CST 303
COMPUTER NETWORKS

Text Books

- 1. Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).

- 2. Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill

Course Outcomes

- CO1 Explain the features of computer networks, protocols, physical   layer and network design models.

- CO2 Measure the performance of a network using different   performance metrics.

- CO3 Illustrate the design issues of data link layer, link layer   protocols, wired LAN, wireless LAN protocols and connecting devices

- CO4 Select appropriate routing algorithms, congestion control techniques, and Quality of Service requirements for a network

- CO5 Illustrate the functions and protocols of the network   layer, transport layer, and application layer in inter-

  networking

- CO6 Design different network and transport layer   protocols.

Computer network

- A computer network is defined as the interconnection of two or more computers.

- It is done to enable the computers to communicate and share available resources.

- 2 computers are interconnected if they are able to exchange information.

- Communication is the process of exchanging information between two persons or devices.

- Connection can be made via copper wire, fiber optics, microwaves or communication satellites etc.

- If one computer cannot forcibly start, stop or control another computer then it is termed as autonomous.

Applications of Computer Networks/Uses of Computer networks

- **Business Applications**

- **Home Applications**

- **Mobile Users**

- **Social Issues**

Business Applications

1. Resource Sharing:

2. Client-Server model:

3. Communication Medium:

4. ecommerce:

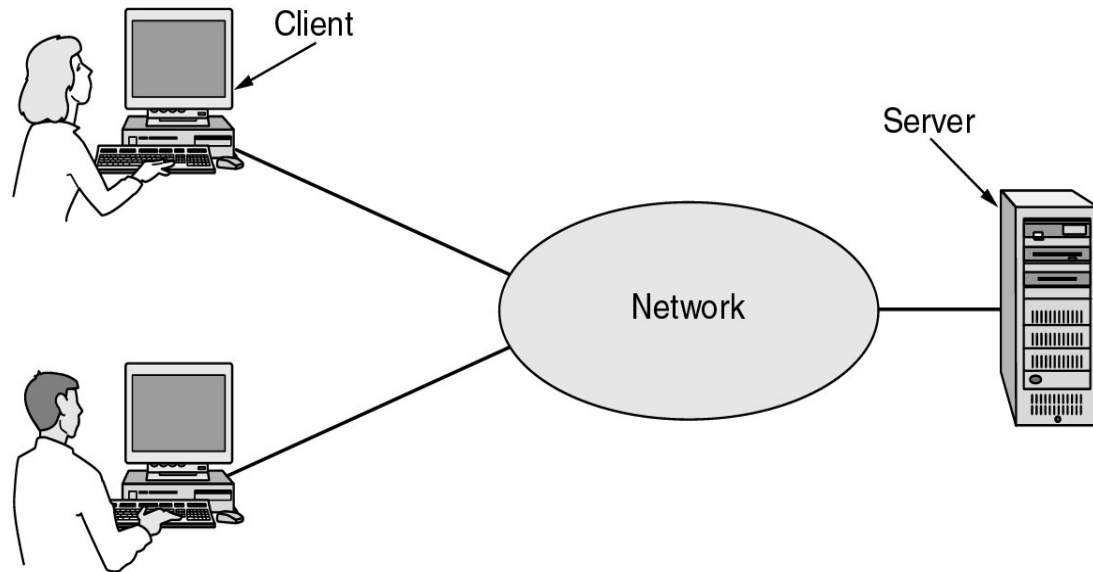# Business Applications

1. Resource Sharing:

The goal is to make all programs, equipments(like printers etc), and especially data, available to anyone on the network without regard to the physical location of the resource and the user.

2. Server-Client model:

- One can imagine a company's information system as consisting of one or more databases and some employees who need to access it remotely.

- In this model, the data is stored on powerful computers called Servers.

- Often these are centrally housed and maintained by a system administrator.

- In contrast, the employees have simple machines, called Clients, on their desks, using which they access remote data.

Business Applications of Networks

- A network with two clients and one server.

- The client-server model involves requests and replies.
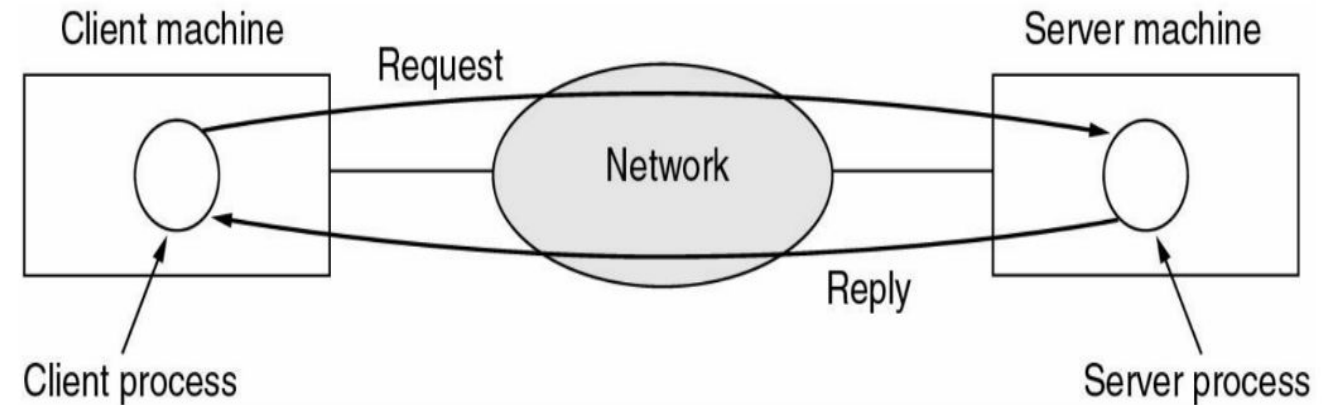
Business Applications

3. Communication Medium:

- A computer network can provide a powerful communication medium among employees.
- Virtually every company that has two or more computers now has e-mail (electronic mail), which employees generally use for a great deal of daily communication.

