Unit : 1

Basics of Computer Network

A. K. Panchasara

Computer Engineering, AVPTI, RAJKOT

Course Outcome (CO1)

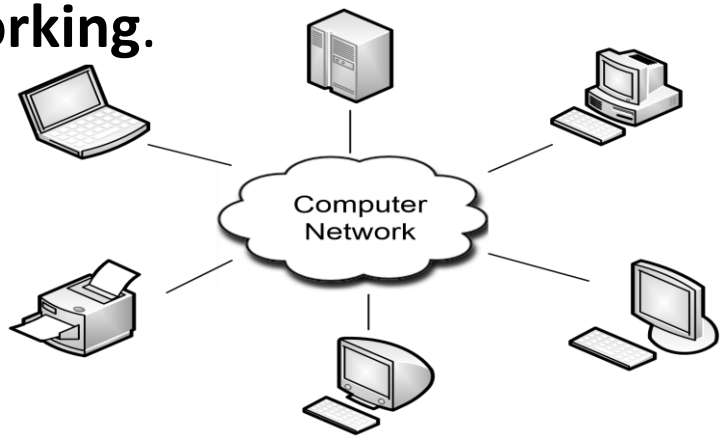
- After completion of the unit…
  - Students will be able to Classify various types of networks based on their construction, usage and scope.

Learning Outcome (LO)

- Students will be able to
  - Define “Communication”
  - Define “Computer Network”
  - list the applications of computer networks
  - List the advantages of computer networks

1.1 Definition and History of Network

- Data transfer without the help of network and with network.
- Computer Network → Computer Network is defined as two or more computers are connected in such a way that they can share their data, information as well as their resources.
- Computers/peripherals on a network are called 'nodes'.
- The links connecting the devices are called ***communication channels***.
- The concept of connecting computers for sharing resources or data is called **networking**.



1.2 Usage of Computer Network

❖ Characteristics of Network:

- Resource sharing
- High reliability
- Saving money
- Powerful communication
- Scalability
- Low cost
- Time saving
- Flexibility of equipments
- Improved performance

Networks are used by people because;

✓ Access to remote information: WWW, E-commerce, E-shopping

✓ person to person communication: e-mail, chat, video conferencing

✓ interactive entertainment: games, songs, video on demand.

Advantages and need of CN

✓ Efficient resource management

✓ Faster data sharing

✓ Keeping information reliable and up to date

✓ High reliability

✓ Efficient communication

1.2 Usage of Computer Network

- 1. Resource sharing
  - All programs, data and devices should be available to any one on the network.
- 2.high reliability
  - All files (data) are replicated on two or more machines so if one fails, other can provide the same.
- 3. Saving money
  - Requires less hardware so cost is decresed.
- 4. powerful communication medium
  - One person makes changes to an online document, the other can see the change immediately instead of waiting several days.

- 5. Scalability
  - Can add and remove more machines to existing setup.
- 6. low cost
  - Compared to telephonic talk.
- 7. time saving
  - E mail services instead of postal services
- 8. flexibility of equipment location
  - Can change the location of any device at any time.
- 9. Improved performance
  - By adding hardware and software

Network Hardware

- Hardware is collection of physical network components to establish a network (N/W)
  - Transmission media
    - Guided media (twisted pair, co axial cable, fiber optic cable)
    - Un guided media(radio wave, microwave , infrared etc.)
  - Servers
  - Workstations/ clients/ nodes/ terminals
  - Connectors
  - NIC (Network interface card)
  - Modem
  - Networking and internetworking devices like hub, bridge, switch, router, gateway.

❖ Network criteria

- There are mainly three criteria→ performance, reliability and security

1. **Performance:** it can be measured by Transit time and Response time

- Transit time is the amount of time required for a message to travel from one device to another.
- Response time is the elapsed time between an inquiry and a response.
- The performance of a network depends on a number of factors, including the number of users, the type of transmission medium, the capabilities of the connected hardware, and the efficiency of the software.

2. **Reliability:** it can be measured by

- Frequency of failure of network
- Recovery time of a network after a failure.
- Catastrophic events

3. **Security:** Network security issues include protecting data from unauthorized access, damage and viruses, and implementing policies and procedures for recovery.

❖ Network Applications

- Financial services
- Marketing and sales
- Electronic messaging
- Manufacturing
- Directory services and infarction services
- Cellular telephone and cable TV services
- Teleconferencing
- Electronic data exchange (without using paper)

1.3 Protocol

- **Protocol** → ***is a set of rules that manages communication***. It represents an agreement between communicating devices. Without a protocol, two devices may be connected but can't communicate.
- A protocol defines what is communicated, how it is communicated, and when it is communicated.
- The *key elements* of protocol are: Syntax, Semantics and Timing

➥ **Syntax:** it is the structure or format of the data, meaning the order in which they are presented. E.g. first eight bits are for sender address, next eight bits are for receiver address and rest of the bits for the message.

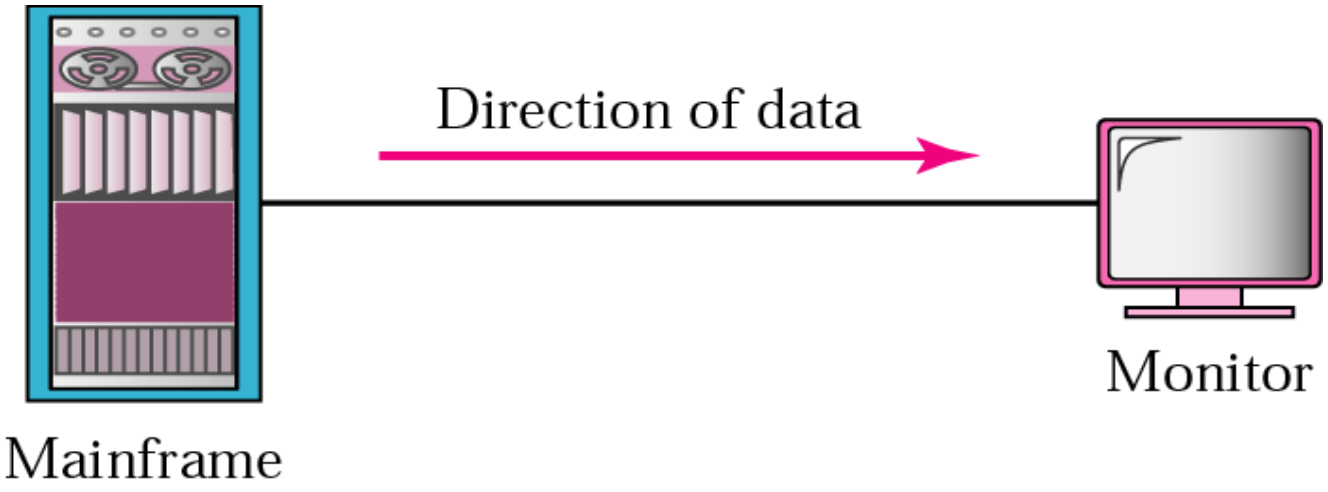
➥ **Semantics:** it refers to the meaning of each section of bits.

