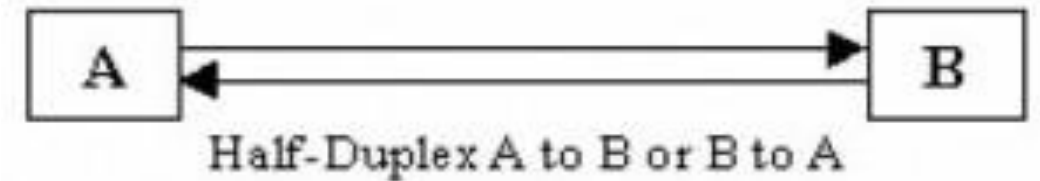


# Data Transmission Modes

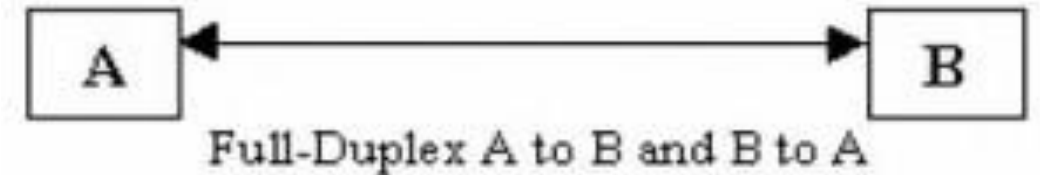
1. Simplex



2. Half Duplex



3. Full Duplex



# Simplex mode

- Communication **can take place only in one direction.**
- The receiver receives the signal from the transmitting device.
- This mode of **flow of information is Unidirectional.**
- Example: Radio, T.V., Pager transmission.

# Half-duplex mode

- Communication channel is used in both directions, but only in one direction at a time.
- Thus a half-duplex line can alternately send and receive data.
- Example is the walky talky.

# Full-duplex mode

- Communication channel is used in both directions at the same time.
- Use of full-duplex line improves the efficiency .
- Example of this mode of transmission is the telephone line.

# Protocol: Set Of Rules

- In computer networks, communication occurs between entities in different systems.
- An entity is anything capable of sending or receiving information.
- For communication to occur, the entities must agree on a protocol.
- ***A protocol is a set of rules that govern data communications. It defines what is communicated, how it is communicated, and when it is communicated.***
- Without a protocol ,two devices may be connected but can not communicate.

# Protocol

- Key elements of protocol
  - Syntax
  - Semantics
  - Timing
- *Syntax : refers to the structure or format of the data, i.e the order in which they are presented.*
- *Semantics: The word semantics refers to the meaning of each section of bits.*
- *Timing : refers to when data should be sent and how fast they can be sent.*

# Protocol

□ The Internet and web are built on such protocols (examples of internet protocol)

- Hyper-Text Transfer Protocol (HTTP)
- File Transfer Protocol (FTP)
- Transmission Control Protocol / Internet Protocol (TCP/IP)
- Simple Mail Transfer Protocol (SMTP)

# Standard Organization

- A standard provides a Model for development that makes it possible for products from different manufactures can work together and also essential for creating and maintaining an open and competitive market for manufactures.
- Networking wouldn't exist without standards.
- Data Communication standard: Two categories
  - De Facto(By Fact) : standards that have not been approved by an organized body but have been adopted as standard are de facto standards.
  - De jure (By Law) : standards that have been approved by an officially recognized body are de jure standards.



# Standard Organization

- The following organizations are developed by corporation among standard creation committee, forums and government regulatory agencies and also responsible for researching, developing, testing, and implementing the standards that make the Internet possible.
- **International Organization for Standardization (ISO)** : world's largest developer and publisher of international standards. Founded in 1946, 157 countries, one member per country, based in Geneva, Switzerland.
- **Consultative Committee for International Telegraphy and Telephony (CCITT)** : devoted to the research and establishment of standard for telecommunication.
- **Electronic Industries Association (EIA)** : it is a trade organization for electronics manufacturer in the US.

# Standard Organization

- **American National Standards Institute (ANSI)**: is a private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States.
- ANSI accredits standards that are developed by representatives of other standards organizations, government agencies, consumer groups, companies, and others.
- These standards ensure that the characteristics and performance of products are consistent, that people use the same definitions and terms, and that products are tested the same way.
- ANSI also accredits organizations that carry out product or personnel certification in accordance with requirements defined in international standards.

# Standard Organization

- **Institute of Electrical and Electronics Engineers (IEEE)** : it is the world's largest association of technical professionals with more than 423,000 members in over 160 countries around the world.
- Its objectives are the educational and technical advancement of electrical and electronic engineering, telecommunications, computer engineering and allied disciplines.
- The IEEE traces its founding to 1884 and the American Institute of Electrical Engineers. In 1912, the rival Institute of Radio Engineers was formed.
- Although the AIEE was initially larger, the IRE attracted more students and was larger by the mid 1950s.

# Standard Organization

- **International Telecommunication Union (ITU):** is a specialized agency of the United Nations responsible for all matters related to information and communication technologies.
- Established in 1865 as the International Telegraph Union it is one of the oldest international organizations in operation.
- Radio communication (ITU-R)
- Telecommunication (ITU-T)
- Development (ITU-D)

# Standard Organization

- **Internet Society (ISOC)**: The Internet Society (ISOC) is an American nonprofit organization founded in 1992 to provide leadership in Internet-related standards, education, access, and policy. 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, the United States, and Geneva, Switzerland.
- **Internet Engineering Task Force (IETF)**: The Internet Engineering Task Force (IETF) is an open standards organization, which develops and promotes voluntary Internet standards, in particular the standards that comprise the Internet protocol suite (TCP/IP)
- The IETF started out as an activity supported by the federal government of the United States, but since 1993 it has operated as a standards-development function under the auspices of the Internet Society, an international membership-based non-profit organization.