Person to person communication: peer-to-peer system-there are no fixed clients and servers.
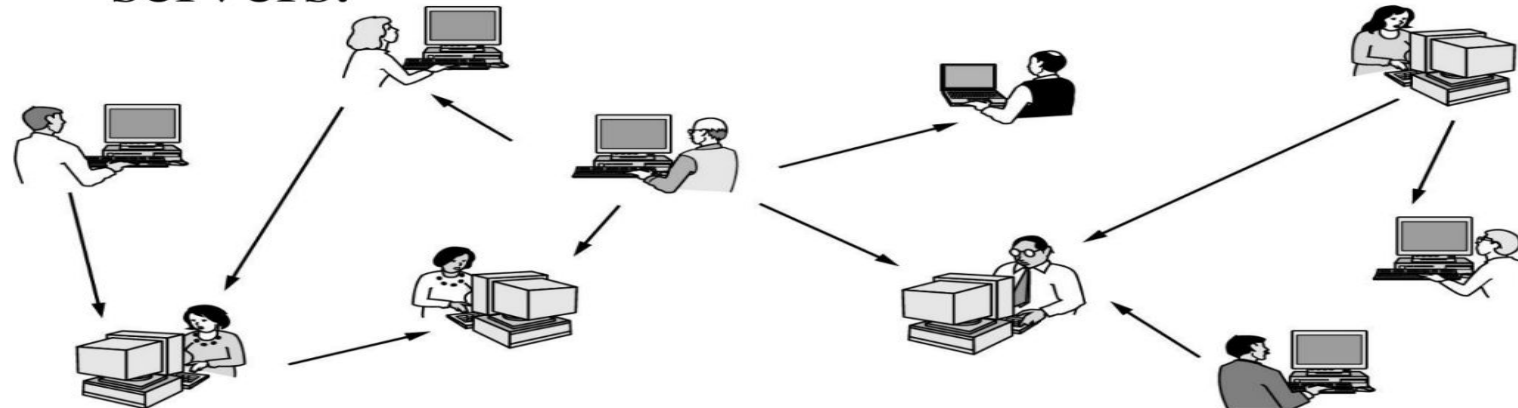
Business Applications

4. E-Commerce:

- A goal that is starting to become more important in businesses is doing business with consumers over the Internet.
- Airlines, bookstores and music vendors have discovered that many customers like the convenience of shopping from home.

The most popular forms of e commerce are

Tag and Full Name	Example
B2C - Business-to-Consumer	Ordering books on-line
B2B - Business-to-Business	Car manufacturer ordering tires from supplier
C2C - Consumer-to-Consumer	Auctioning second-hand products on line
G2C - Government-to-Consumer	Government distributing tax forms electronically
P2P - Peer-to-Peer	File sharing

Home Applications

- Some of the most important uses of the Internet for home users are as follows:

  - Person-to-person communication. (email,instant messaging,group chat,video call)

  - Access to remote information.(browsing,online newspaper,online digital libraries)

  - Interactive entertainment.(online games,live TV)

  - E-commerce (home shopping,online payments)

Mobile Users

- Mobile computers, such as notebook computers and Mobile phones, is one of the fastest-growing segment of the entire computer industry.

- Here mobile users/device means portable device.

- The computer network is widely used in new-age technology like smartwatches, wearable devices, tablets, online transactions, purchasing or selling products online, etc.

Mobile Users

- Although wireless networking and mobile computing are often related, they are not identical, as the below figure shows.

Wireless	Mobile	Applications
No	No	Desktop computers in offices
No	Yes	A notebook computer used in a hotel room
Yes	No	Networks in older, unwired buildings
Yes	Yes	Portable office; PDA for store inventory

Combinations of wireless networks and mobile computing.

Social Issues

• Widespread introduction of networking has introduced new social, ethical, and political problems.

• Exchange messages using newsgroup may lead to conflicts.

• Another area: Employee rights vs employer rights

• Network offers the potential to send anonymous messages

• Electronic junk mails (Spam) may contain viruses

• Copyright violation due to transmission of music & videos.

No.	Questions	Marks	CO
1.	Find Mac-ID of your phone	2	CO1
2.	Check your internet speed of different Data providers	2	CO1
3.	Find IP address of college Website	1	CO1
4.	USE PING APP TO PIN TO GOOGLE.COM	2	CO1
5.	Find the hosting location of college website	1	CO1
6.	Find an app to locate mobile tower near you	1	CO1
7.	Identify the network provider and find the range of frequencies they handle and try IPCONFIG command	1	CO1

Network Hardware & Network Software

- A network is a combination of hardware and software that sends data from one location to another.

- The physical equipment

- The software consists of instruction sets that make possible the services that we expect from a network.

Hardware Components

- Servers

- Clients

- Peers

- Transmission Media

- Connecting Devices

Hardware Components

- **Servers** –high-configuration computers -manage the resources of the network. The network operating system is typically installed in the server and so they give user accesses to the network resources. Servers can be of various kinds: file servers, database servers, print servers etc.

- **Clients** – Clients are computers that request and receive service from the servers to access and use the network resources.

- **Peers** – Peers are computers that provide as well as receive services from other peers in a workgroup network.