➥ **Timing:** it refers to two characteristics: *when* data should be sent and *how fast* they can be sent.

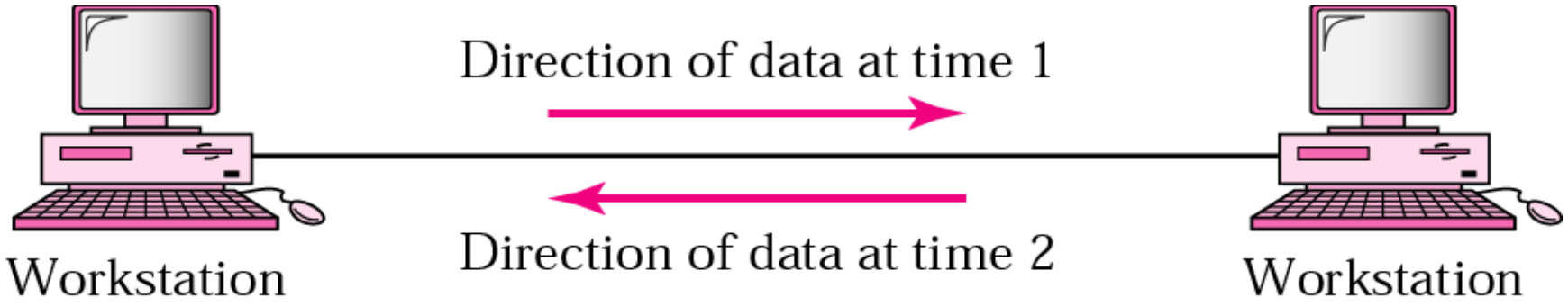
- Some examples of protocols are: HTTP, FTP, SMTP, UDP, TCP, IP, POP etc

Method of communication/ Communication Modes

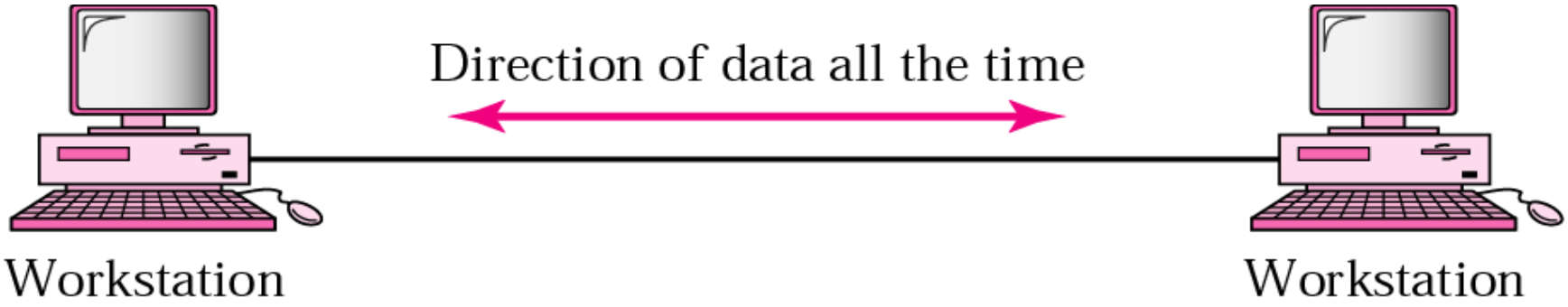
- 1. simplex
  - Only one will be sender and other will be receiver
  - Example: keyboard-monitor



- 2. Half duplex
  - Both the devices can send and receive data but at a time only one.
  - Example: walkie talkie



- 3. Full duplex
  - Both can send and receive the data at any time
  - Example: mobile phones



1.3.1 Standard Organizations

- Data communication standards are of two categories:

➥ **De Facto (By Fact or By Convention):** Standards that have not been approved by an organized body but have been adopted as standards are de facto standards.

- **De Jure (By Law or By Regulations):** Those standards that have been approved by an officially recognized body.
- are de jure standards.

1.3.1 Standard Organizations

➥ **Some standard organizations:**

ISO	International Standards Organization
CCITT	Consultative Committee for International Telegraphy and Telephony
ANSI	American National Standards Institute
IEEE	Institute for Electrical and Electronics Engineers
ITU-T	International Telecommunication Union-Telecommunication
ISOC	Internet Society
IETF	Internet Engineering Task Force
EIA	Electronic Industries Association

Learning outcome

- Students will be able to
  - Differentiate various line configurations

1.4 Line Configuration / Network Attributes

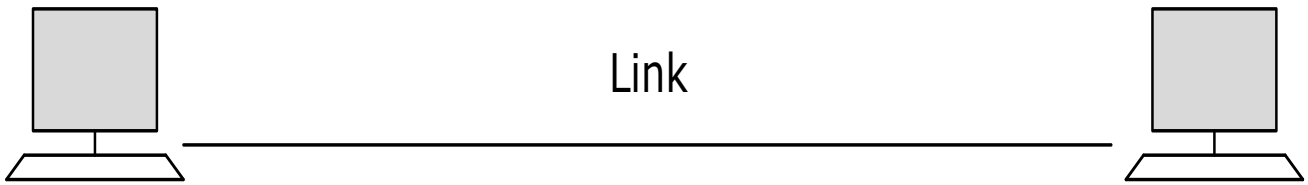
❖ Line Configuration

- Line configuration *defines the attachment of communication devices to a link.*
- A link *is a communications pathway that transfers data from one device to another.*
- 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: point-to-point and multipoint.