# Line Configuration

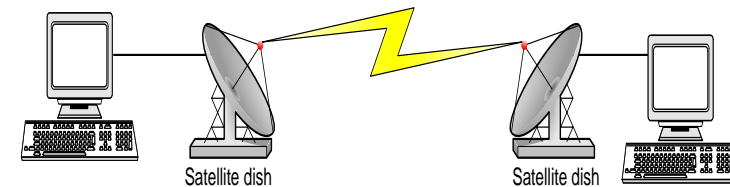
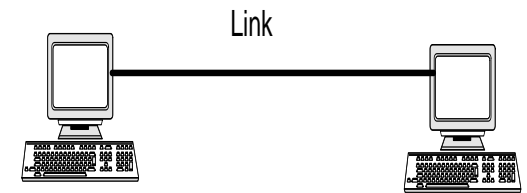
- Two or more devices connected through a link is a network.
- A link is a transmission path through which data is transfer between two or more device.
- A device can be a computer, printer, or any other device capable of sending or receiving data from the other node/device through the network.
- Types of Line Configurations
  - Point to Point connection
  - Multipoint connection

# Point to Point connection

1. It is a **dedicated communication link between two devices.**
2. It is **simple to set up, understand and maintain.**
3. It is **connected through cable or wire but satellite or microwave link is also possible.**

## ➤ Example

1. **Communication** between **Television** and **remote control** for changing the channels through **infrared ray.**
2. **A computer connected by a telephone line.**



# There are three types of P2P CONNECTION

- Unicast
- Multicast
- Broadcast



# Unicast (One-to-One):

- Unicast is a type of transmission in which information is sent from only one sender to only one receiver.
- In other words, Unicast transmissions occur between two nodes only.
- Unicast transmissions include http, SMTP, and telnet, where one sender requests information for only one recipient.

# Multicast (One-to-Many): -

- Multicast is a type of transmission in which information is sent from only one sender to a set of receivers.
- Multicast can be more efficient than unicast when different groups of receivers need to see the same data.
- The multicast technique is used for streaming video or audio teleconferences over the Internet, sending emails to specific recipients, etc. Multicast offers savings on bandwidth and is the preferred way of data communication when data is to be transmitted to a set of computers.

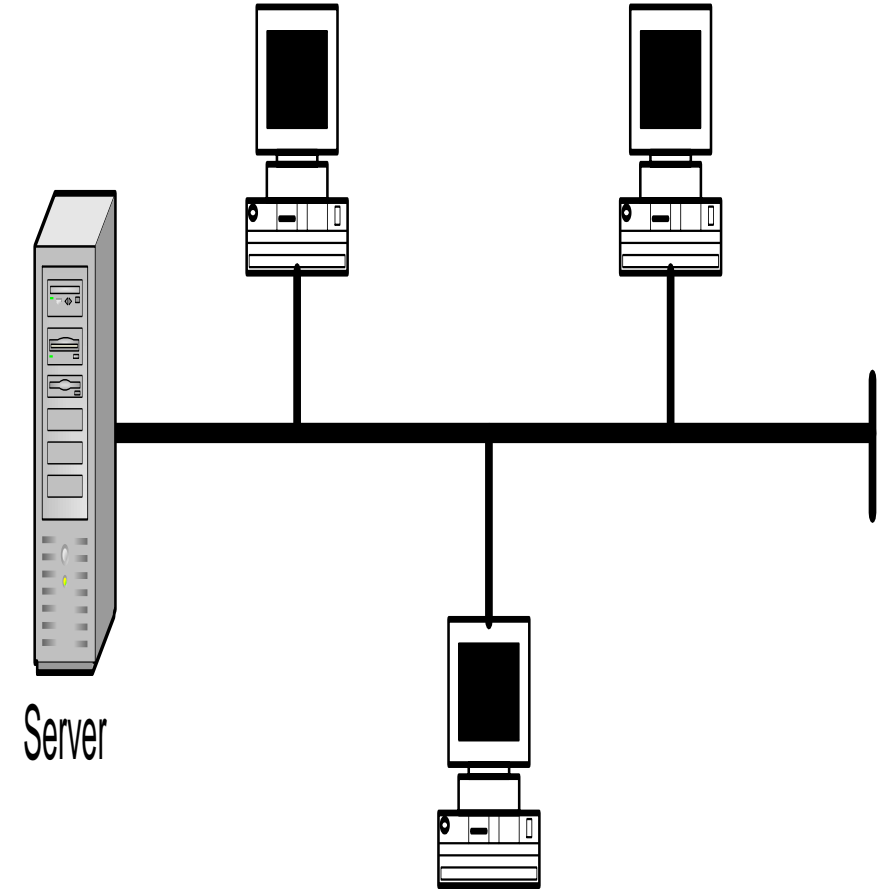
# Broadcast (One-to-All):

- Broadcast is a type of transmission in which information is sent from one computer but is received by all the computers connected to the network.
- This means that every time a computer or a node transmit a packet of type 'broadcast', all other computers will receive that packet.

# Multipoint connection

1. In this connection, **more than two computers are connected through a single link.**
2. It is also called a multidrop configuration.