- **Transmission Media** – Transmission media are the channels through which data is transferred from one device to another in a network. Transmission media may be guided media like coaxial cable, fibre optic cables etc; or maybe unguided media like microwaves, infra-red waves etc.

- **Connecting Devices** – Connecting devices act as middleware between networks or computers, by binding the network media together. Some of the common connecting devices are: Routers,Bridges,Repeters,Gateways,Switches

Software Components

- **Networking Operating System**

- **Protocol Suite**
  - OSI Model (Open System Interconnections)
  - TCP / IP Model

Software Components

- **Networking Operating System** – Network Operating Systems is typically installed in the server and facilitate workstations in a network to share files, database, applications, printers etc.

- **Protocol Suite** – A protocol is a rule or guideline followed by each computer for data communication.

- Protocol suite is a set of related protocols that are laid down for computer networks. The two popular protocol suites are –
    a. OSI Model (Open System Interconnections)
    b. TCP / IP Model

Types of Computer network

- Networks can be classified based on following categories

 Transmission technology

 Topology

 Scale

 Transmission Media

Based on types of transmission technology

- Broadcast Networks

- Point-to-point Networks

Point-to-point Networks

- a dedicated link between two devices.

- The entire capacity of the link is reserved for transmission between those two devices.

- Transfer from source to destination may includes one or more intermediate machines

- Point-to-point transmission with one sender and one receiver is sometimes called unicasting

Point-to-point Networks
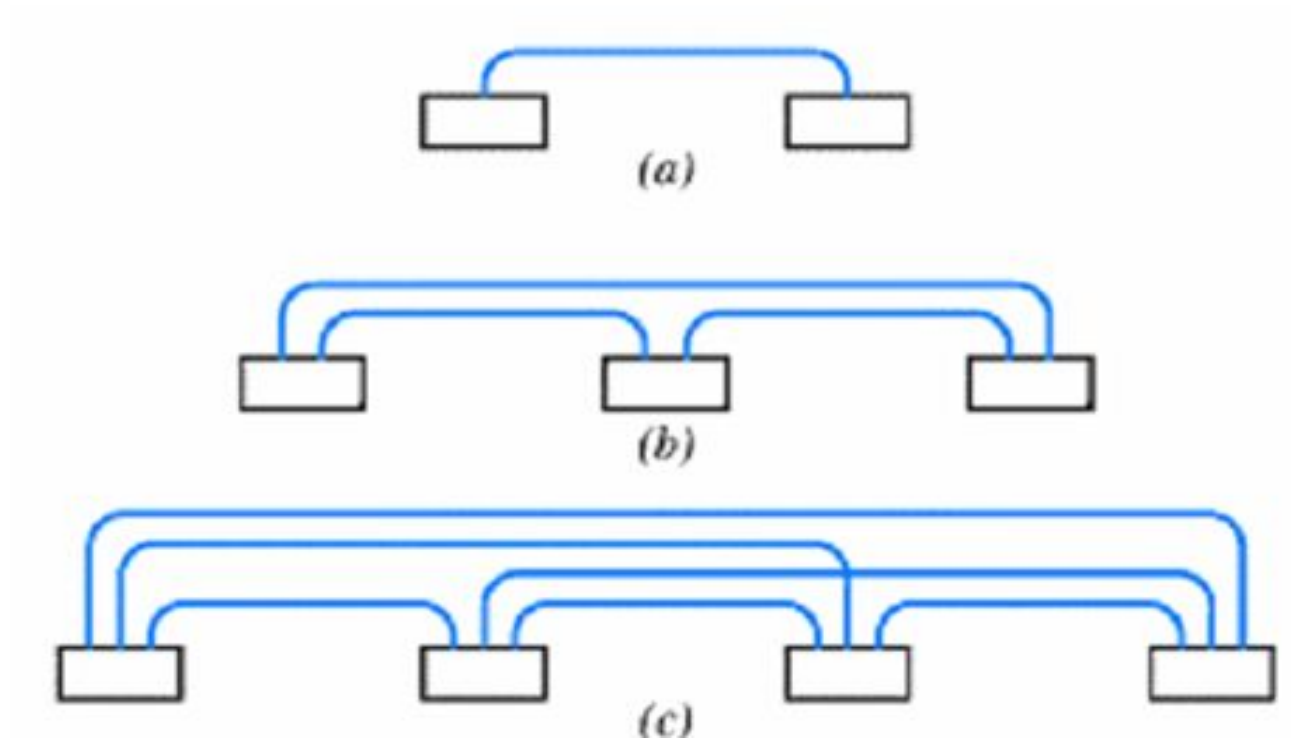
Broadcast Networks

- A *single communication channel* is shared by all the machines on the network

- *packets* sent by any machine are received by all the others

- Address field in a packet specifies the recipient

- After receiving the packet, the address field is checked

- If it is intended for itself, it processes the packet, otherwise it is ignored
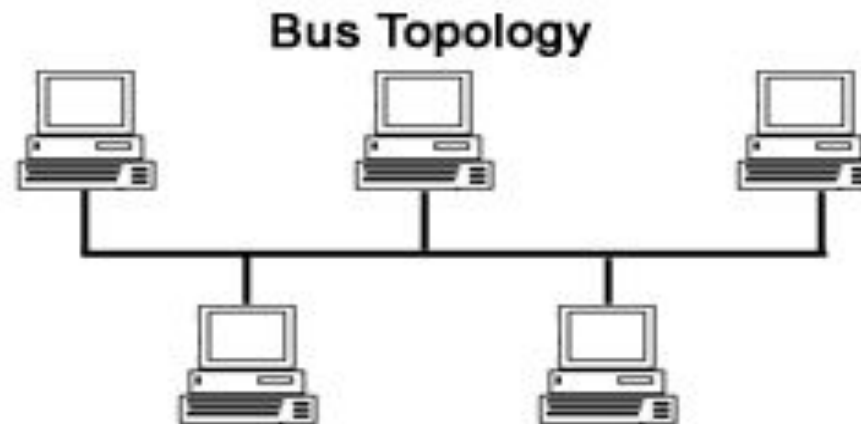