➥ Point to point

- A point-to-point connection provides a dedicated link between two devices.
- Two and only two devices are connected by a dedicated link.
- The entire capacity of the link is reserved for transmission between those two devices.

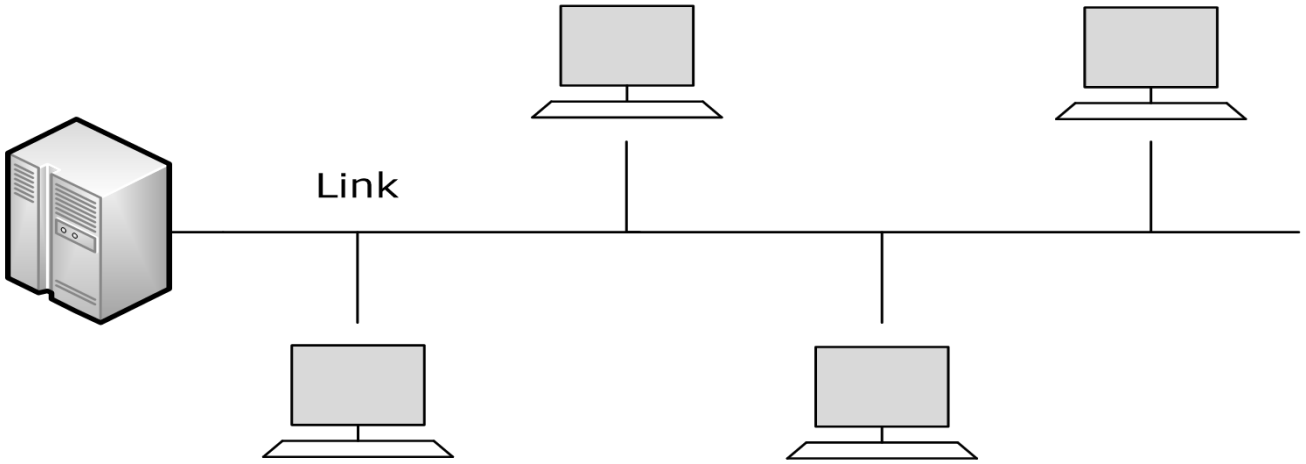
1.4 Line Configuration / Network Attributes



- Example of point to point connection is TV and remote control

➥ **Multi point (OR Multidrop)**

- A multipoint (also called multidrop) connection is one in which more than two specific devices share a single link.



1.4 Line Configuration / Network Attributes

- In a multipoint environment, the capacity of the channel is shared, either spatially or temporally.
- If several devices can use the link simultaneously, it is a *spatially shared* connection.
- If Fixed time slots are allocated to the users are called time shared line configuration.

Learning outcome

- Students will be able to
  - Design computer network considering particular topology.

1.5 Topology

- Topology describes the actual layout of network transmission media.
- Physical topology: it refers to the configuration of cables, computers and other peripherals. ***OR Geometric representation of the relationship of all links and linking devices.***
- Logical topology: it is the method used to pass information between workstations.
- Some general types of network topologies are:

BUS topology

STAR topology

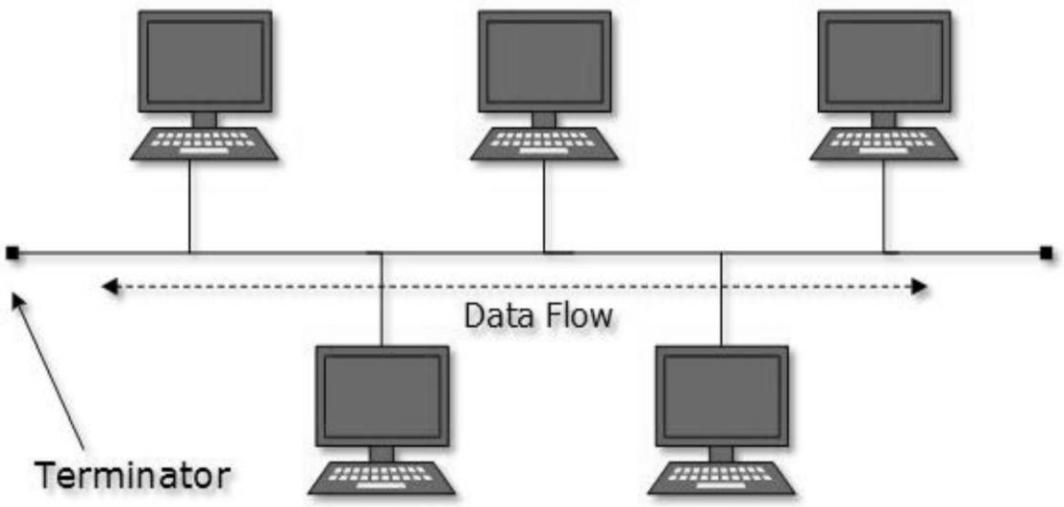
RING topology

MESH topology

TREE topology

BUS topology

- It is also known as linear bus topology.
- It is a multi point structure topology.
- In bus topology all device share single communication line or cable. All devices are connected to this shared cable **(Backbone cable)**.



- Data is sent to all the computers in the network.
- Only one computer at a time can send the data (or information).

BUS topology

- Bus topology is a passive topology in which the computers on the network are not responsible for moving the data.