- Example
- **ATM** is an example of **Multipoint connection**



# Network Topology

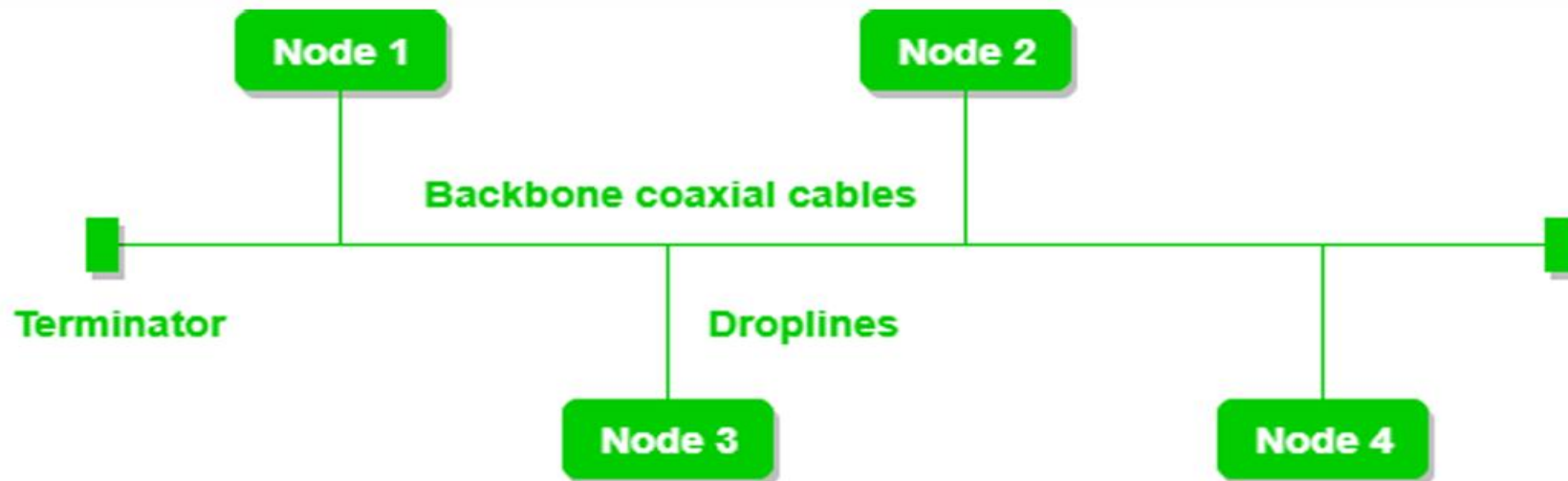
- **Network Topology** defines the **structure of the network of how all the components are interconnected to each other.**

## □ Different Types of Network Topology

- Mesh topology
- Star topology
- Bus topology
- Ring topology
- Tree topology
- Hybrid topology.

# 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.



# Advantages:-

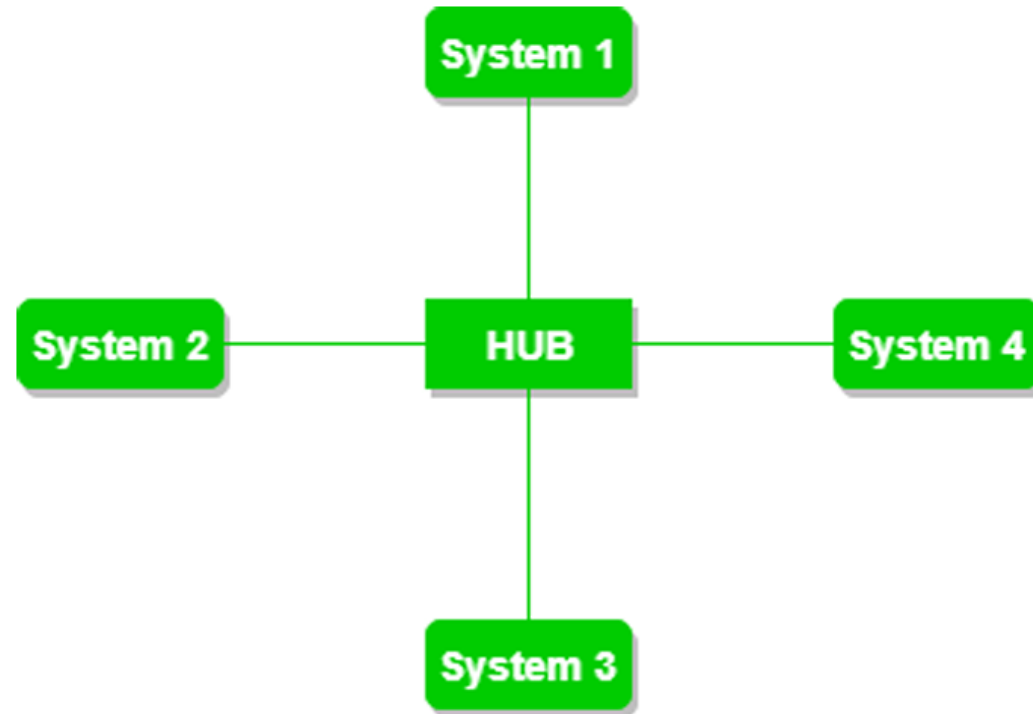
- Easy to connect a computer or peripheral to a linear bus.
- Requires less cable length than a star topology

# Disadvantages:-

- Entire network shuts down if there is a break in the main cable.
- Terminators are required at both the ends of the backbone cable.
- Difficult to identify the problem if the entire network shuts down.



# Star Topology



# 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.

# Advantages:-

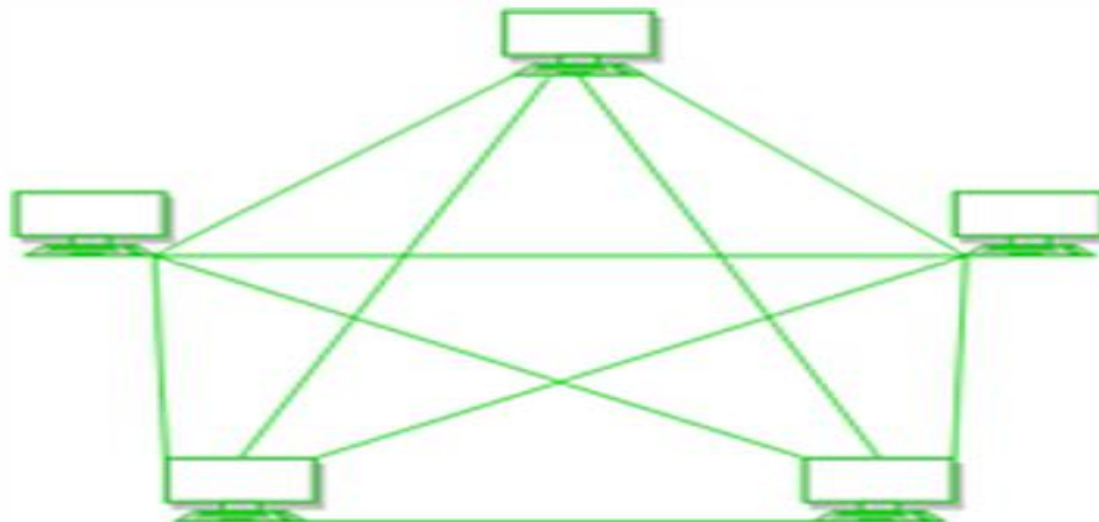
- Easy to install and wire.
- No disruptions to the network then connecting or removing devices.
- Easy to detect faults and to remove parts.