A Broadcast Example
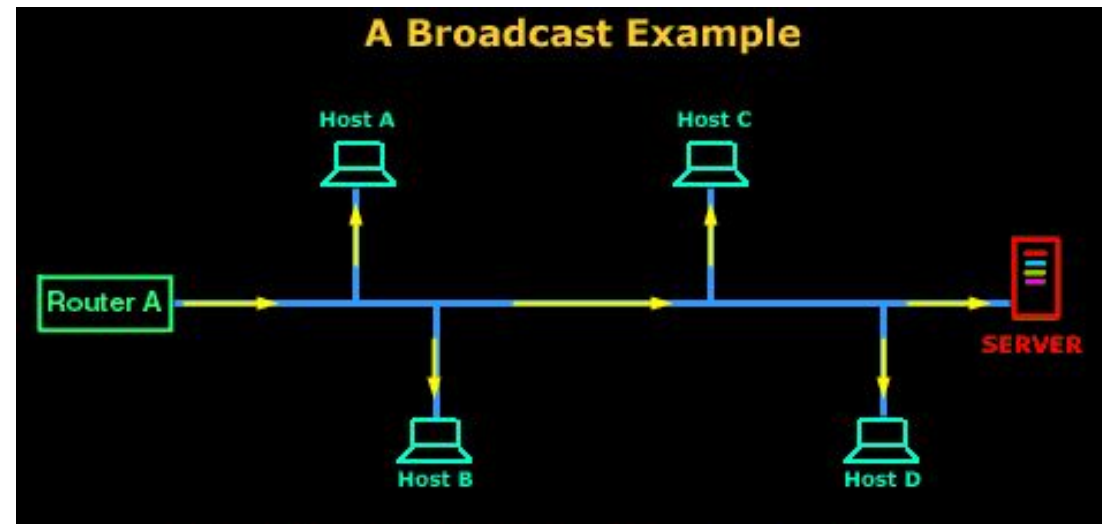
Classification based on topology

- Network Topology is the pattern used to arrange the nodes of network (describe the way computers are connected)

- Basic topologies:
  - Bus
  - Ring
  - Star
  - Mesh
  - Hybrid

Bus Topology

- Simplest
- all the stations are connected through a single cable(known as a backbone cable)

Bus Topology

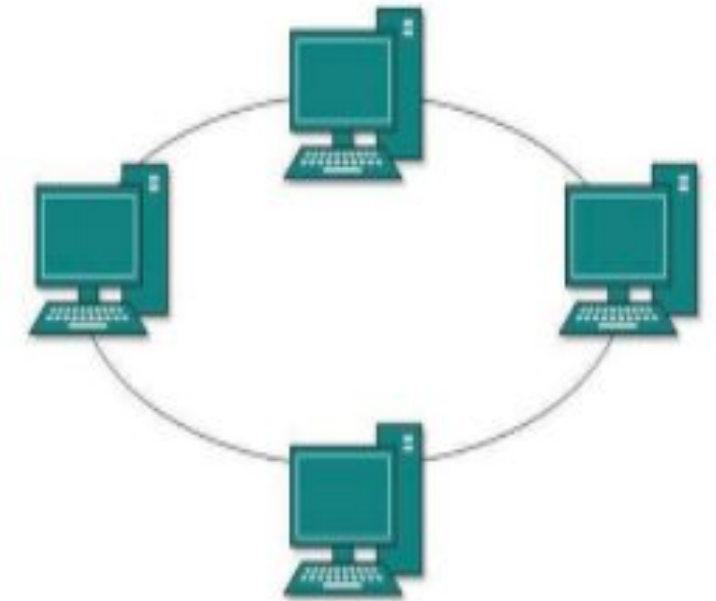# Bus topology

- Advantages:
  - ease of installation.
  - uses less.

Disadvantages :
  - Difficult reconnection and fault isolation.
  - A fault or break in the bus cable stops all transmission
  - As a signal travels along the backbone, some of its energy is transformed into heat. Therefore it becomes weaker and weaker as it travels farther and farther.

Ring Topology

- connected in a closed loop

- Each node connects to exactly two other nodes, creating a circular network structure.

- A signal is passed along the ring in one direction, from device to device,

    until it reaches its destination.

- One broken device can disable entire network

Ring Topology

- **Advantages**
  - A ring is relatively easy to install and reconfigure.
  - Fault isolation is simplified.

- **Disadvantages**
  - Unidirectional traffic can be a disadvantage.
  - In a simple ring, a break in the ring (such as a disabled station) can disable the entire network.

Star Topology

- Devices are connected to a central node called a hub.

- Each device has a dedicated point-to-point link only to Hub

- The devices are not directly linked to one another.