➥ **Advantages of BUS topology**

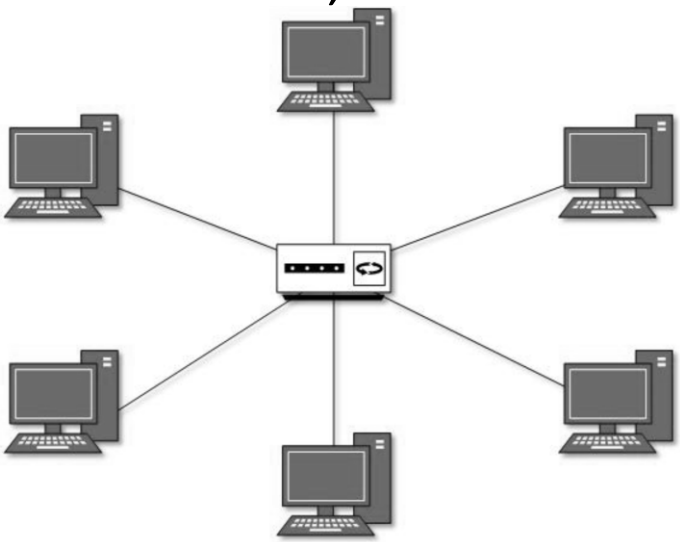
- It is simple.
- Reliable in very small network.
- Easy to install and easy to use.
- It requires less amount of cables.
- It is easy to extend the bus.

➥ **Disadvantages of BUS topology**

- It can not work efficiently in heavy network traffic.
- If main cable broken, entire network shuts down.
- Terminators are required at both ends of the backbone cable.

STAR topology

- In it, each device has a dedicated point-to-point link only to a central controller, usually called a **hub** shown in figure. The devices are not directly linked to one another.
- A star topology does not allow direct traffic between devices.
- The controller acts as an exchange: If one device wants to send data to another, it sends the data to the controller, which then transfer the data to the other connected device.
- If the central controller fails, the whole network got crashed.



STAR topology

STAR topology

- But if a computer connected to the central hub is fails, the rest of the network continuous to work.

➥ **Advantages of STAR topology**

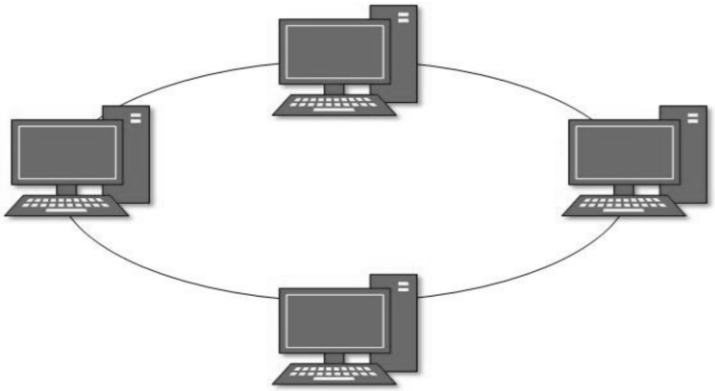
- Easy to configure and connect new devices in star topology.
- The failure of a single device or cable doesn't bring down the entire network.
- It is easy to find faults in the network.

➥ **Disadvantages of STAR topology**

- As every computer connected to the central hub, this topology requires more cables.
- Failure of the central device (hub) causes the failure of the whole network.
- It is expensive than bus topology.

RING topology

- In RING topology, computers are connected on single circle cable shown in figure.
- In it, each device has a dedicated point-to-point connection with only the two devices on either side of it.
- There are no terminal ends.
- A signal is passed along the ring in one direction, from device to device, until it reaches its destination.
- Each device in the ring incorporates (includes) a repeater.
- When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along the network.



RING topology

RING topology

- This type of network uses **Token passing method** to transfer data.
- (method of Token passing)

➥ **Advantages of RING topology**

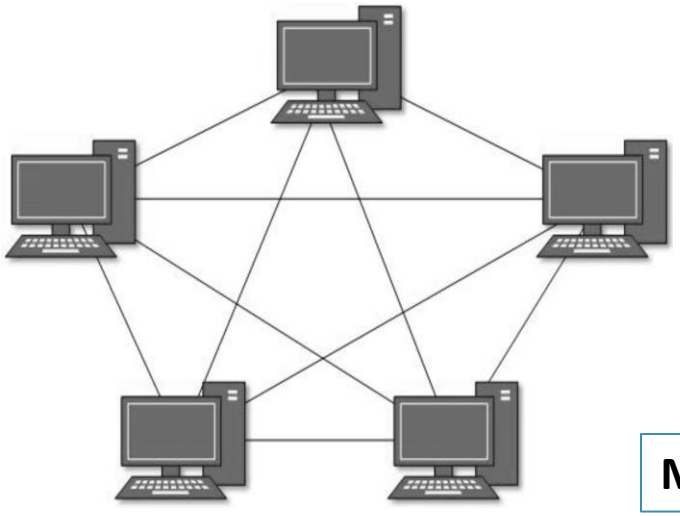
- Easy to configure.
- Working well in heavy load.
- Network allows equal access to all the computers.

➥ **Disadvantages of RING topology**

- Failure of one device can crash the whole network.
- Difficult to troubleshoot.
- If more devices are connected then network becomes slower.

MESH topology

- In a mesh topology, every device has a dedicated point-to-point link to every other device.
- Every node in the network has point to point connection with ever other node.
- The term *dedicated means that the link carries traffic only between the* two devices it connects.



MESH topology

MESH topology

➥ **Advantages of MESH topology**

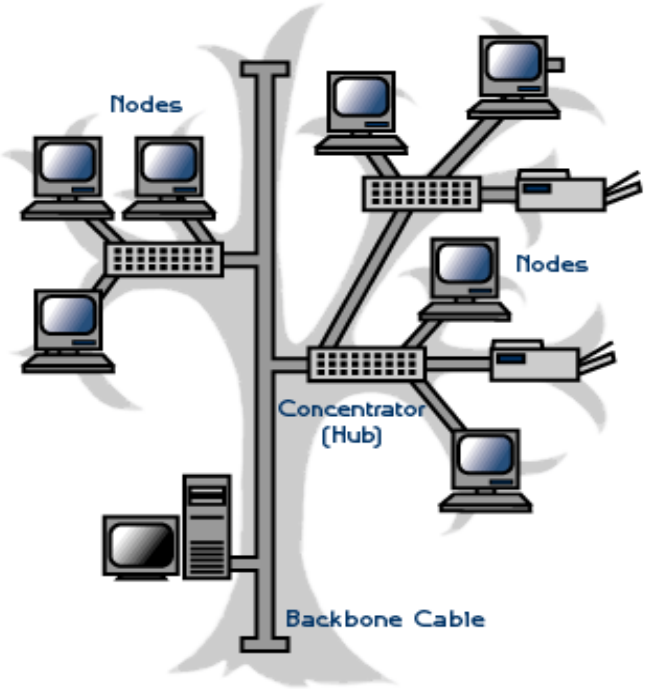
- Less traffic problems due to dedicated lines.
- Faster data transfer.
- Provide security of data through dedicated lines.
- It is robust as if one link becomes unusable, it does not crash the entire system.