# Disadvantages:-

- Requires more cables length than a linear topology.
- If the hub or concentrator fails, nodes attached are disabled.
- More expensive than bus topologies because of the cost of the concentrators.
- Performance is based on the single concentrator i.e. hub.

# Mesh Topology

- Mesh topology is a type of network topology in which all devices in the network are interconnected.
- Each device with a point-to-point connection to every other device in the network.
- Mesh topologies use routers to determine the best path.



# Advantages:-

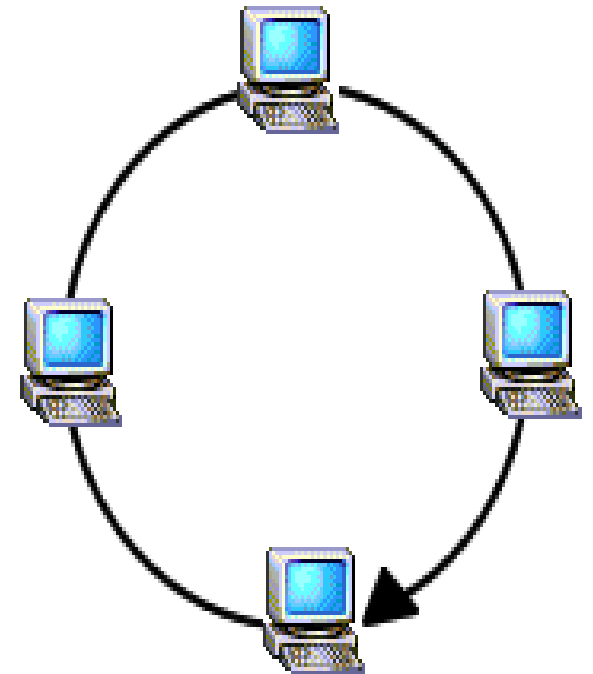
- Communication is very fast between the nodes.
- It is robust.
- The fault is diagnosed easily.
- Data is reliable because data is transferred among the devices through dedicated channels or links.(point to point connection)
- Provides security and privacy.

# 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. i.e. Expensive

# Ring Topology

- Computers are connected by a **single loop of cable**, the **data signals travel around the loop in one direction**, passing through each computer.
- Ring topology is an **active topology** because each **computer repeats** (boosts) the **signal before passing it** on to the next computer.
- One method of transmitting data around a ring is **called token passing**.
- Token passing is a method of sending data in a ring.
- A small packet called the token passed around the ring to each computer in turn.





# Ring Topology

- If a computer has information to send, it modifies the token, adds address information and the data and sends it down the ring.
- The information travels around the ring until it either reaches its destination or returns to the sender.
- When the intended destination computer receives the packet, it returns a message to the sender including its arrival.
- A new token is then created by the sender and sent down the ring, allowing another station to capture the token and begin transmission.

# Advantages of Ring topology

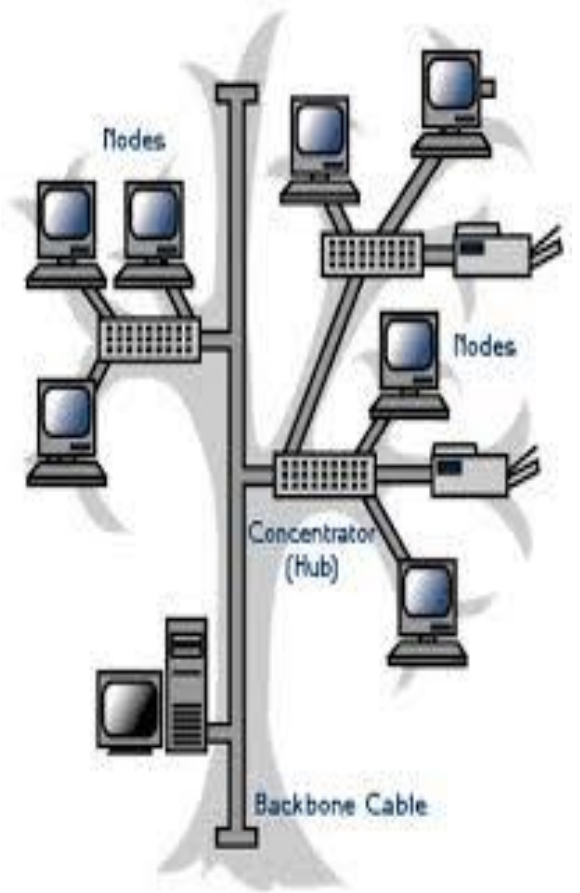
1. All the computers have equal access to the network.
2. Provides error checking and acknowledgement.
3. It is **easy to install** and reconfigure.
4. The network **performance remains the same even with many users**

# Disadvantages of Ring topology<sup>1</sup>

1. If one computer fails, the entire network can be affected.
2. It is difficult to troubleshoot the ring network.
3. Adding and removing computers disturbs the network.

# Tree Topology

- Tree topologies **have a root node**, and all other nodes are connected which form a hierarchy.
- So it is also known as hierarchical topology.
- This topology **combines various star topologies together in a single bus**, so it is known as a **Star Bus topology**.
- Tree topology is a very common network which is similar to a bus and star topology.
- Not every device plugs directly to central hub.
- The **majority of devices connect to secondary hub that in turn connected to central hub.**



# Tree Topology

- Active Hub: the active hub contains repeater ,which is a hardware device that regenerates the received bit patterns before sending them out.
- Passive hub : A Passive hub provides simple physical connection between the attached devices.
- The secondary hub may be active or passive.