- Does not allow direct traffic between devices

- Failure of central hub will make the entire network collapse
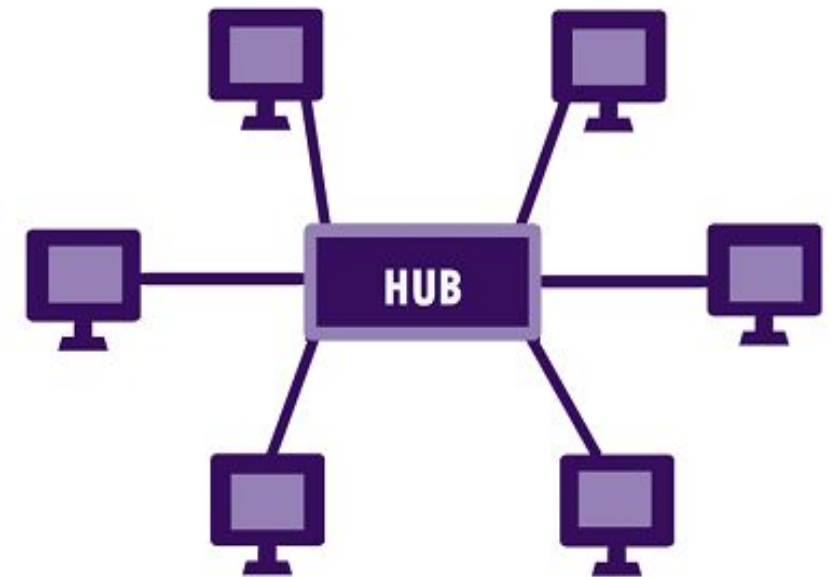
Star Topology

- **Advantages**
  - Each device needs only one connection: between that device and the hub.

  - If one link fails, only that link is affected. All other links remain active.

- **Disadvantages**
  - The dependency of the whole topology bon one single point, the hub. If the hub goes down, the whole system is dead.
  - Although a star requires far less cable than a mesh, each node must be linked to a central hub.
  - Cost of installation is high

Mesh Topology

- Every device has a dedicated point-to-point link to every other device.

- There are multiple paths from one computer to another

- Internet is an example of mesh topology

- Total no: of links required for mesh topology is   n(n-1)/2.
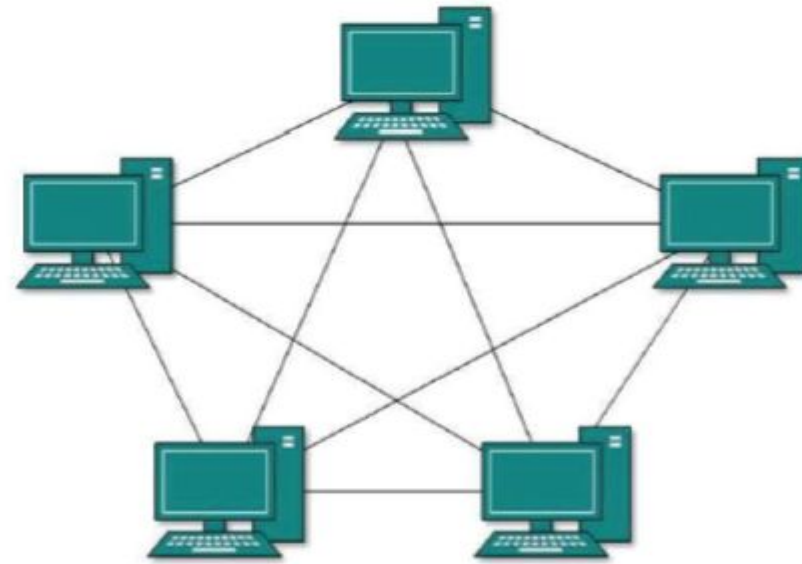
Mesh topology

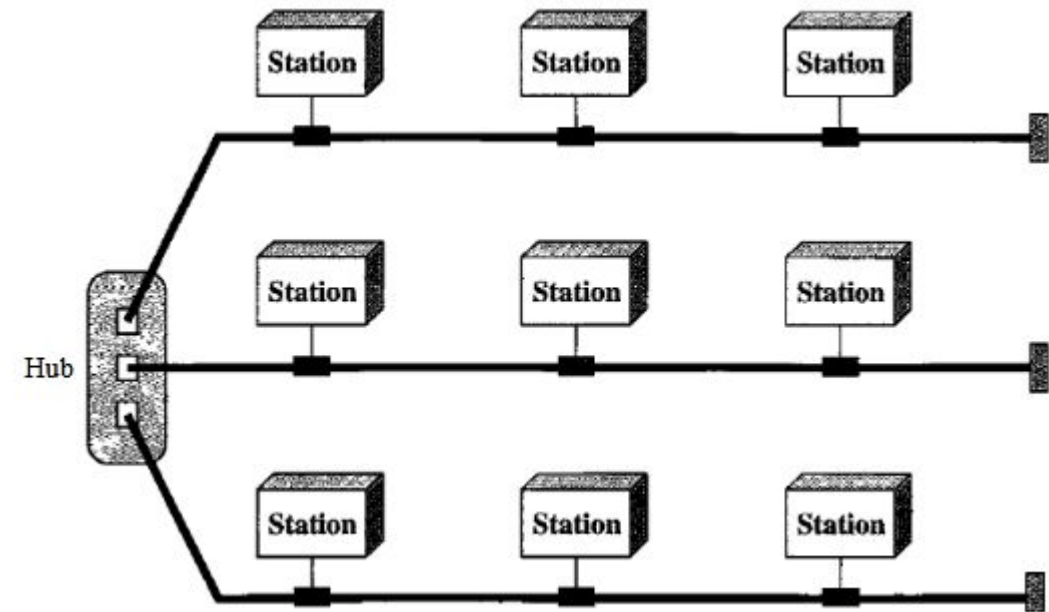- **Advantages of a mesh topology**
  - Manages high amounts of traffic, because multiple devices can transmit data simultaneously.
  - A failure of one device does not cause a break in the network or transmission of data.
  - Adding additional devices does not disrupt data transmission between other devices.