➥ **Disadvantages of MESH topology**

- More numbers of cables and other peripherals are required.
- Installation and configuration is very difficult.
- It is very expensive.
- It is usually implemented in limited situations.

TREE topology

- Tree topology is also known as Hierarchical Topology. It is a variation of star topology (multiple star topology). It is also a combination of bus and star topology (Hybrid Topology).
- It involves a variety of single nodes connected to a central node.
- This type of topology mainly used in WAN/MAN
- The good example of tree topology is → Cable TV.



TREE topology

TREE topology

➥ **Advantages of TREE topology**

- It is easy to add more number of nodes in the network.
- It is easy to manage the network.
- Error detection is easy.

➥ **Disadvantages of TREE topology**

- More numbers of cables are required.
- Costly.
- Difficult to install and configure.
- Central hub fails, then whole network fails.

Topology	Description	Advantages	Disadvantages	Formula to Find Number of Cables
Star	All nodes are connected to a central hub or switch.	- Centralized management - Fault isolation: Failure in one node does not affect others - Easy to add or remove nodes	- Dependency on central hub: Failure of hub affects entire network - Higher cabling requirements compared to other topologies	Number of Cables = Number of Nodes
Ring	Nodes are connected in a circular manner, with each node connected to exactly two other nodes.	- Simple and easy to install - Equal data transmission rights for all nodes	- Failure of one node can disrupt the entire network - Limited scalability and difficult to add or remove nodes	Number of Cables = Number of Nodes
Bus	All nodes are connected to a single communication line (bus).	- Simple and inexpensive to implement - Easy to add or remove nodes	- Single point of failure: Failure of the main bus disrupts entire network - Limited scalability and bandwidth	Number of Cables = 1
Mesh	Every node is connected to every other node in the network.	- Redundancy: Multiple paths for data transmission enhance reliability - Scalability: Easy to add new nodes without affecting others	- Complex and expensive to implement with a large number of nodes - High cabling requirements - More difficult to manage and maintain	Number of Cables = n * (n - 1) / 2
Tree (Hierarchical)	Nodes are organized in a hierarchical structure, resembling a tree with a root node at the top and branches extending downward.	- Scalable and flexible - Centralized management from the root node - Efficient data flow due to hierarchical structure	- Dependency on the root node: Failure of the root node disrupts the entire network - Limited flexibility for network expansion	Number of Cables = Number of Nodes - 1
Hybrid	Combination of two or more different topologies.	- Offers benefits of multiple topologies - Can tailor the network to specific needs	- Complex to design and manage - Potential for increased costs and complexity	Varies based on the combination of topologies

Learning outcome

- Students will be able to
  - Categorize networks based on scope and connections.

1.6 Categories of Network

- Network classified into the three primary categories.

  LAN → Local Area Network

  MAN → Metropolitan Area Network

  Wan → Wide Area Network

❖ LAN (Local Area Network)

- In it, computers and other networking devices are interconnected within limited geographically area. **OR** LAN networks connect computers together over small distance like resident, school, building, laboratories, campus etc.

Local Area Network (LAN)

LAN

- LAN can be wired or wireless.
- Twisted pair, fiber optic and coaxial cables are used in LAN.
- Generally topology used in LAN are → bus, ring, star.

➥ Characteristics of LAN

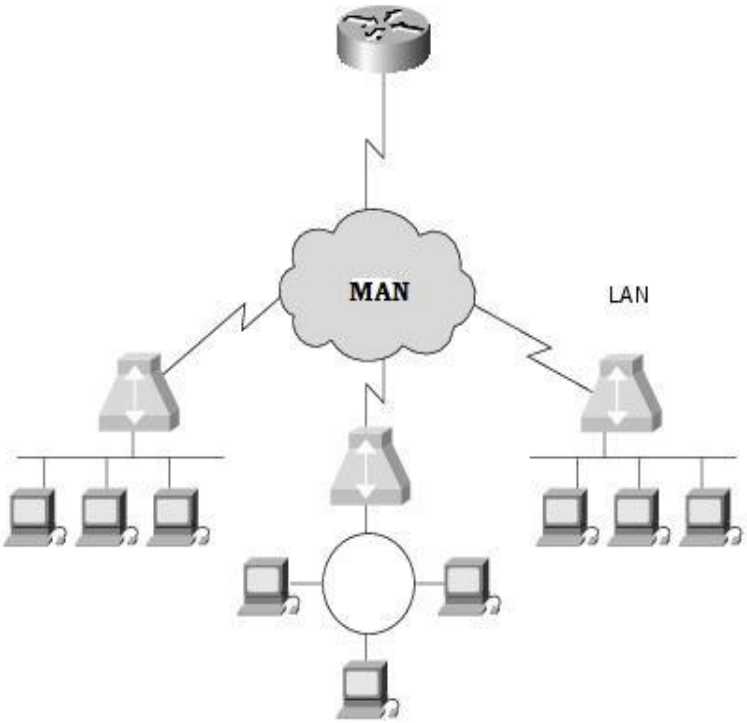
- It allows users to share devices like printers, application data, resources etc.
- It transfers data at very high speed (up to 1 gbps).
- It exists in limited geographical area (up to few kilometers).
- Multiple access can be allowed in LAN.

➥ Advantages of LAN

- Cost effective technology (Less costly).
- Resource sharing and multiple access.
- High data transfer rate.
- Any number of users can be accommodated.
- It is flexible and can fit in any site requirement.
- Low error rate.