# Advantages & Disadvantages of Tree Topology

- **Advantages**

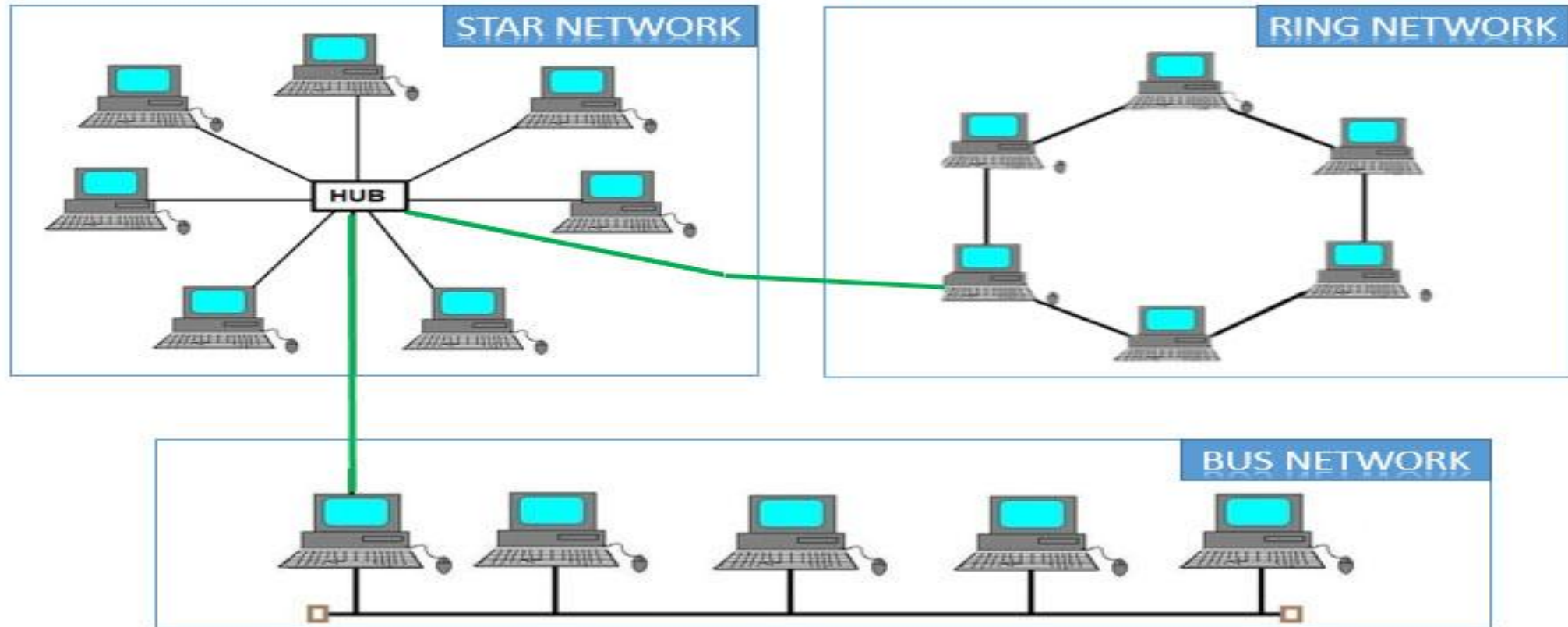
- More devices to be attached to a single central hub.
- It increase the distance a signal can travel between devices.
- Allows the network to isolate and prioritize the communication from different computers

- **Disadvantages**

- Overall length of each segment is limited by the type of cabling used
- If the backbone line breaks .the entire segment goes down
- More difficult to configure and wire than other topologies.

# Hybrid Topology

## HYBRID TOPOLOGY



# Hybrid Topology

- Mixture of two or more topologies in one network makes hybrid topology.
- **Advantages**
  - Reliable ,effective,flexible
  - Scalable and easy to maintain
- **Disadvantages**
  - Complex in design
  - Costly



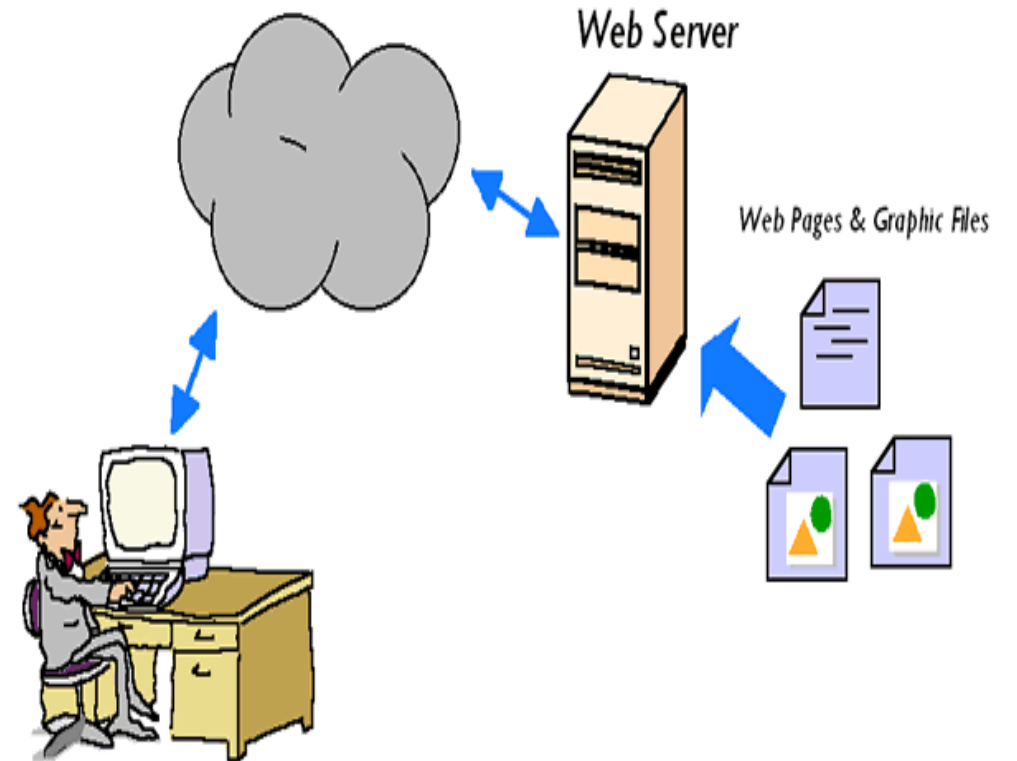
# Server

- A Server is a computer or device on a network that manages network resources.
- There are many number of server on a network.
- Server serves all the people on the network to share its resources.



