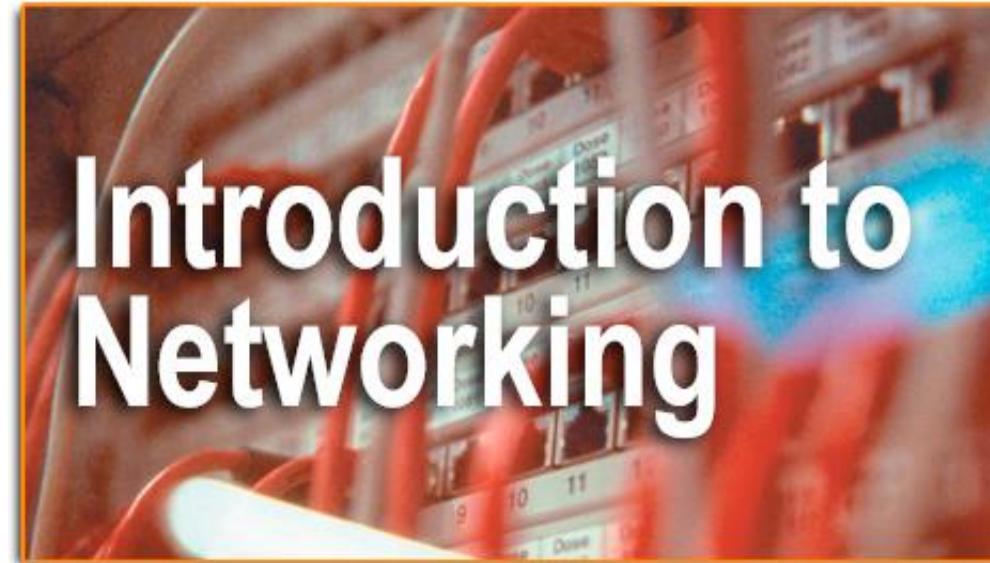


Lesson 1-Introducing Basic Network Concepts



OBJECTIVES

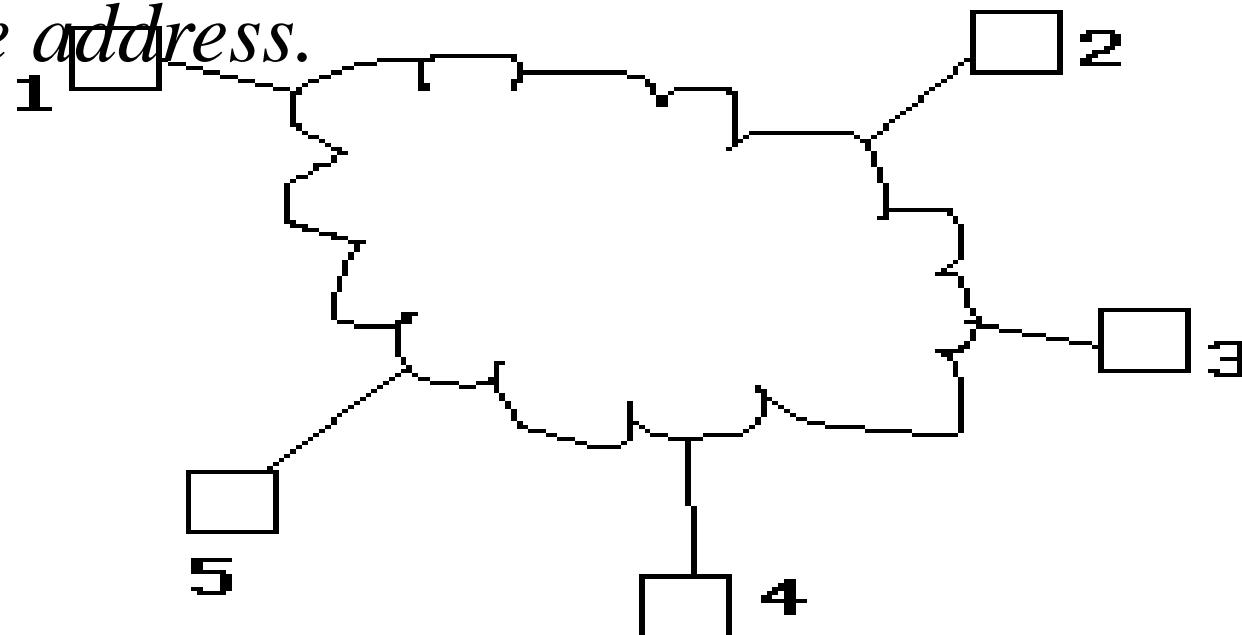
- To understand networking concepts and basic communication model.
- To understand network architectures and components required for data communication.
- To analyze the function and design strategy of physical, data link, network layer and transport layer.
- To Acquire knowledge of various application protocol standard developed for internet.

Overview

- Introduction to networks.
- Need for networks.
- Classification of networks.

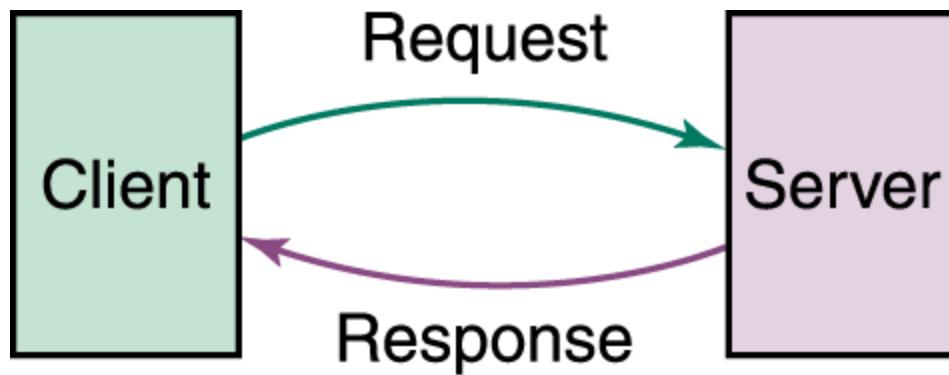
Introduction to Networks

- *A Network:* A group of devices that can communicate with each other over links.
- *Each device is called a host.* Each host has a unique address.



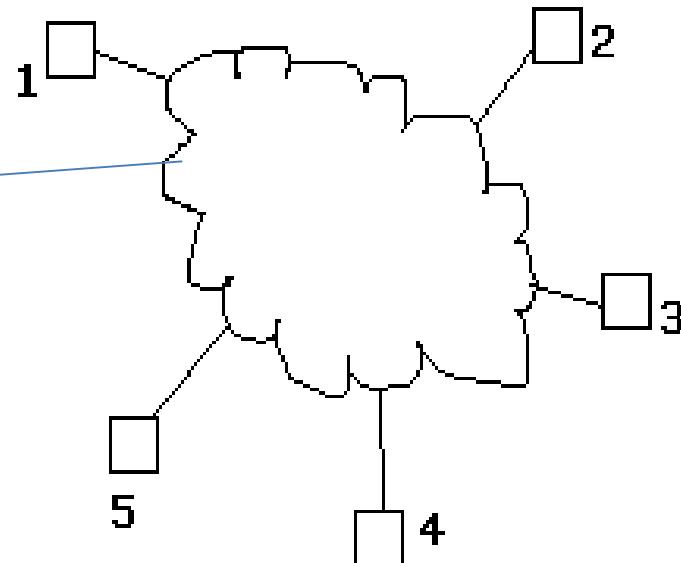
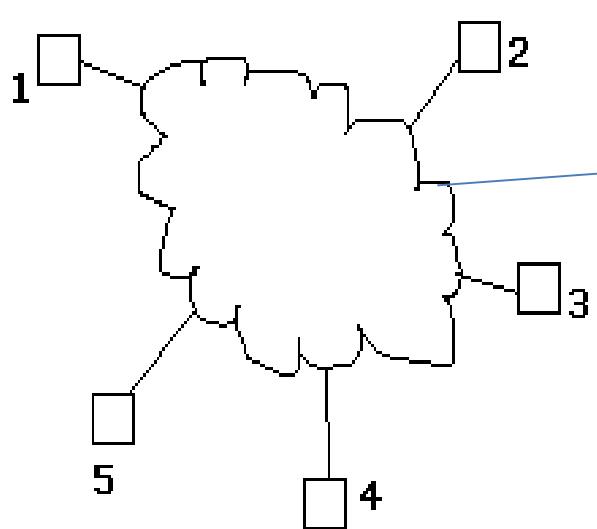
- **Network** is a connection between two or more devices.
- Which is connected by a communication links.
- A node can be computer, printer or any other devices which is capable of sending and receiving information at each other.

Example:



INTERNET

- An **internet**: A network of networks or connection between two or more Networks each host has an address of the form **n/h** where n is the network number and h is the number of the host on network n.



Introduction to Networks

- A network consists of two or more entities or objects sharing resources and information.
- A computer network consists of two or more computing devices connected to each other to share resources and information.
- The network becomes a powerful tool when computers communicate and share resources with other computers on the same network or entirely distinct networks.

Introduction to Networks

- Computers on a network can act as a client or a server.
- A client is a computer that requests for resources.
- A server is a computer that controls and provides access to resources.

Introduction to Networks

- Data is a piece of information.
- The computing concept ‘hierarchy of data’ is used when planning a network.
- It is essential to maintain a hierarchy of data to manage and control resources among computers.
- Network access to data must be evaluated carefully to avoid security issues.