- **Disadvantages of a mesh topology**
  - The cost to implement is higher than other network topologies, making it a less desirable option.
  - Building and maintaining the topology is difficult and time consuming.
  - The chance of redundant connections is high, which adds to the high costs and potential for reduced efficiency.

Hybrid Topology

- Combination of various different topologies

- Two or more topologies are combined together

- For example, we can have a main star topology with each branch connecting

- several stations in a bus topology.

Hybrid Topology

- Advantages:
  - reliable, flexible, effective

- Disadvantages:
  - complex design , costly infrastructure

- **For n devices in a network, what is the number of cable links required for a mesh, ring, bus, and star topology?**

Solution

- Mesh topology: In this topology, each and every device has been connected to other device through 'point to point link'. For n devices in a network, links are required for mesh topology.

- 'Ring topology': Here, every device is connected to 2 devices on either side. For 'n devices in a network', n links are required for ring topology.

- Bus topology: Here, the 'devices are connected' to main cables using drop lines. For n devices in a network, n-1 cables are required.

- Star topology: Here, every device is connected using star hub. For 'n devices' in a 'network', n cable links are used in star topology.

Based on Scale

- Personal Area Networks

- Local Area Networks

- Metropolitan Area Networks

- Wide Area Networks

- Internetworks or Internet

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

	LAN	MAN	WAN
	Local Area Network	**Metropolitan Area Network**	**Wide Area Network**
Coverage	Small geographical area	Covers cities or towns	Large geographical area
ownership	private	Private/public	Private/public
Design & maintenance	easy	difficult	difficult
cost	Low cost of set up	Moderate cost	high
Error rate in data transmission	Very low error rate	low error rate	Comparatively high error rate
Propagation delay	short	moderate	long

Personal Area Networks

- Networks that are meant for single person

- Eg: a wireless network connecting a computer with its mouse, keyboard, and printer
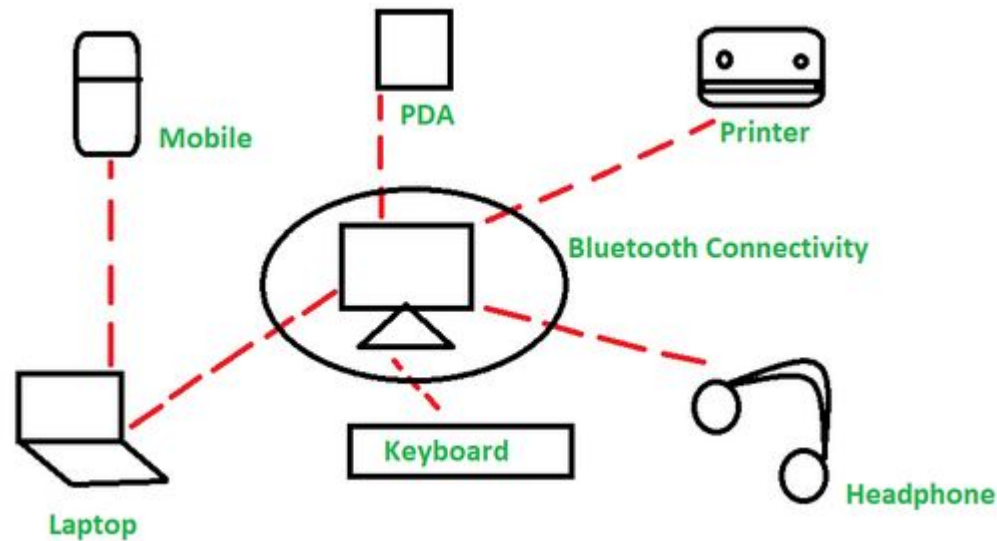
Local Area Networks

- Generally called as LANs

- Privately owned networks

- Inter-processor distance:10m to 1km

- Networks placed in a single room or building or campus

- LANs are distinguished by 3 characteristics –

    - Size

    - Transmission Technology

    - Topology

LAN

- **Size** :-
    - LANs are restricted in size
    - Worst-case transmission time is bounded and known in advance.
    - Knowing this bound makes it possible to use certain kinds of designs
    - Simplifies Network management.

- **Transmission Technology** :-
    - consist of a single cable to which all the machines are attached .
    - Traditional LAN runs at speed of 10 to 100 Mbps
    - Newer LANs operate at 10 Gbps
    - Low delay
    - Makes very few errors
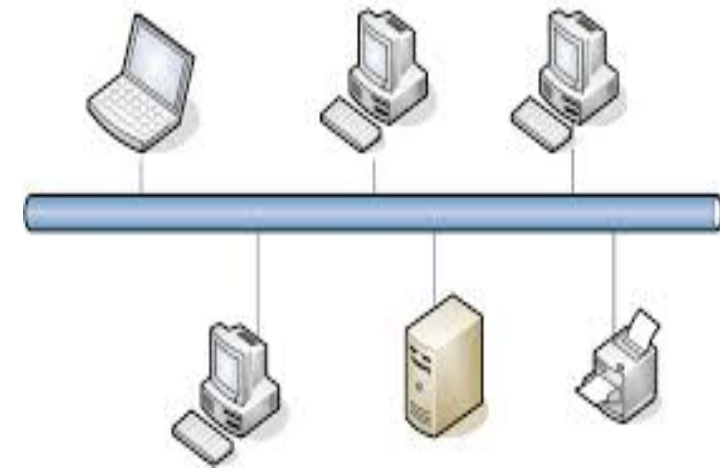
LAN