# Web Servers

- Web server is computer that **delivers webpages.**
- A Web server **serves static content to a Web browser by loading a file from a disk and serving it across the network to a user's Web browser.**
- The browser and server talking to each other **using HTTP** mediate this entire exchange.

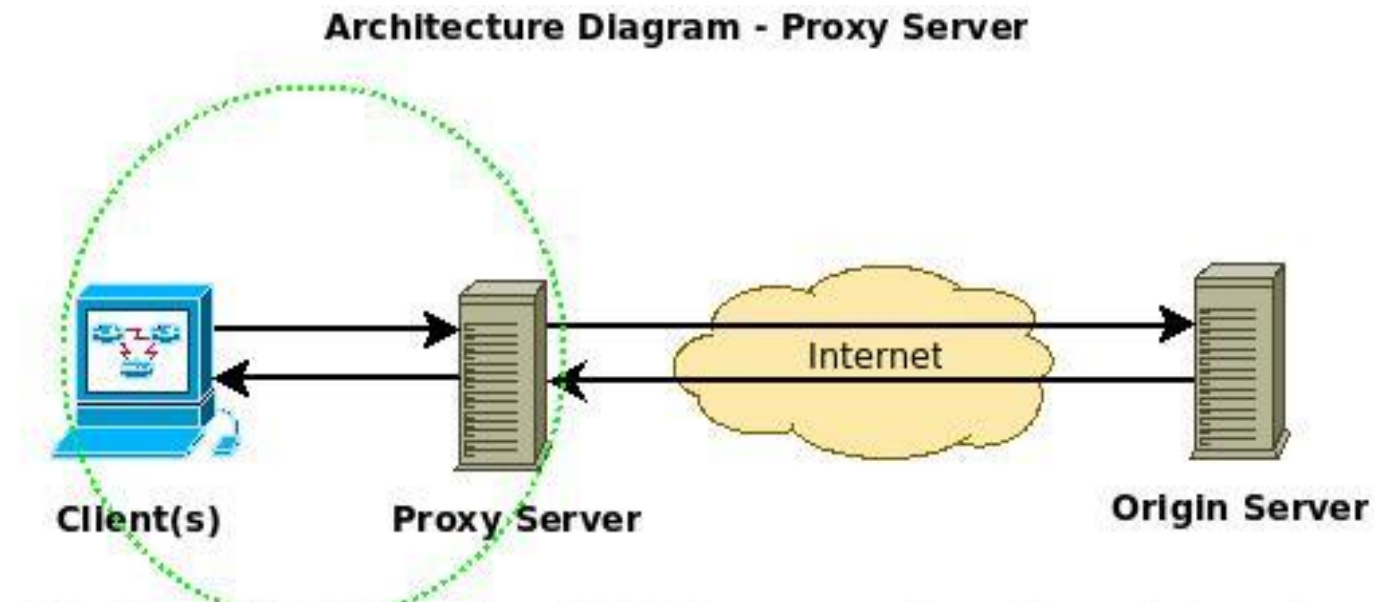


# Web Servers

- A web server is server software, or hardware dedicated to running this software, that can satisfy client requests on the World Wide Web. A web server can, in general, contain one or more websites. A web server processes incoming network requests over HTTP and several other related protocols.
- The primary function of a web server is to store, process and deliver web pages to clients.[1] The communication between client and server takes place using the Hypertext Transfer Protocol (HTTP). Pages delivered are most frequently HTML documents, which may include images, style sheets and scripts in addition to the text content.

# Proxy Server

- A proxy server is an **intermediary server that sits between a client and a destination server.**
- It **processes requests from clients seeking resources from other servers, forwarding those requests and returning the responses** back to the clients.



# Proxy Server

- A proxy server thus functions on behalf of the client when requesting service, potentially masking the true origin of the request to the resource server.
- This can enhance privacy, security, and performance.

# Application of Proxy Server

## ❑ Anonymity and Privacy:

- Proxy servers can mask a user's IP address, making their online activities more private.
- This is especially useful for individuals who want to browse the web without being tracked by websites or third parties.