Uses of Network

- It is Used for
 - i) Business Application
 - ii) Home Application
 - iii) Mobile Users/ Application
 - iv) Social issues
 - v) E-Mail

NETWORK USAGE

- In the old days, computer systems were highly centralized.
- Now, a large number of autonomous computers are interconnected to do the job → Computer network → Distributed systems.
- Computer network v.s. distributed system
 - **Computer network**: a collection of autonomous computers interconnected by a single technology.
 - **Distributed systems**: a collection of autonomous computers appears to its users as a single coherent system. Coherence, model, implementation (middleware).
 - Examples: The Internet is not a single network but a network of networks. The Web is a distributed system that runs on top of the Internet.

Uses of Computer Networks

Computer networks are collections of autonomous computers,
e.g., the Internet

They have many uses:

- Business (VoIP, data/HW sharing, video conf)
- Home (Web, email, Netflix, games, cloud, social nets)
- Mobile users (maps, AV material, finding restaurants)

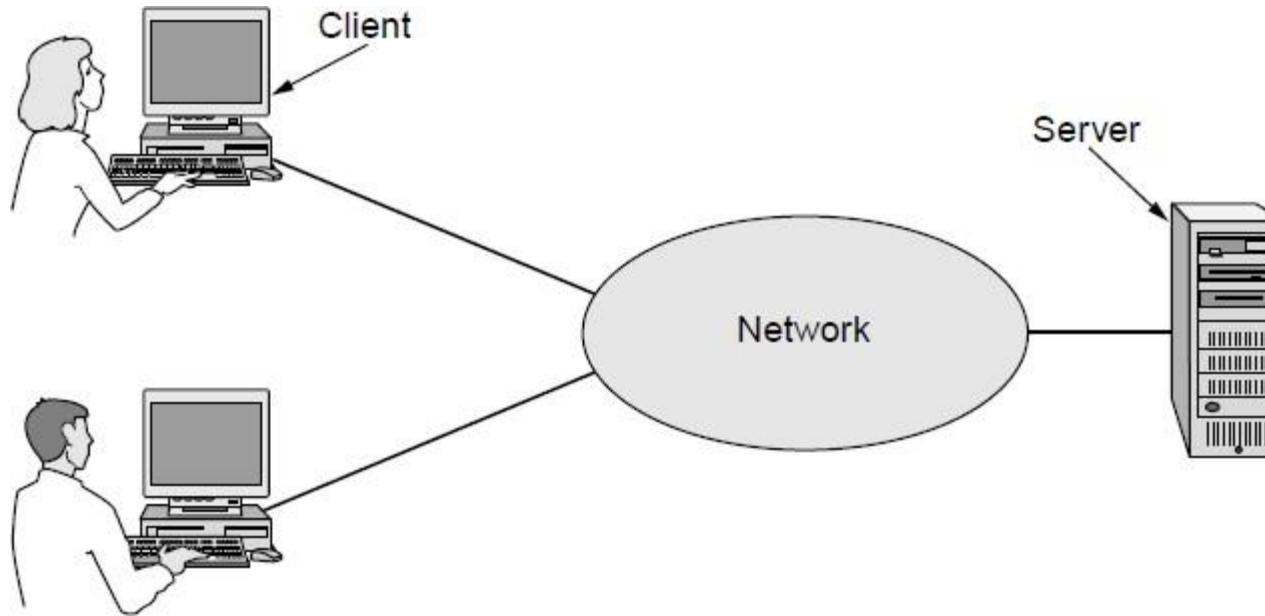
These uses raise:

- Social Issues

This text covers networks for all of these uses

Business Applications (1)

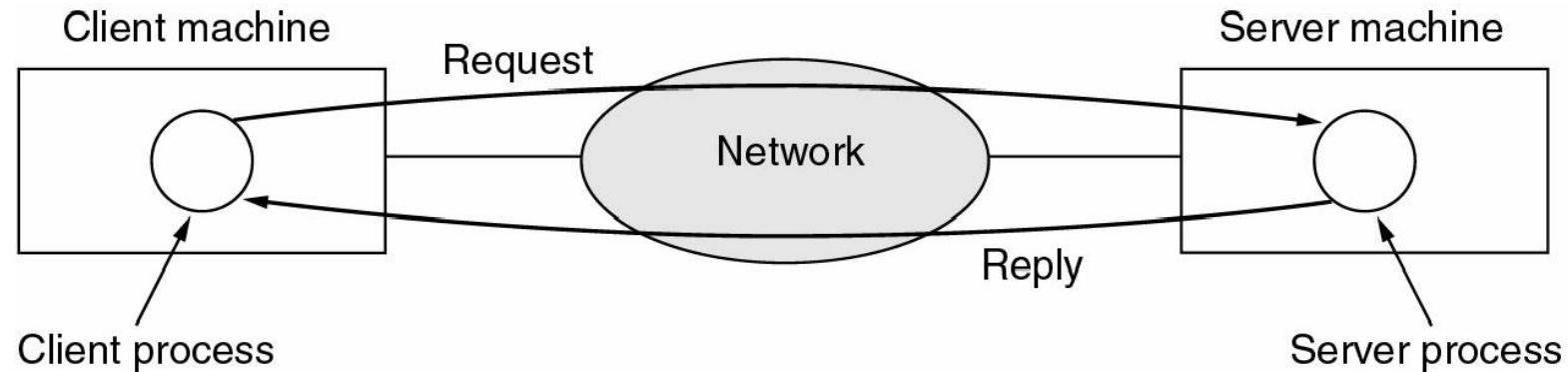
Resource sharing : To make all programs, equipment, and especially data available to anyone on the network without regard to the physical location of the resource and the user. A network with two clients and one server



You certainly know about clients and servers.
This course is about the network part.

Network Usage: Business applications

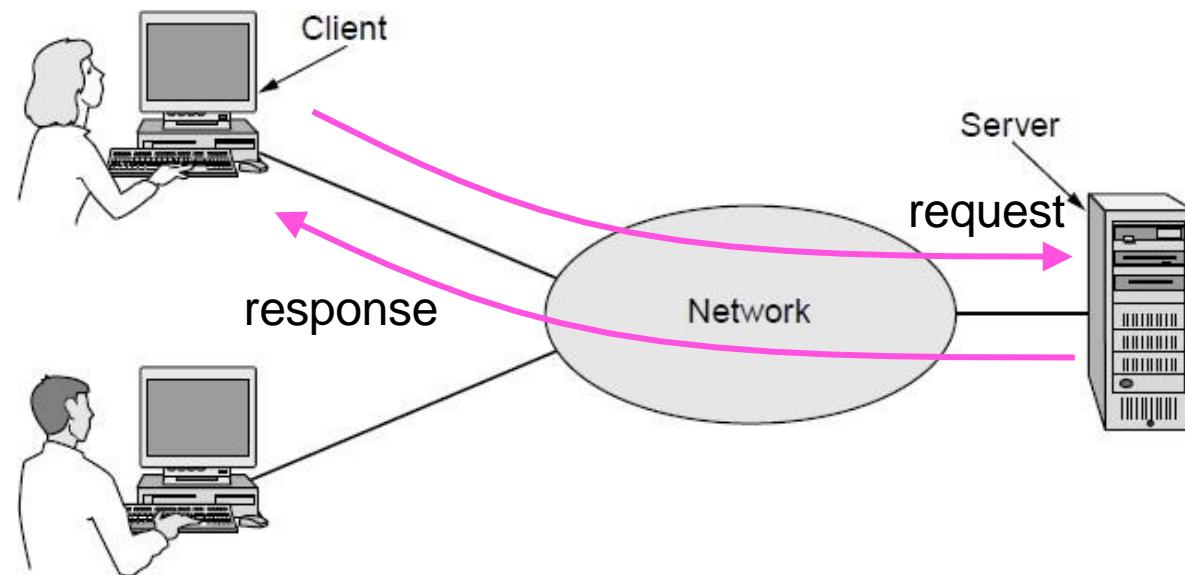
The **client-server model** involves requests and replies.