❖ MAN (Metropolitan Area Network)

- MAN is a larger version of LAN which covers an area that is larger area than LAN but smaller area than WAN.
- MAN is formed by collecting multiple LANs.
- A MAN typically covers an area of 5 to 50 km diameter.
- A best known example of MAN is cable television.



Metropolitan Area Network (MAN)

MAN

➥ Advantages of MAN

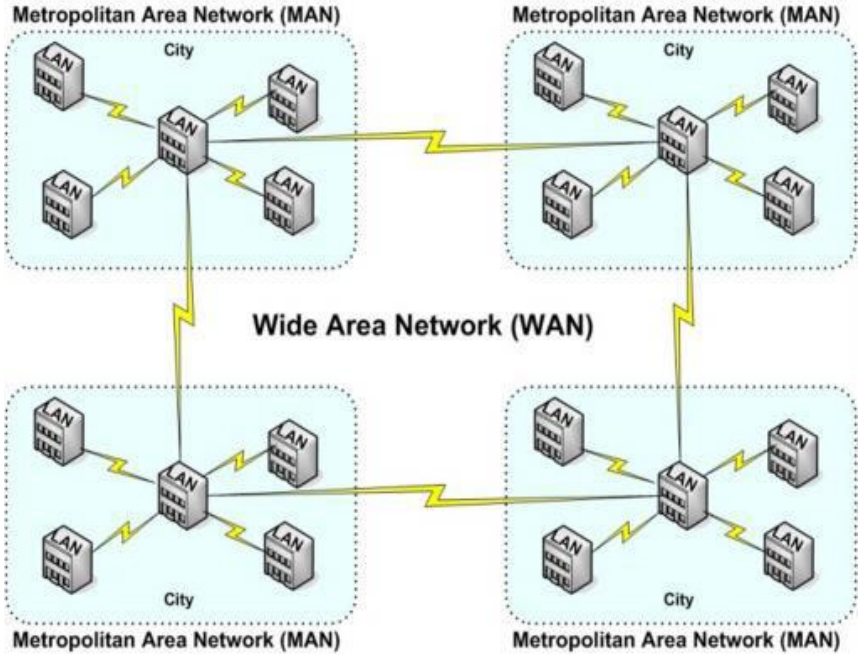
- It provides good backbone for a large network.
- The Dual bus used in MAN helps in transmission of data in both direction.
- It provides large and controllable network.
- It required fewer resources compare to WAN.
- It can be used in sharing of regional resources.

➥ Disadvantages of MAN

- More cables required in connection from one place to another.
- It is difficult to make system secure.

❖ WAN (Wide Area Network)

- It is a larger version of MAN.
- When network covers a very large distance such as cities, states, countries or continent is called WAN.
- Communication between different countries can be possible through WAN.
- The communication takes place in WAN using telephone lines, satellite or microwaves.



Wide Area Network (WAN)

WAN

➥ Advantages of WAN

- It covers almost unlimited geographical area.
- It shares software and resources worldwide.
- WAN supports global market and global business.

➥ Disadvantages of WAN

- This technology is very expensive.
- Due to longer distance, error rates are high.
- It is difficult to design and maintain.
- Setting up of a network is very expensive and slow.

Learning outcome

- Students will be able to
  - Explain uses of various types of servers.

1.7 Different types of Servers

- **Server** → Refer to the *computer systems that receive requests from the clients and process them. After the processing is complete, the servers send a reply to the clients who sent the request.* **OR** *Server is a computer or device on a network that manages network resources.*
- Servers are of two types → Dedicated server and non dedicated server.

❖ **Dedicated server**

- It is defined as the computer with operating system and that *can not be used by a user.*
- Dedicated servers do nothing, but *fulfils the requests of clients*.
- They are commonly found in client server environments.
- It is *not available for running user applications.*
- The cost of dedicated server is high.
- This type of server generally used in large network system.

➥ **Advantages of dedicated server**

- Its response time is very fast.
- It can't be used as node.
- It is more reliable, more efficient and more secure.

➥ **Disadvantages of dedicated server**

- All data is stored on a single server, if the server fails all data becomes unavailable.
- Installation and configuration is difficult.

❖ **Non-Dedicated server**

- Non-dedicated servers do double duty by requesting and providing services.
- It is the microcomputer, which is made as a server and can also act as an individual workstation even while it controls the network.
- Its response time is slow.

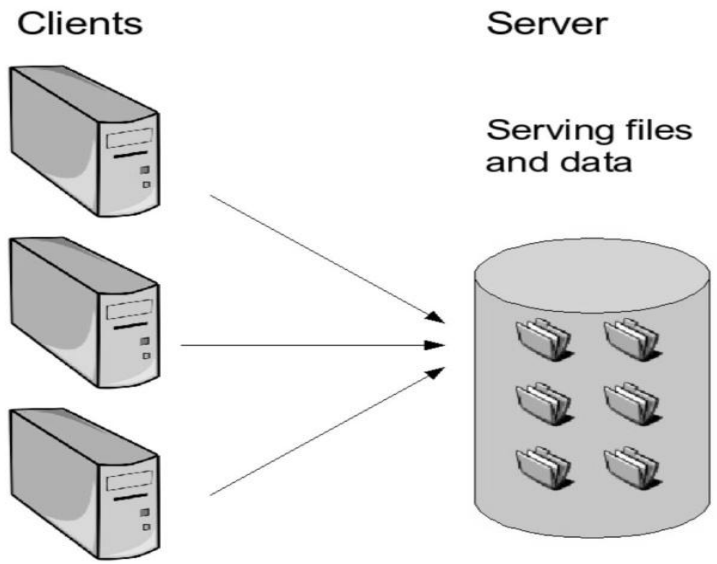
➥ **Different types of servers are →**

Different Servers
File server
Print Server
Mail server
Proxy server
Web server
Database server
Application server