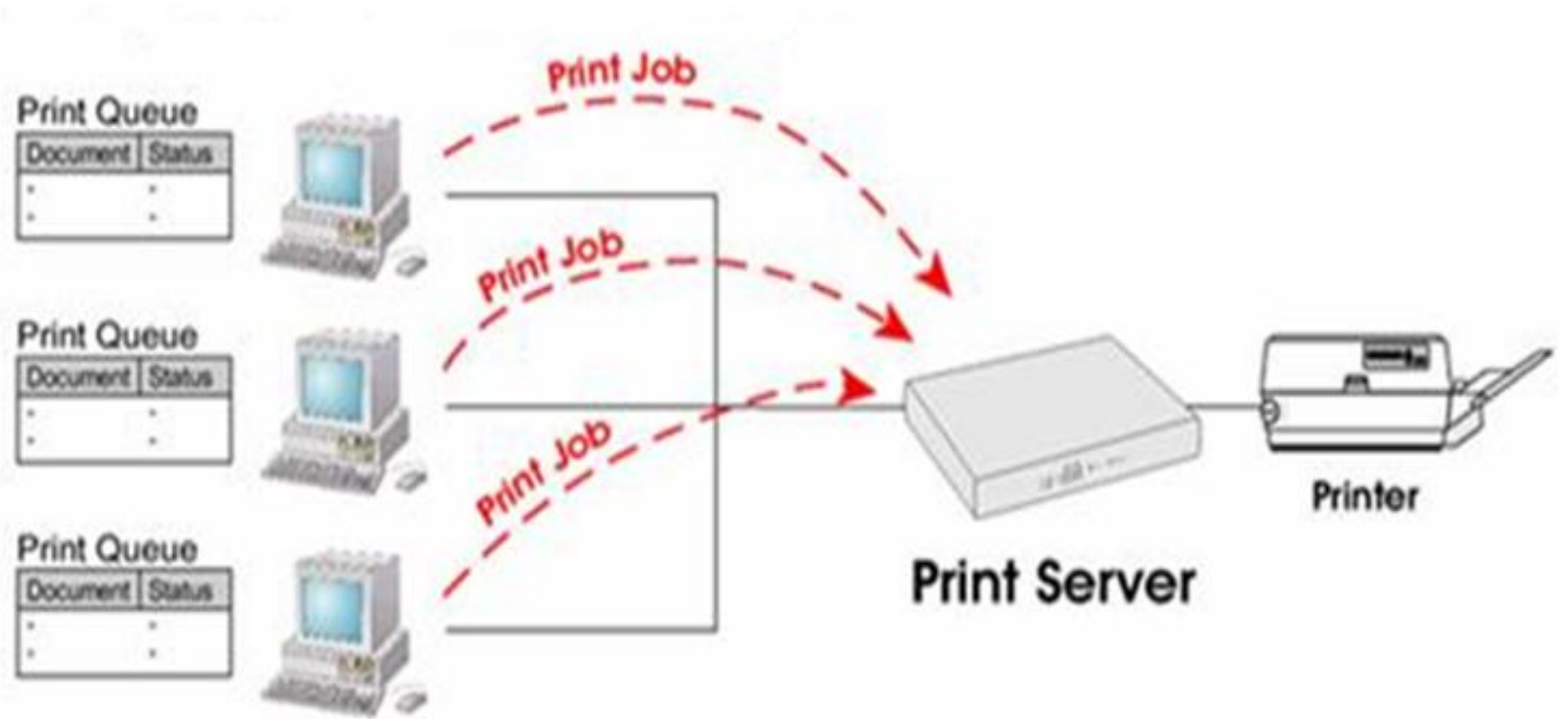
## ❑ Content Filtering and Access Control:

- Organizations often use proxy servers to filter content, blocking access to inappropriate or harmful websites.
- This helps in maintaining workplace productivity and ensuring compliance with company policies.

# Print servers

- A print server is a computer that manages one or more printers in a network .
- a print server, or printer server, is a type of server that connects printers to client computers over a network.
- It accepts print jobs from the computers and sends the jobs to the appropriate printers, queuing the jobs locally to accommodate the fact that work may arrive more quickly than the printer can actually handle.

# Print servers





# Print servers

- **Functions:**
- include the **ability to inspect the queue of jobs to be processed**, the **ability to reorder or delete waiting print jobs**, or the **ability to do various kinds of accounting** (such as **counting pages**, which may involve reading data generated by the printer(s)).
- Print servers may be **used to enforce administration policies, such as color printing quotas, user/department authentication, or watermarking printed documents.**

# Application of Print Server

## 1. Inspecting the Queue of Jobs:

1. Allows users to **view jobs waiting to be processed**.
2. Provides **job details like order, file name, size, and status**.

## 2. Reordering Print Jobs:

1. Offers the ability to **prioritize certain print jobs by moving them up or down in the queue**.

## 3. Deleting Waiting Print Jobs:

1. Enables users to **cancel jobs that are stuck, unnecessary, or submitted by mistake**.

## 4. Accounting Features:

1. Tracks the **usage of printing resources**.
2. Counts **pages printed, which can involve parsing data from the printer or job submission to ensure accurate accounting**.

# Application of Print Server

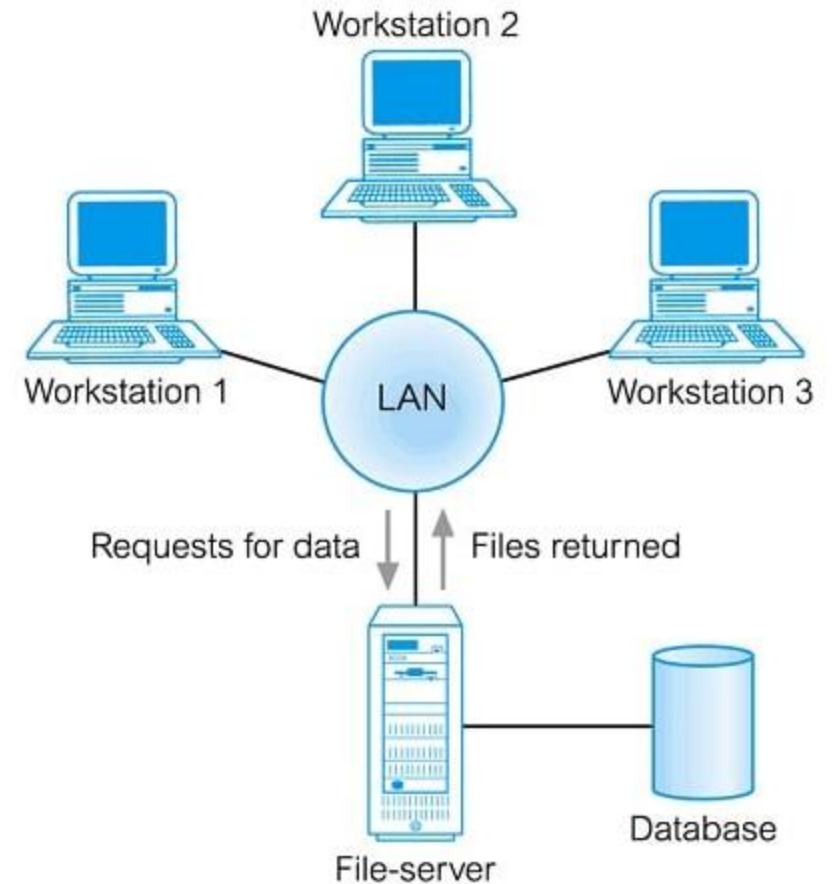
- **Enforcing Color Printing Quotas:** Print servers can **monitor and limit the number of pages printed in color by individual users or departments.** Helps control costs associated with **expensive color printing.**
- **User/Department Authentication:** Ensures only **authorized users can access printing services.** Can be integrated with systems like Active Directory for centralized authentication. **Allows tracking and reporting based on user or department usage.**
- **Watermarking Printed Documents:** **Automatically adds a watermark (e.g., "Confidential," username, date, or department) to printed documents.** Enhances **document security and traceability.**