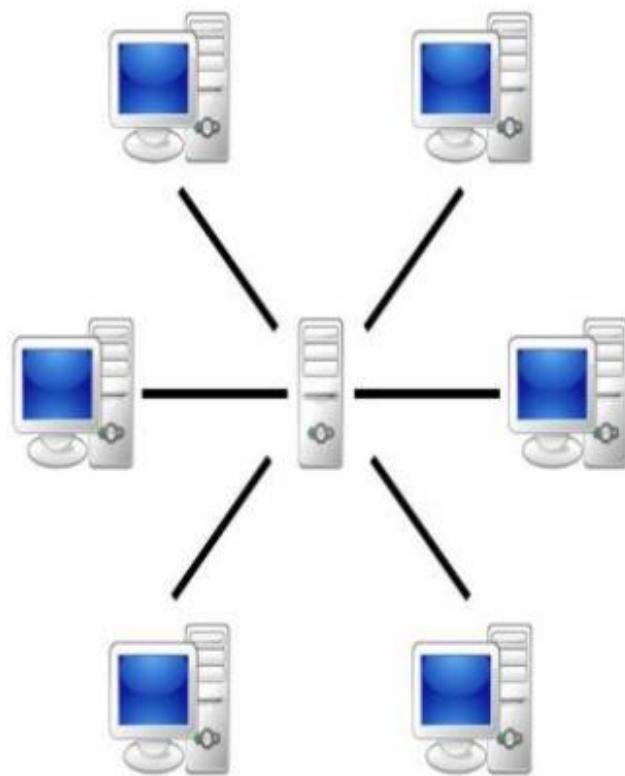
Business Applications (2)

Client makes requests

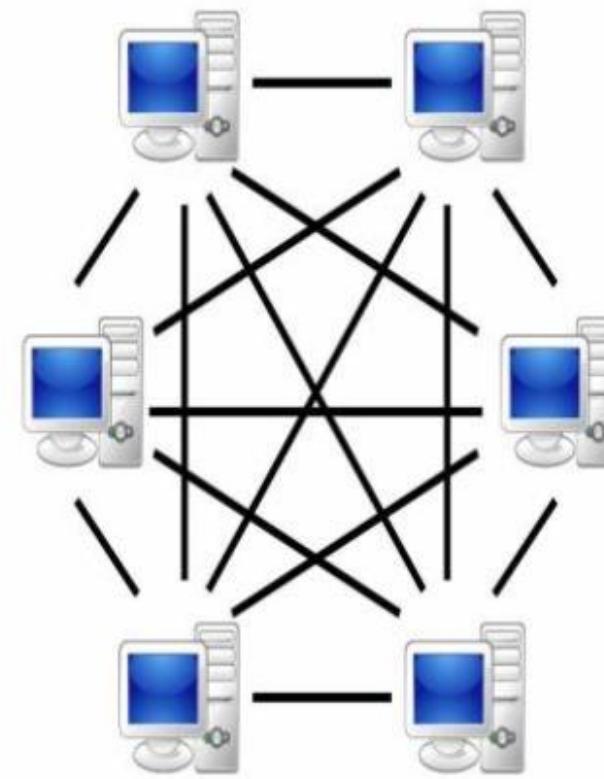
Server gives answers



Other popular uses are communication, e.g., email, VoIP, and e-commerce



Server-based



P2P-network

Network Usage: Business applications

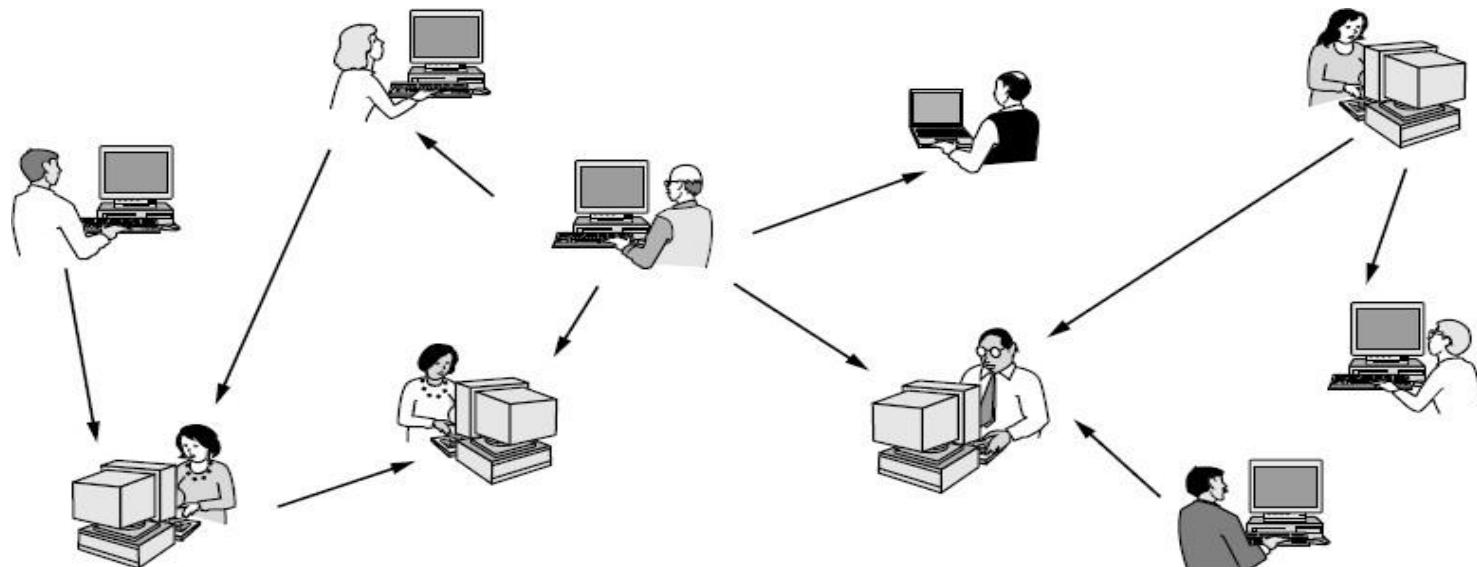
- Communication : To provide a powerful communication medium among widely separated employees.
 - Email,
 - BBS,
 - Video conferencing (QQ, MSN).
- E-commerce :
 - B2B,
 - B2C.

Network Usage · Home applications

- Access to remote information
- Person-to-person communication
- Electronic commerce
- Interactive entertainment
- Ubiquitous computing

Home Applications (1)

- Homes contain many networked devices, e.g., computers, Internet TVs, smartphones, etc.
- Home users communicate, e.g., social networks, consume content (Web, music, video, newspapers, etc.)
- Some applications use the peer-to-peer model in which there are no fixed clients and servers:



Network Usage· Home applications

- Access to remote information
 - Access to remote financial institutions.
 - Access to on-line and personalized newspapers.
 - Access to information systems like the WWW, which contains information about the arts, business, cooking, government, health, history, hobbies, recreation, science, sports, travel, and
 - too many other topics to even mention.
 - (Some better left unmentioned)

Network Usage · Home applications

- Person-to-person communication
 - Email
 - Instant messaging: chat room
 - Using the Internet to carry telephone calls, video phone, and Internet radio (YouTube)
 - Facebook, MSN, QQ, BBS
 - Wiki (Wikipedia)
 - Tele-learning

Home Applications (2)

Some forms of e-commerce

Tag	Full name	Example
B2C	Business-to-consumer	Ordering books online
B2B	Business-to-business	Car manufacturer ordering tires from supplier
G2C	Government-to-consumer	Government distributing tax forms electronically
C2C	Consumer-to-consumer	Auctioning second-hand products online
P2P	Peer-to-peer	Music sharing

Network Usage · Home applications

- Interactive entertainment
 - VOD (video on demand) , interactive films and interactive TVs.
 - Network game playing
 - Maybe a brand new industry based on computer networking and entertainment
- Ubiquitous computing
 - Computing is embedded into everyday life
 - Power-line networks
 - RFID

Mobile Users

- Tablets, laptops, and smart phones are popular; WiFi hotspots and 3G cellular provide wireless connectivity
- Mobile users communicate, e.g., voice and texts, consume content, e.g., video and Web, and use sensors, e.g., GPS
- Wireless and mobile are related but different:

Wireless	Mobile	Typical applications
No	No	Desktop computers in offices
No	Yes	A notebook computer used in a hotel room
Yes	No	Networks in unwired buildings
Yes	Yes	Store inventory with a handheld computer

Social Issues

- Network neutrality – no network restrictions
- Content ownership, e.g., DMCA takedowns
- Anonymity and censorship
- Privacy, e.g., Web tracking and profiling; terrorists
- Jurisdiction: gambling, porn, political speech
- Theft, e.g., botnets and phishing
- Incorrect (medical) information and fake news
- Facebook & Twitter and Russian trolls

Data Representation

- Information today comes in different forms such as text, numbers, images, audio, and video.

Text

- In data communications, text is represented as a bit pattern, a sequence of bits (0s or 1s). Different sets of bit patterns have been designed to represent text symbols. Each set is called a **code**, and the process of representing symbols is called **coding**.

- the prevalent coding system is called Unicode, which uses 32 bits to represent a symbol or character used in any language in the world.

[https://en.wikipedia.org/wiki/List_of_Unicode_characters]

- The American Standard Code for Information Interchange (ASCII), developed some decades ago in the United States, now constitutes the first 127 characters in Unicode and is also referred to as Basic Latin.

[https://en.wikipedia.org/wiki/ASCII#ASCII_control_characters]

Numbers

- Numbers are also represented by bit patterns.
- However, a code such as ASCII is not used to represent numbers;
- the number is directly converted to a binary number to simplify mathematical operations.

Images

- Images are also represented by bit patterns. In its simplest form, an image is composed of a matrix of pixels (picture elements), where each pixel is a small dot. The size of the pixel depends on the resolution.
- There are several methods to represent color images. One method is called RGB, so called because each color is made of a combination of three primary colors: red, green, and blue.

Audio

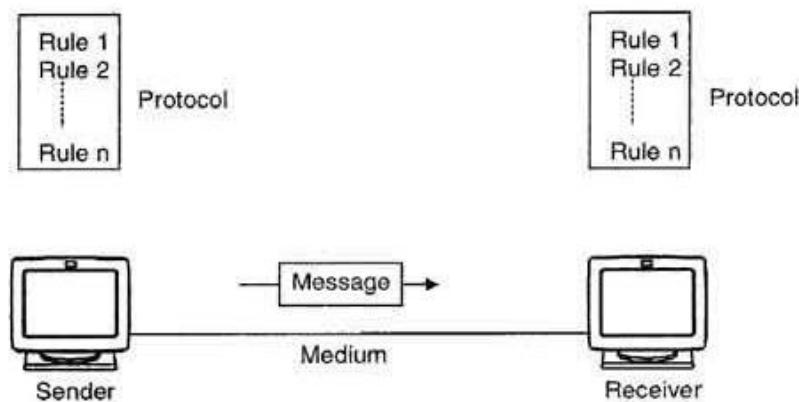
Audio refers to the recording or broadcasting of sound or music.