➥ **Different types of servers are →**

❖ **File server**

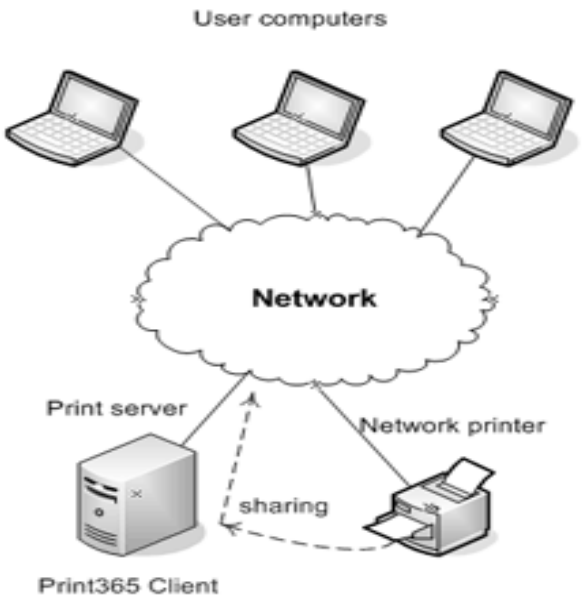
- File server is a computer responsible for the central storage and management of data files so that other computers on the same network can access the files..
- It allows users to share information over a network without having to physically transfer files by floppy diskette or some other external storage device like CD/DVD/pen drive etc.
- Any user on the network can store files on the network.



File server

- In file server FTP (File Transfer Protocol) is used. FTP is making possible to move one or more files securely between computers.
- File server is generally not performing any *computational tasks, and does not run programs on behalf of its clients.*
- It is designed primarily to enable the *storage and retrieval of data* while the computation is carried out by the workstations.

❖ Print server (Printer server)

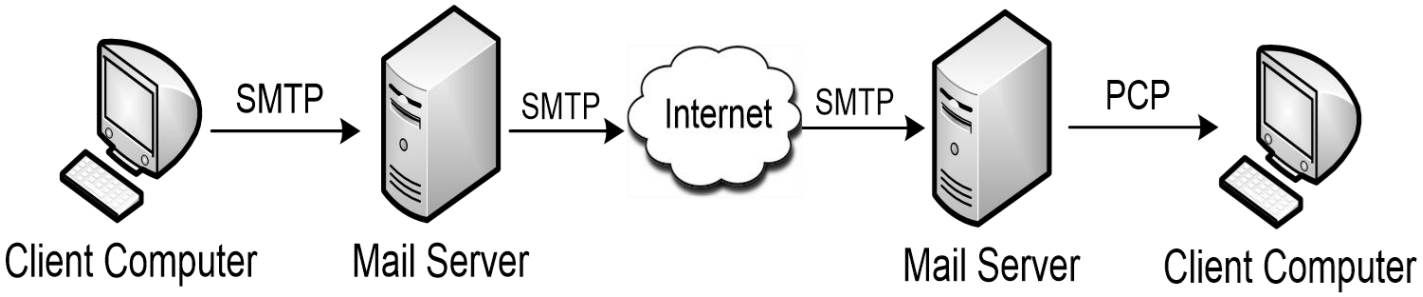


Print server

- A print server, or printer server, is a device that connects printers to client computers over a network.
- *A print server is a computer that manages one or more printers.*
- It can accept print jobs from the computers and send the jobs to the appropriate printers.
- Print servers allow printers to be shared by other users on the network.
- There is no restriction regarding the number of client systems in a network while using print server.
- *It is easy to add new clients as well as new printers in a network.*
- Main disadvantage is → most of features of multi functions printers are not supported.

❖ Mail server

- Mail Server is usually a storage area where E-mail is stored for local users.
- Mail server moves and stores mails over corporate network and across the internet
- Specially designed software are installed in server to manage exchange of mails.

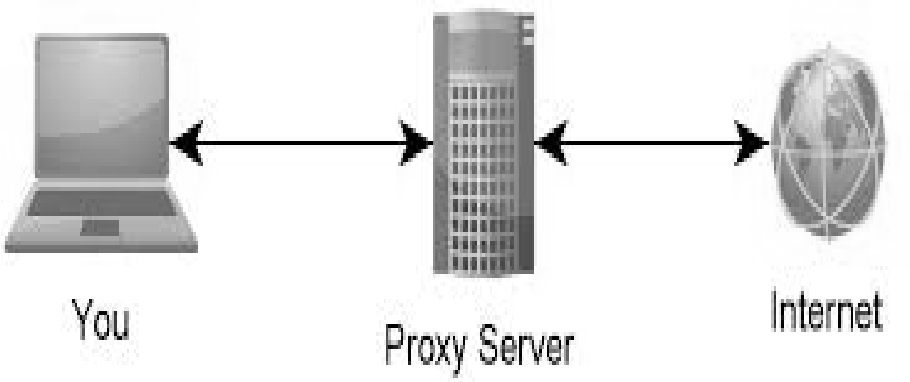


Mail server

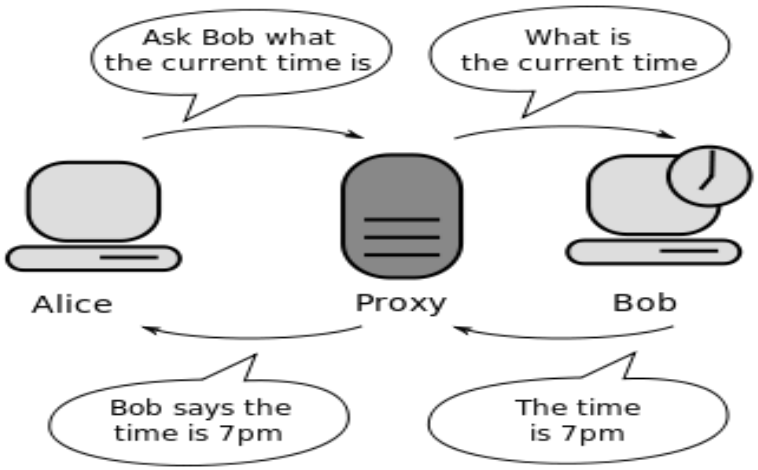
❖ Proxy server

- A proxy server is a server which services the requests of its clients by forwarding requests to other servers. It may be a computer system or an application program.
- It sits between a client application (like web browser) and a real server.
- A client connects to the proxy server, requesting some service such as file connection, web page or other resource available from a different server.
- A proxy server provides the resource by connecting to the specified server and requesting the service on behalf of the client.
- It may alter the client's request or server response and sometime it may serve the requests without contacting the real server using 'cache'.
- A proxy server that passes all requests and replies unmodified is usually called a gateway or tunnelling proxy.