# File server

- A **file server** is a **dedicated computer** or device **on a network** that is responsible for **storing, managing, and providing access to files for users** on that network.

It **allows multiple users or client devices to share and access data files** over a local network or the internet.

- In file server FTP (File Transfer Protocol) is installed.



# File server

1. **Centralized Storage:** The file server **stores data in a central location, making it easier for users to access, share, and manage** files without having to keep copies on individual devices.
2. **File Management:** It **manages the organization of files and directories, ensuring that data is structured in a way that is easy to access.**
3. **Permissions and Security:** File servers can **enforce access controls and permissions, ensuring that only authorized users can access or modify specific files** or folders.
4. **Backup and Recovery:** File servers are commonly used to **create backups of important data and enable data recovery in case of failure** or data loss.

# Applications of a File Server:

- **File Sharing:** A file server **allows multiple users within a network to share files, making it easier for teams or departments** to collaborate on documents, spreadsheets, and other resources.
- **Data Backup and Centralized Storage:** Organizations use **file servers to maintain backups of important data in a centralized location, ensuring that critical information is protected** and available for recovery in case of data loss or hardware failure.

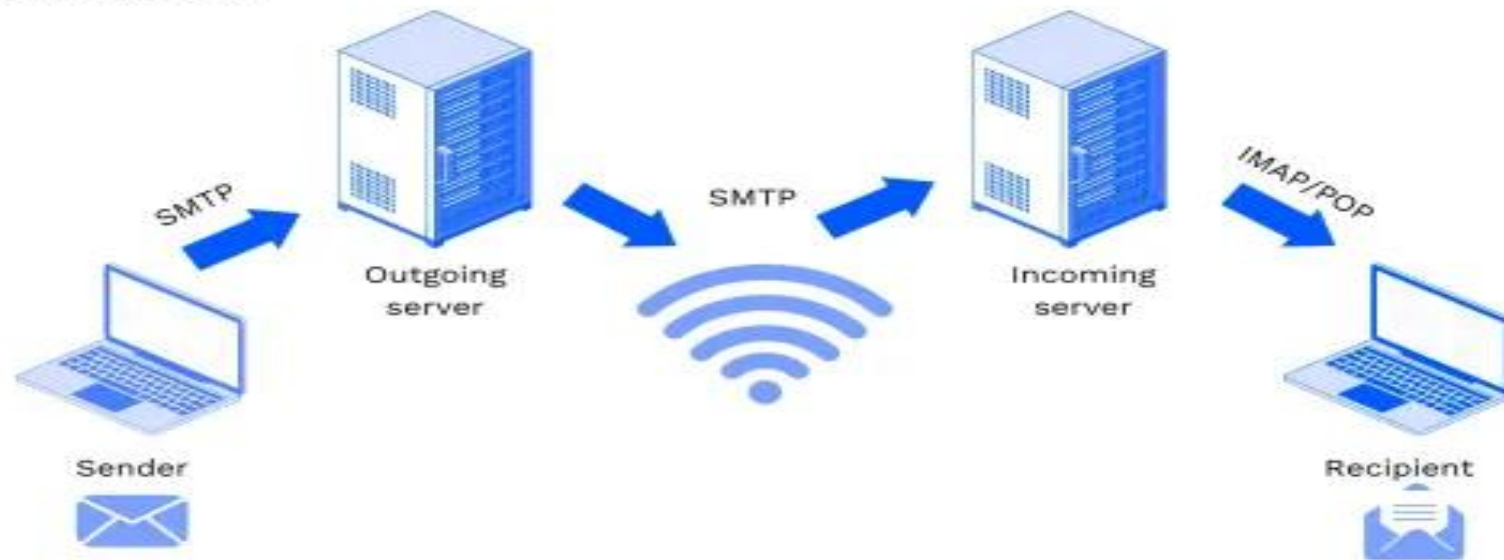
# Mail Server

- A **mail server** is a computer **that is responsible for sending, receiving, storing, and managing email** messages over a network.
- It is similar to the post office where mail is stored and sorted before being sent to its final destination.
- mail server --MTA; (*mail transport agent*) is an **application that receives incoming email from local users and remote senders and forwards outgoing messages for delivery.**
- It **acts as an intermediary between email clients** (such as **Outlook** or **Gmail**) and other **mail servers**, ensuring that messages are properly **routed, delivered, and stored.**

# Mail Server

- Microsoft Exchange, Exim and Send mail are common examples of mail server programs.

Email server workflow





# Applications of Mail Servers:

- **Email Delivery:** Mail servers facilitate the sending, receiving, and routing of email messages between users or systems.
- When you send an email, your email client communicates with the SMTP server, which then forwards the message to the recipient's mail server.
- **Email Storage and Retrieval:** Mail servers store incoming email messages, allowing users to access and manage their messages.
- IMAP and POP3 protocols are used for retrieving emails from the server, where IMAP allows for more advanced features like folder management and synchronization across multiple devices, while POP3 typically downloads the email and removes it from the server.