Video

Video refers to the recording or broadcasting of a picture or movie. Video can either be produced as a continuous entity (e.g., by a TV camera), or it can be a combination of images,

Data Communication

Data communication are the exchange of data between two nodes via some form of link transmission medium such as a cable



Communication Model

- Data communications are exchange of data between **two devices via some transmission medium.**
- **It should be done in two ways**
- **Local** - It takes LAN Connection.
- **Remote** - It takes Long distance like MAN & WAN.
- Data should be Transferred in the form of **0's and 1's**

Block Diagram for Communication Model:



Characteristics of Communication Model :

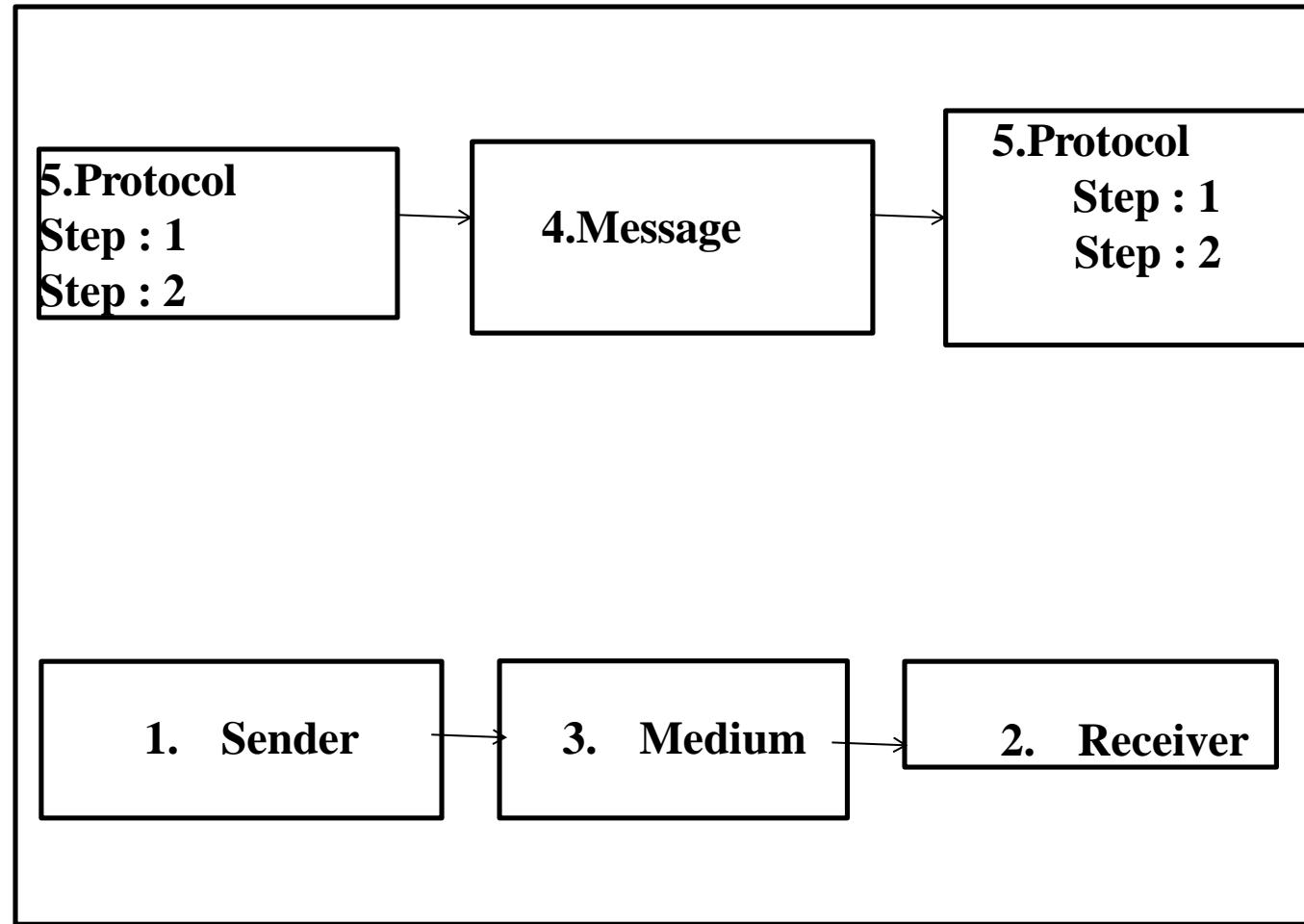
- 1) **Delivery**- The System must deliver the data to the correct Destination.
- 2) **Accuracy**- The System must deliver the data at Accurate way.

3) Timeline - The System must deliver the data at **Exact Time**.

4) Jitter - It refers to the variable in the **Perfect Arrival Time**.

Components of Communication Model :

- i) Sender
- ii) Receiver
- iii) Medium
- iv) Message
- v) Protocol



- 1. Sender** : It is a device , that Sends the information to the Receiver.
- 2. Receiver** : It is a device , that Receives the information from the Sender.
- 3. Medium** : It is the physical path between Sender to Receiver.
- 4. Message** : This is the passing Informations.
- 5. Protocol** : It is a set of rules and regulations that “ Governed “ from data communication.

Data Flow

Simplex:

- Communication is always unidirectional
- One device can transmit and the other device will receive
- Example keyboards traditional monitors

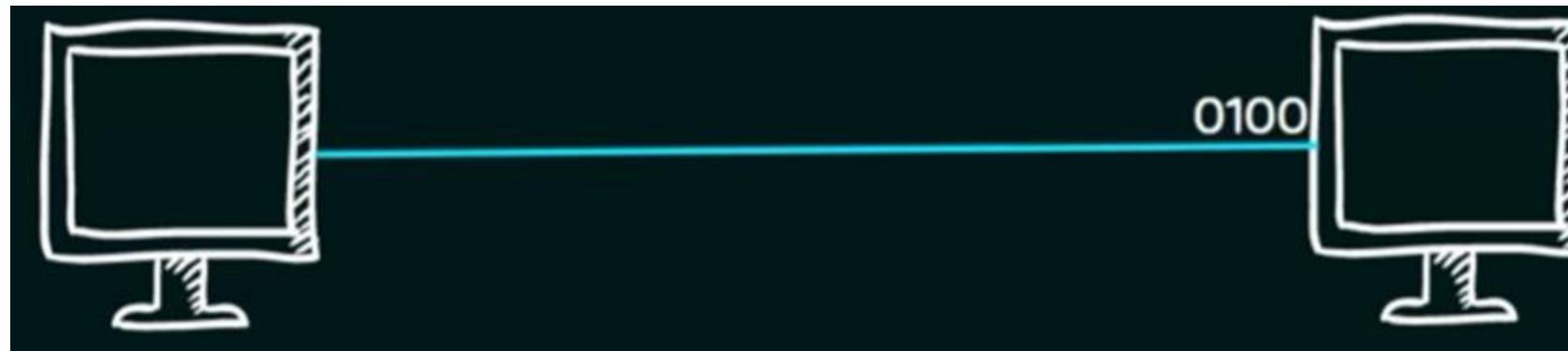
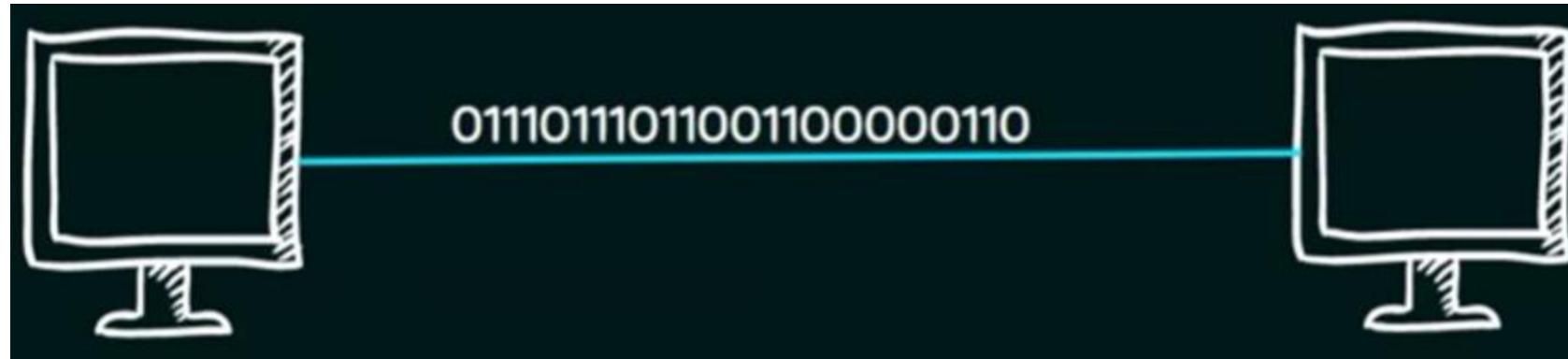
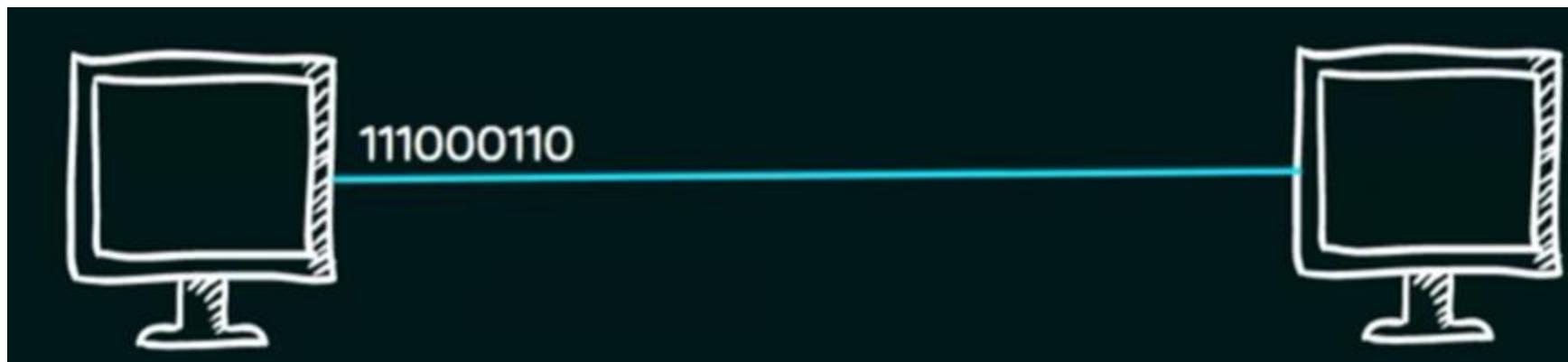
Data Flow