- **LAN Topologies are :-**
  - Bus

  - Ring

LAN

- **Topology** :-
  - Bus (Linear cable) network
    - at any instant, at most one machine is the master and is allowed to transmit.
    - All other machines are required to refrain from sending
    - **Arbitration mechanism** :- to resolve conflicts when two or more machines want to transmit simultaneously.
    - It may be Centralized or distributed (decentralized)

BUS Topology

LAN

- Eg:-IEEE 802.3 popularly called Ethernet is bus based broadcast network with decentralized control
  - operates at 10 Mbps to 10 Gbps
  - Computers on an Ethernet can transmit whenever they want to;
  - if two or more packets collide, each computer just waits a random time and tries again later
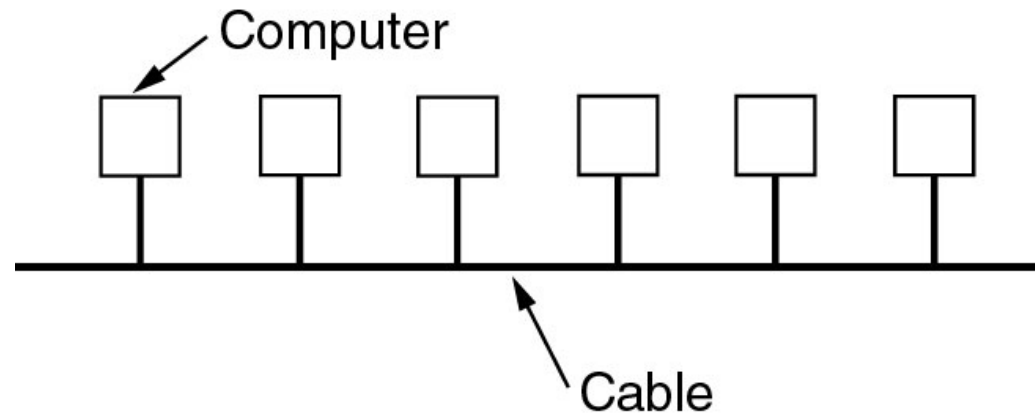
LAN

- Ring Network:
  - Devices acts as repeaters to boost the signal
  - The transmission of data takes place by token passing.
  - A token is a special series of bits that contains control infor
  - Possession of the token allows a network device to tran network.
  - Each network has only one token.

Ring Network Topology

File Server

Hub
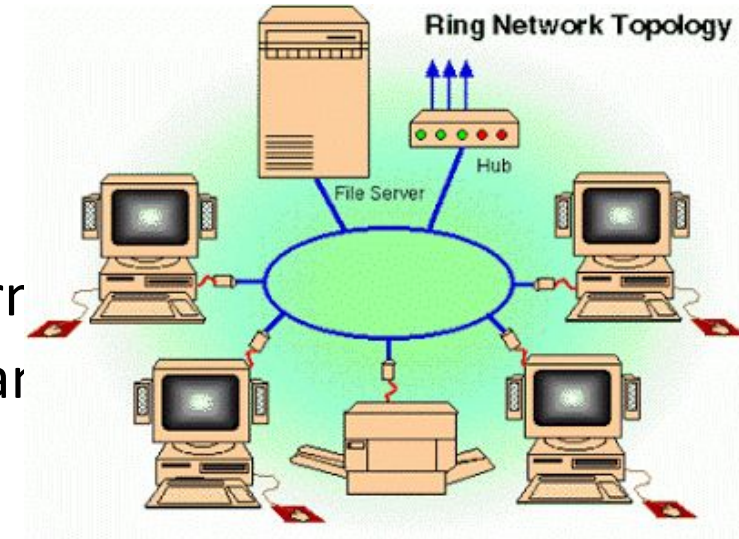
LAN

✔ **Working of Ring Network:**

- The sending computer removes the token from the ring and sends the requested data around the ring.
- Each computer passes the data until the packet finds the computer that matches the address on the data.
- The receiving computer then returns a message to the sending computer indicating that the data has been received.
- After verification, the sending computer creates a new token and releases it to the network.
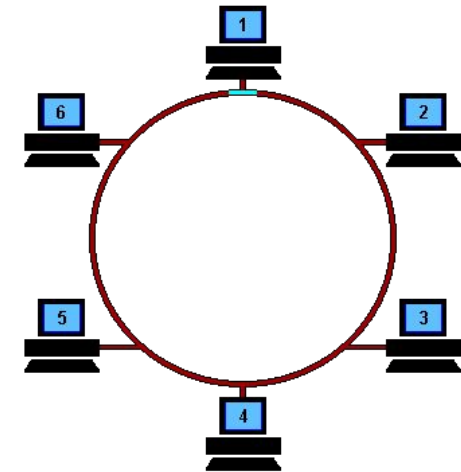
LAN

- Ring Network:
  - Egs:
    - IEEE 802.5 (the IBM token ring), is a ring-based LAN
      - operates at 4 and 16 Mbps.
    - FDDI (*Fiber Distributed Data Interface*) is another example of a ring network
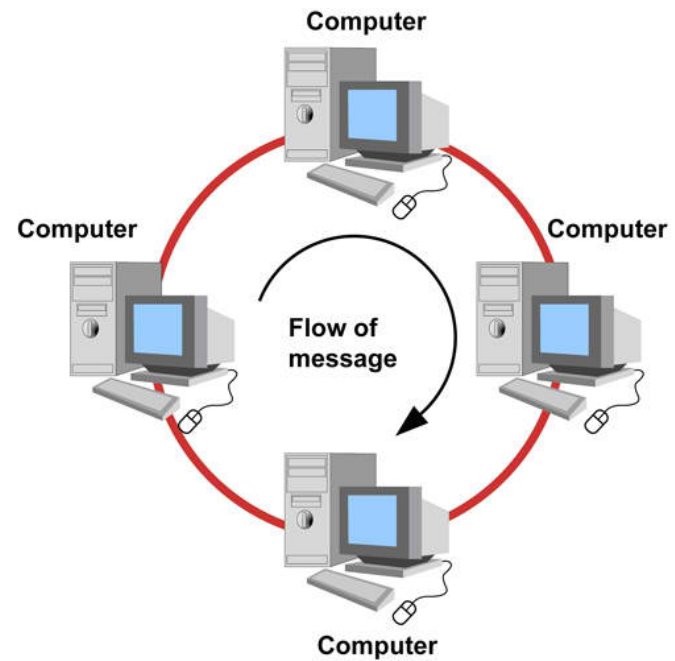
Metropolitan Area Networks (MAN)