- A proxy server can be placed in the user's local computer or at specific key points between the user and the destination servers or the internet.



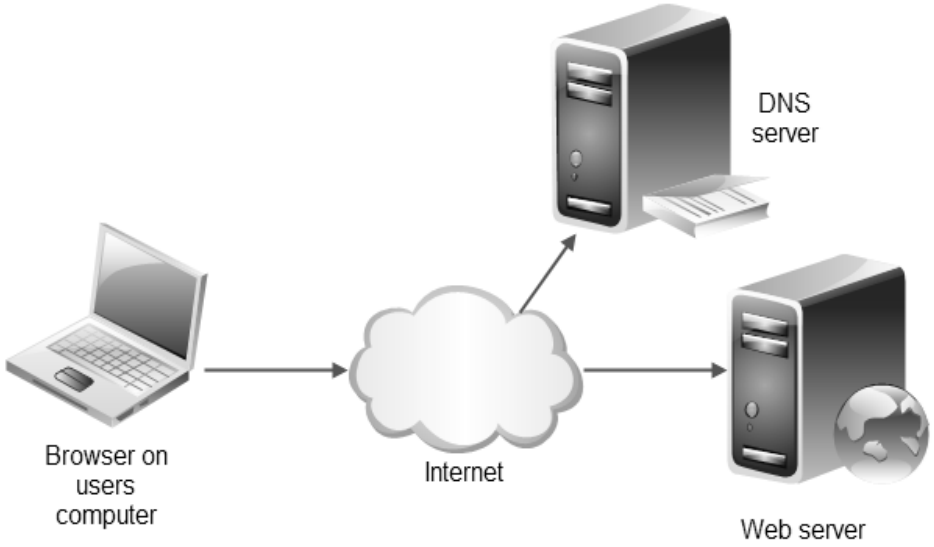
Proxy server



Proxy server example

❖ Web server

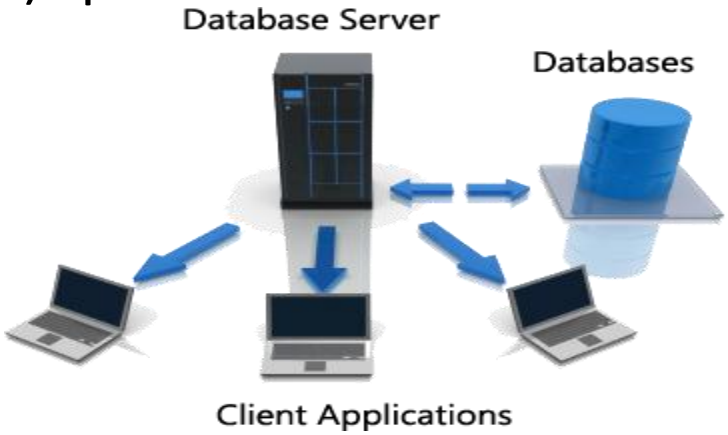
- It is also known as '***internet server***'.
- It is a server that store, process and deliver web pages to clients.
- The communication between client and server takes place using the Hypertext Transfer Protocol (HTTP).
- Pages delivered to clients are most frequently HTML documents, which may include images, multimedia, scripts with text content.



Web server

❖ Database server

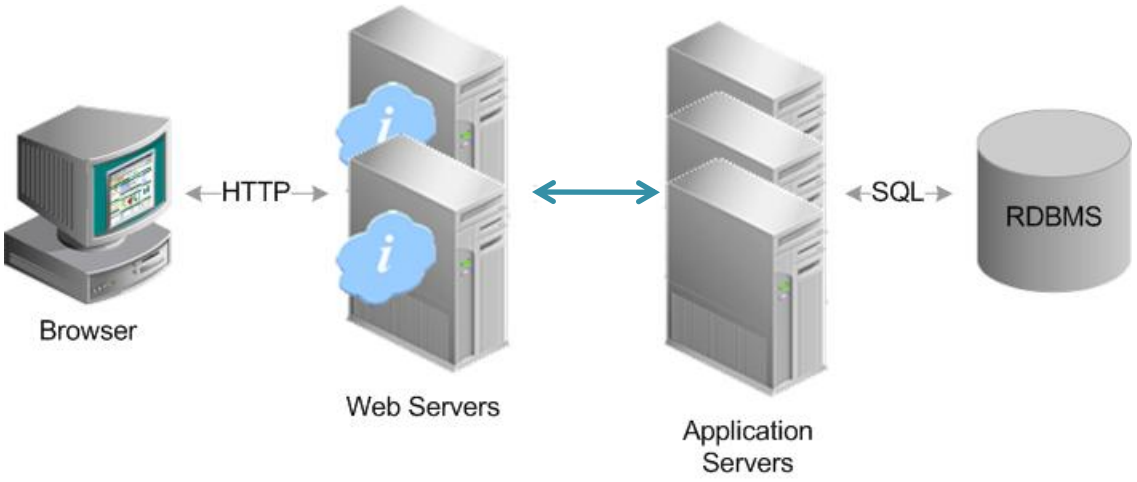
- A database server is a computer program that provides database services to other computer programs or to computers, as defined by the client–server model.
- It should be hardware or software program.
- It may be the back-end portion of a database application (software) or physical computer used to host the database (hardware).
- Many companies utilize a database server for storage. Users can access the data by executing a query using a query language (SQL) specific to the database.



Database server

❖ Application server

- The application server is a framework, an environment where applications can run, no matter what they are or what functions they perform.
- It is also called an '*app server'.*
- It can be used to develop and run web-based applications.
- It is typically used in complex transaction based applications and in three-tier GUI applications.
- It allows data and code integrity.
- It also provides security to the applications.



Application server

Thank You...