Half Duplex:

- Communication is in both directions but not at same time
- If one device is sending the other device can only receive and vice versa
- Example: Walkie-Talkies

Sender

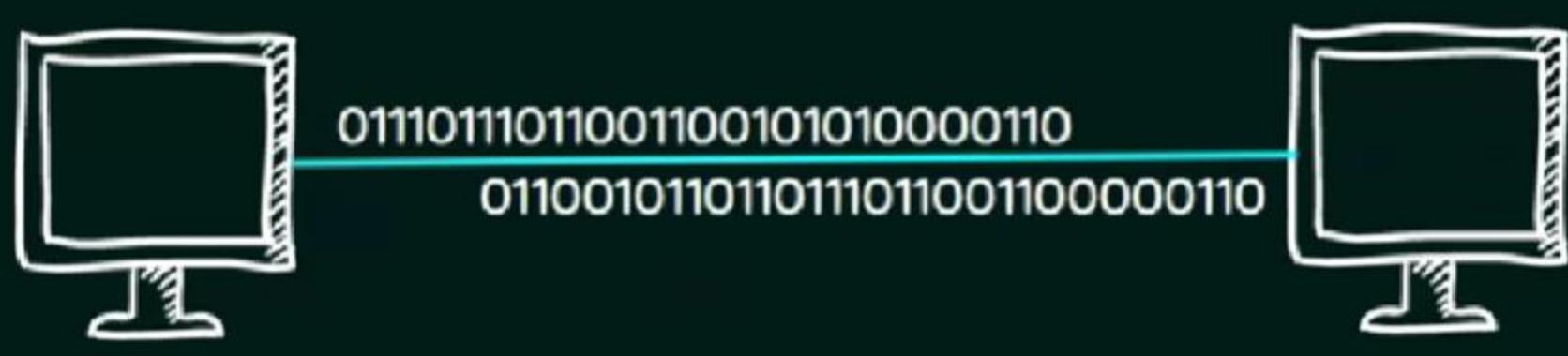
Reciever



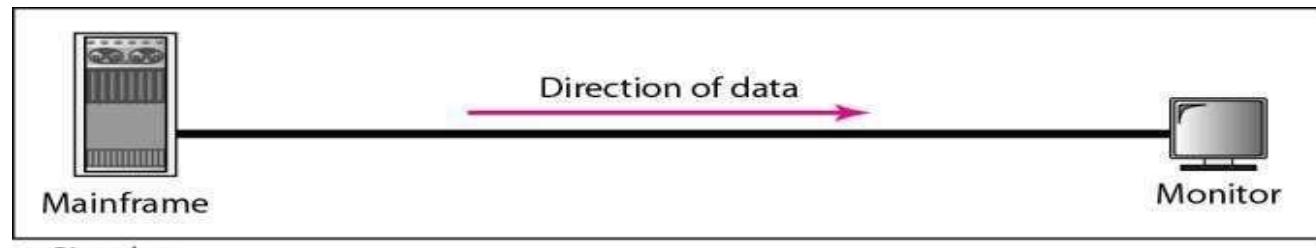
Data Flow

Full Duplex:

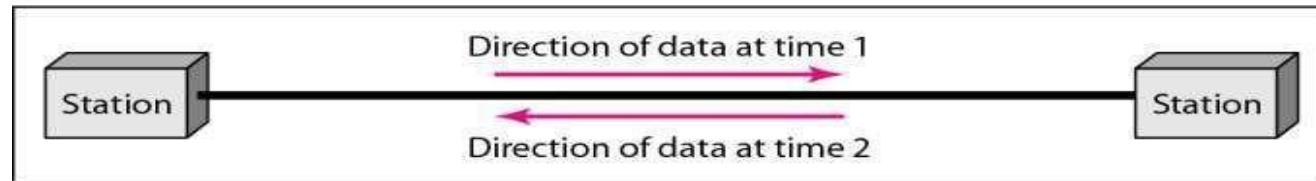
- Communication is in both directions simultaneously
- Device can send and receive at the same time
- Example: Walkie-Talkies



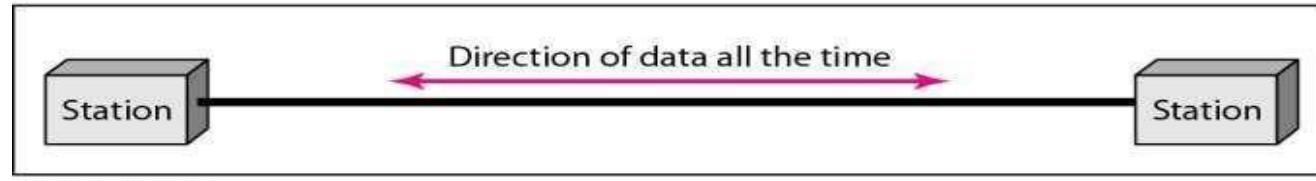
Data Flow



a. Simplex



b. Half-duplex



c. Full-duplex

Figure 1.2

Data flow (simplex, half-duplex, and full-duplex)

Protocols

All communication schemes will have the following things in common

- Sender or source
- Destination or receiver
- Channel or media

Protocols

Protocols = Rules

It is a set of rules that govern data communication

Protocols determines :

What is communicated?

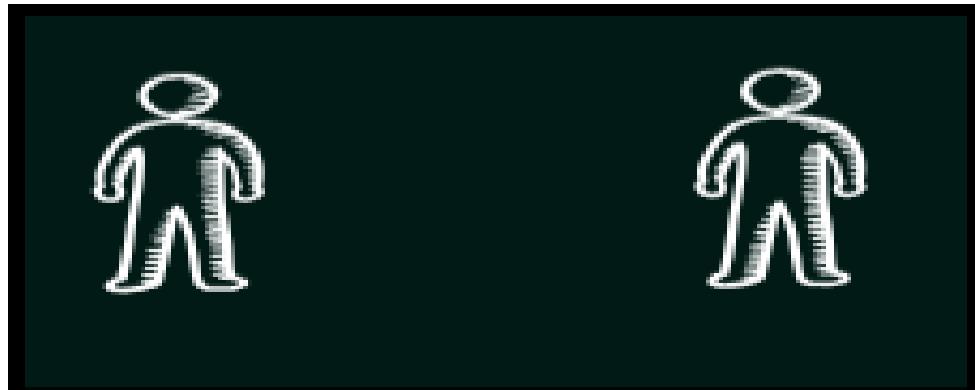
How it is communicated?

When it is communicated?

Protocols – Human Communication

Protocols are necessary for human communication and includes

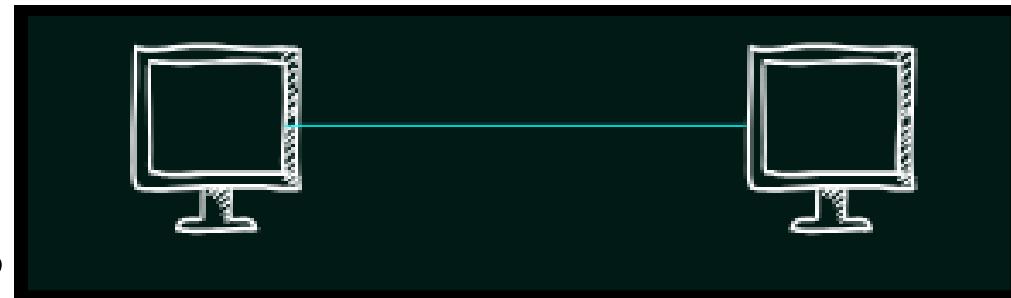
- An identified sender and receiver
- Common language and grammar
- Speed and timing of delivery
- Confirmation or acknowledgment requirements



Protocols – Network Communication

Protocols used in network communication also define:

- Message encoding
- Message formatting and encapsulation
- Message size
- Message timing
- Message delivery options



Message encoding



Message formatting and encapsulation

Agreed Format: Encapsulated the information to identify the sender and the receiver rightly

Message size

Humans break long message into smaller parts or sentences.