- A metropolitan area network, or MAN, covers a city.

- The best-known example of a MAN is the cable television network available in many cities and   also the telephone company network that can provide a high-speed DSL line to the customer

- MAN or Metropolitan area Network covers a larger area than that of a LAN and smaller area as compared to WAN.

Wide Area Networks (WAN)

- spans a large geographical area, often a country or continent

- Best example of WAN is internet

- Internet is considered as the largest WAN in the world

- communicate devices across the world

Wide Area Networks (WAN)

- It contains a collection of machines called hosts intended for running user (i.e., application) programs

- The hosts are owned by the customers

- The hosts are connected by a communication subnet, or just subnet

- The communication subnet is typically owned and operated by a telephone company or Internet service provider

- The job of the subnet is to carry messages from host to host, just as the telephone system carries words from speaker to listener

Wide Area Networks (WAN)

- Subnet consists of two distinct components:
  - transmission lines
  - switching elements

- Transmission lines
  - move bits between machines.
  - made of copper wire, optical fiber, or even radio links.

- Switching elements
  - Specialized computers that connect three or more transmission lines.
  - When data arrive on an incoming line, it must choose an outgoing line on which to forward them.
  - Switching elements are also called as routers

Wide Area Networks (WAN)

- Relation between hosts on LANs and the subnet.
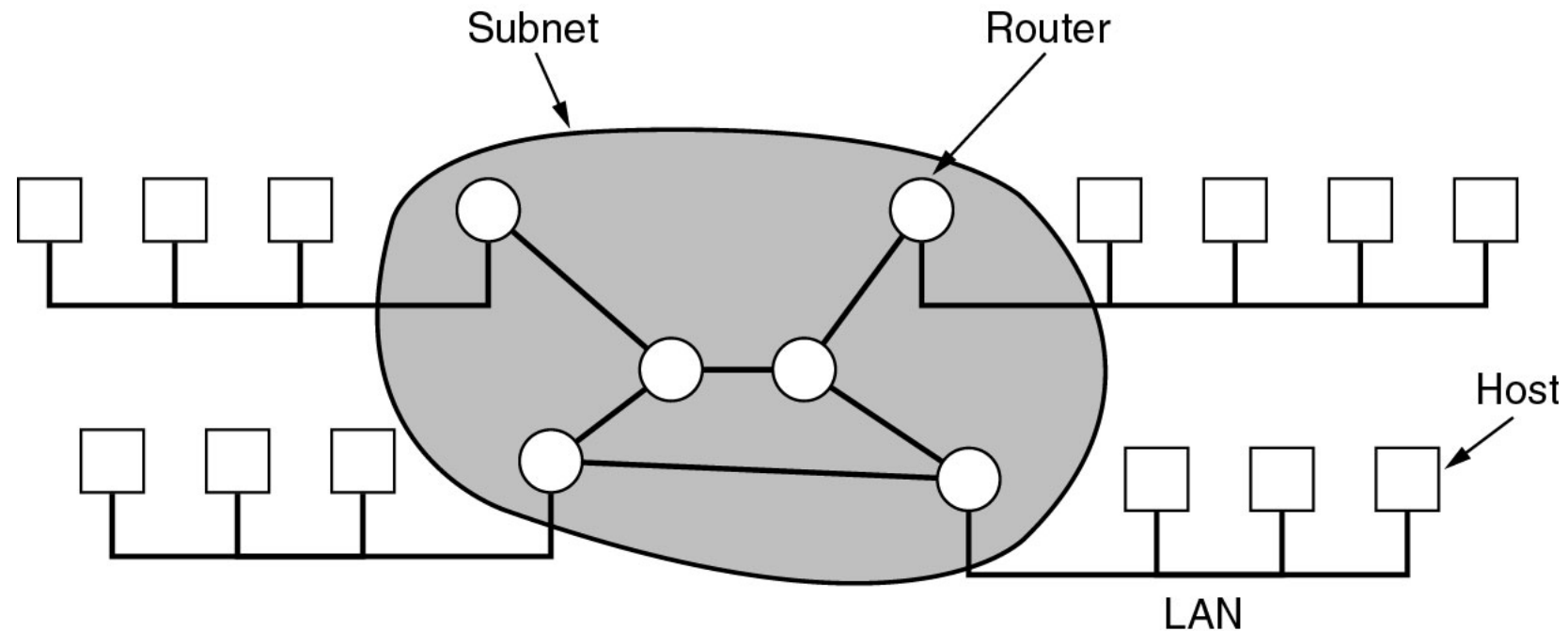
Internetworks

- A collection of interconnected networks is called an internetwork or internet

- A common form of internet is a collection of LANs connected by a WAN

- If the intermediate system contains only routers, it is a subnet

- if it contains both routers and hosts, it is a WAN

- An internetwork is formed when distinct networks are interconnected

Thank you