Long message must also be broken into smaller pieces to travel across a network.

Message timing

- Flow control.
- Response Timeout

Massage delivery options

Unicast

Multicast

Broadcast

NETWORK HARDWARE

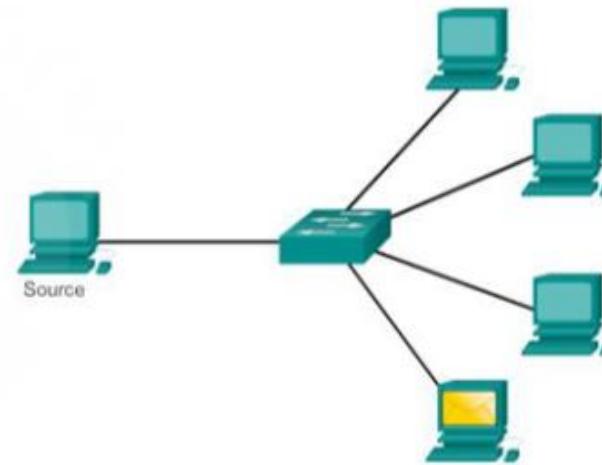
- Network classification:
 - Transmission technology
 - Broadcast networks
 - Point-to-point networks
 - Scale
 - Local area networks (LANs)
 - Metropolitan area networks (MANs not Men)
 - Wide area networks (WANs)
 - Inter-networks (internet vs. Internet)

Network Hardware: Transmission

- Broadcast networks : broadcast networks have a single communication channel that is shared by all the machines on the network. There are three addressing possibilities:
 - Unicasting ,
 - Broadcasting,
 - Multicasting .
- Point-to-point networks : point-to-point networks have many communication connections between individual pairs of machines.

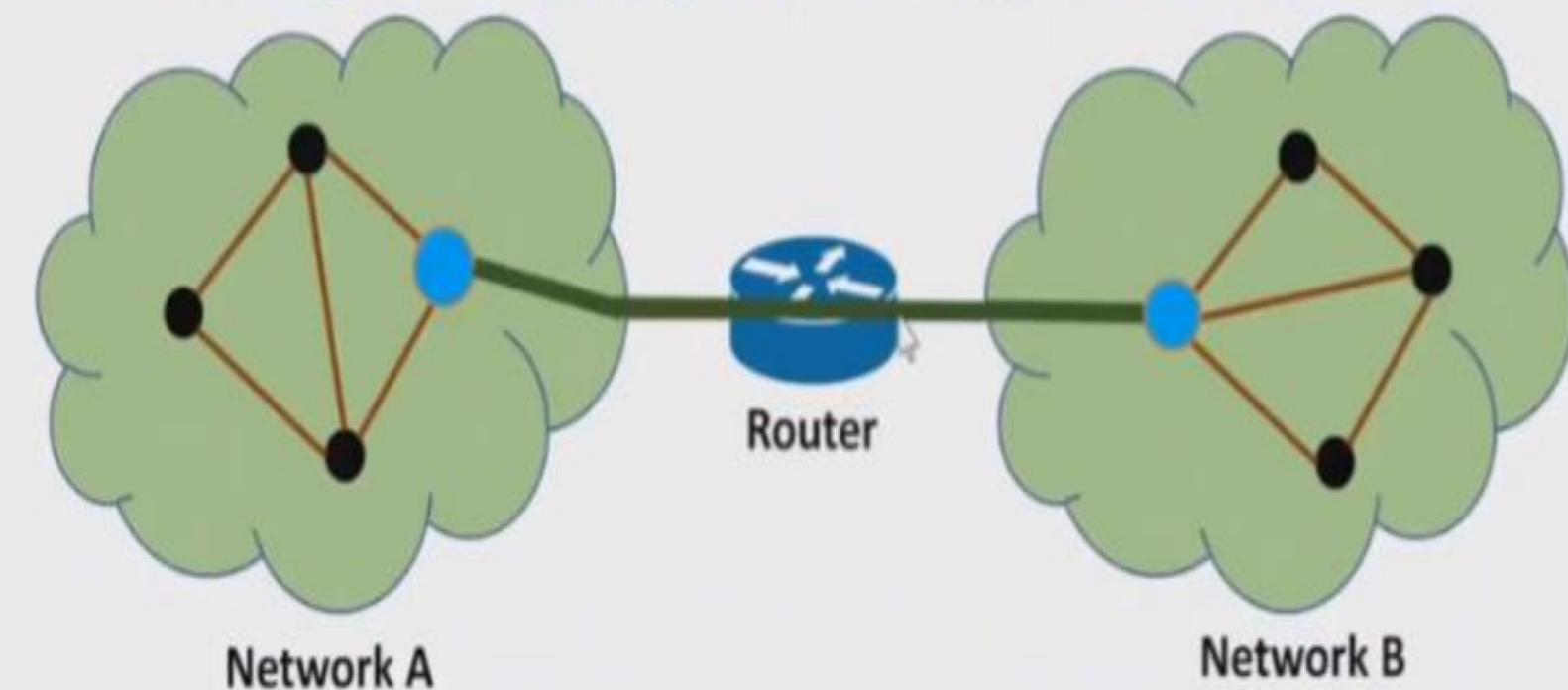
Message Delivery Options

Unicast



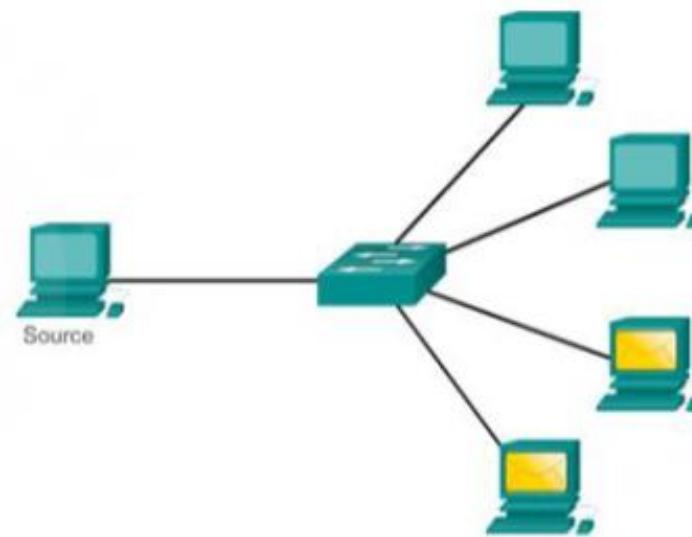
- ❖ Unicast in computer network

- ❑ Unicast means one to one message forwarding.
 - ❑ Using IP of node, unicasting can be done.



Message Delivery Options

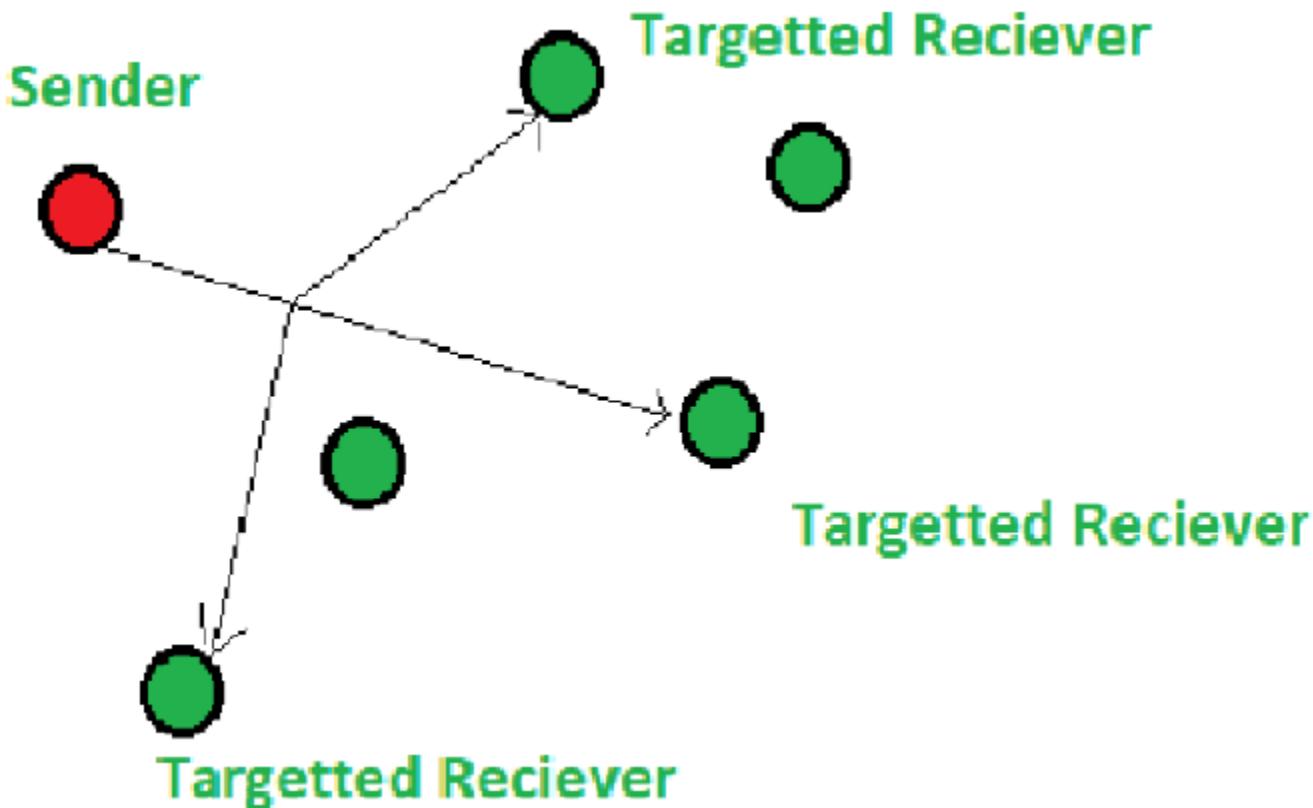
Multicast



Multicast In Computer Network

- **Multicast** is a method of group communication where the sender sends data to multiple receivers or nodes present in the network simultaneously. Multicasting is a type of one-to-many and many-to-many communication as it allows sender or senders to send data packets to multiple receivers at once across LANs or WANs. This process helps in minimizing the data frame of the network because at once the data can be received by multiple nodes.

- **Multicasting** is considered as the special case of broadcasting as it works in similar to Broadcasting, but in Multicasting, the information is sent to the targeted or specific members of the network.



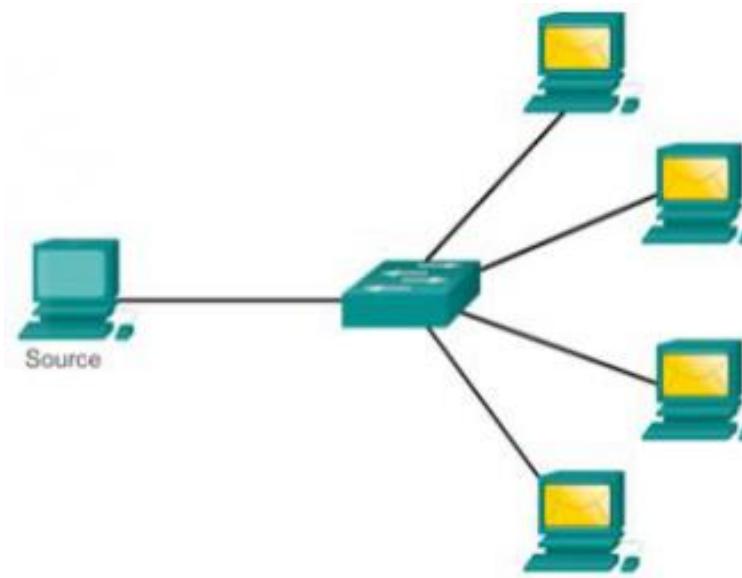
❖ Multicast in computer network

In multicast we send message from one computer many but not to all.

BROADCAST	MULTICAST
A method of transferring a message to all recipients simultaneously	A group communication where data transmission is addressed to a group of destination computers simultaneously
Packets are transmitted to all the connected devices in the network	Packets are transmitted to some of the devices in the network
There is no need for group management	Requires group management
Less secure	More secure
More traffic	Less traffic

Message Delivery Options

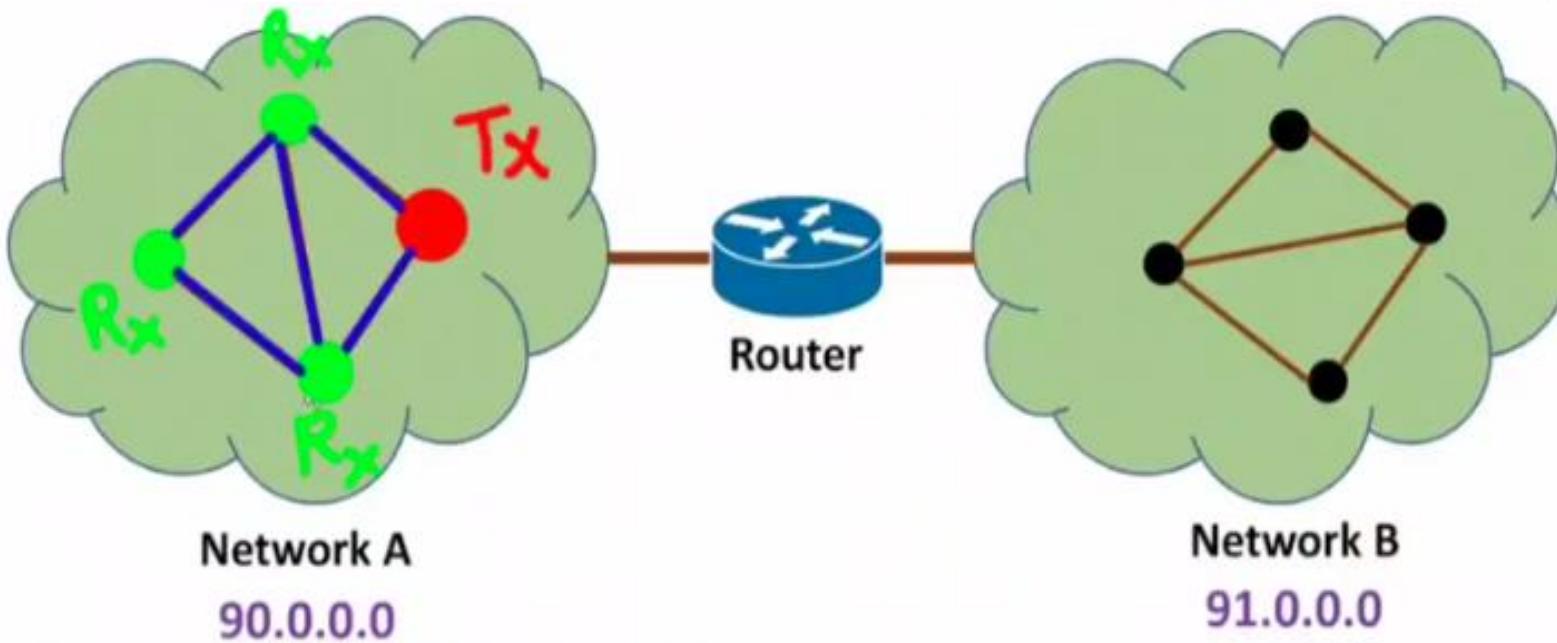
Broadcast



❖ Broadcast in computer network

□ There are two types of broadcast in computer network

1. Limited Broadcast : Limited Broad address is 255.255.255.255. It is limited to given router.
2. Direct Broadcast : Direct broadcast is used to send data to another network. It is not limited to given router.

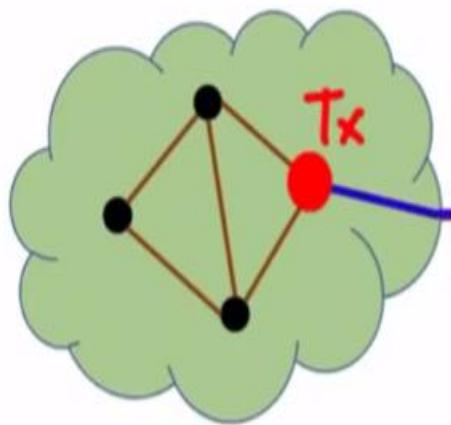


Limited Broadcast in network A
by any node of network A is
done by 255.255.255.255

❖ Broadcast in computer network

□ There are two types of broadcast in computer network

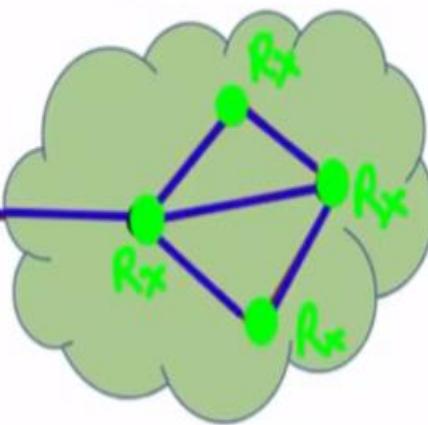
1. Limited Broadcast : Limited Broad address is 255.255.255.255. It is limited to given router.
2. Direct Broadcast : Direct broadcast is used to send data to another network. It is not limited to given router.



Network A

90.0.0.0

Limited Broadcast in network A
by any node of network A is
done by 255.255.255.255



Network B

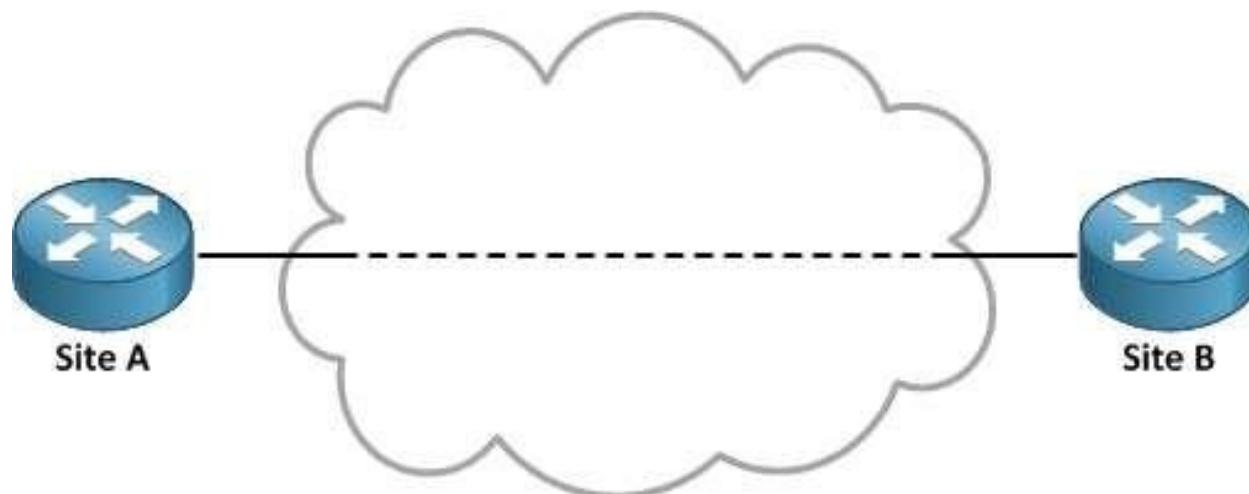
91.0.0.0

Direct Broadcast in network B
by any node of network A is
done by 91.255.255.255

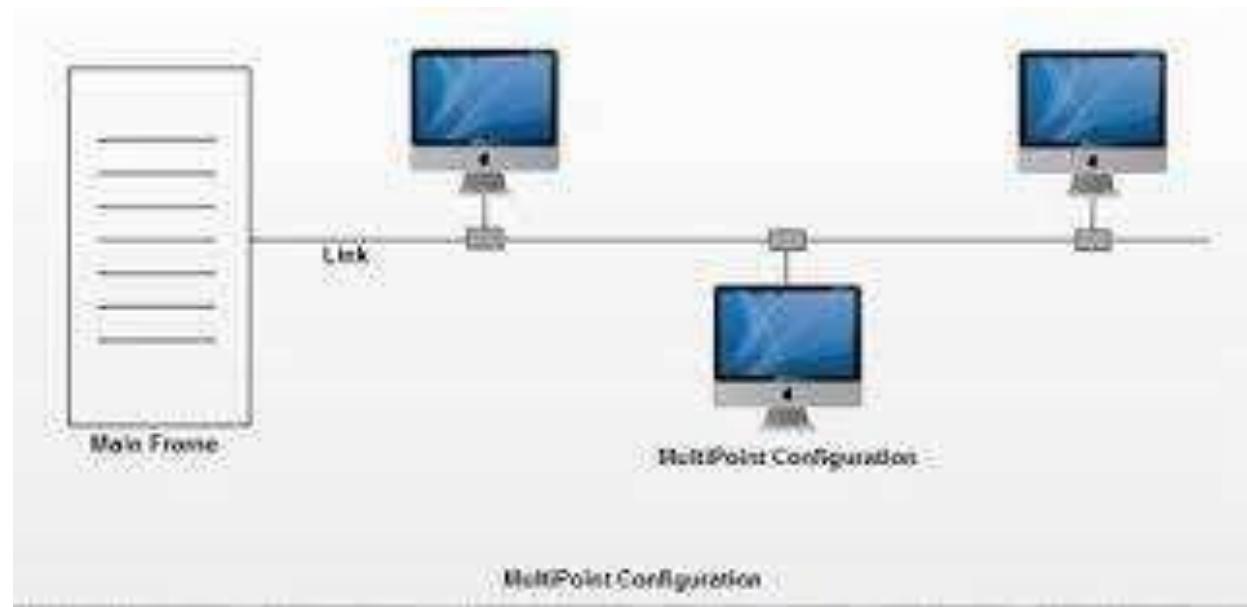
- Point - to - Point Connection : I

It Provides a dedicated links between two devices.

- For example, a wired system that connects two computers together can be thought of a point-to-point link.



- **Multi - Point Connection :** **It is a link between two or more devices.** It is also known as Multi- Point configuration. The networks having multipoint configuration are called **Broadcast Networks.**



Components of Network

- 1) Client** - Which gives the Request.
- 2) Server** - Which gives the Response.
- 3) Modems** - It Indicates Modulator / Demodulator.
- 4) Router** - Which identifies the Path between Client & Server.
- 5) Channels** -Which overcomes the Traffic problems.

Data Transmission Concepts and Terminology

- Data Transmission occurs between sender and receiver over some Transmission Medium or Transmission Media.
- Transmission Media may be classified into **Two Types :**
 - i) **Guided Media [Wired Technology]**
 - ii) **Unguided Media [Wireless Technology]**

i) Guided Media (Wired Network)

- In Guided Media Signals are Passed in
 - a
 - “ same physical path”
- Example:
 - i) Twisted pair Cable
 - ii) Coaxial Cable
 - iii) Fiber Optic Cable

ii) Unguided Media (Wireless Network)

- In Unguided Media Signals are Passed in the form of “ Electromagnetic Waves”
- Example :
 - i) Mobile phones
 - ii) Satellite microwave
 - iii) Infrared

Transmission Mode

- It refers to the direction of information flow between two devices.
- Data flow is the flow of data between 2 points.

The direction of the data flow can be described as

- Simplex Mode
- Half-Duplex Mode
- Full-Duplex Mode

- **Simplex:** Data flows in only one direction on the data communication line (medium).
Examples are Radio and Television broadcasts.
- **Half-Duplex:** Data flows in both directions but only one direction at a time on the data communication line.
Ex. Conversation on walkie-talkies.
- **Full-Duplex:** Data flows in both directions simultaneously. Modems are configured to flow data in both directions.
Ex. Phone Conversation

Data Flow

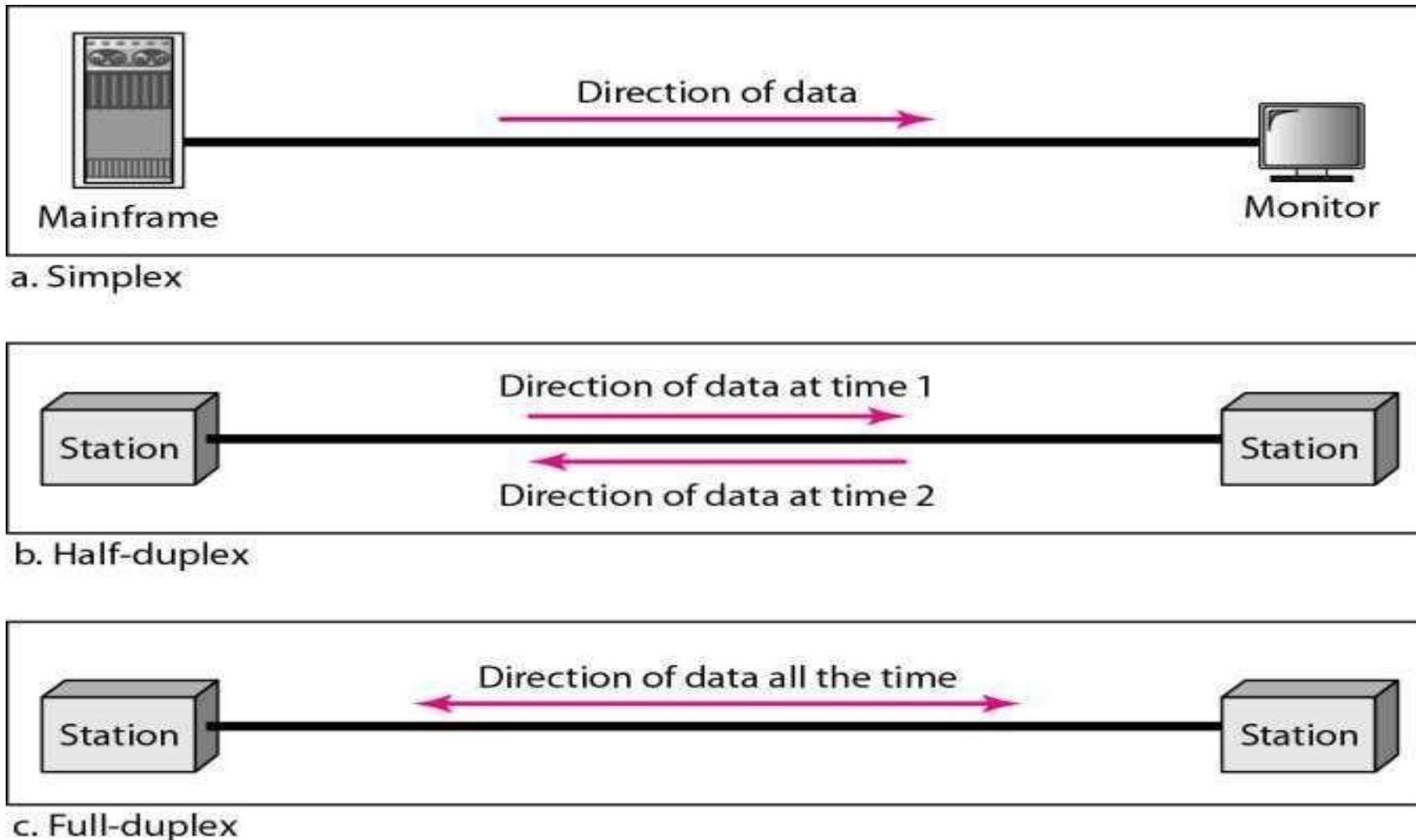
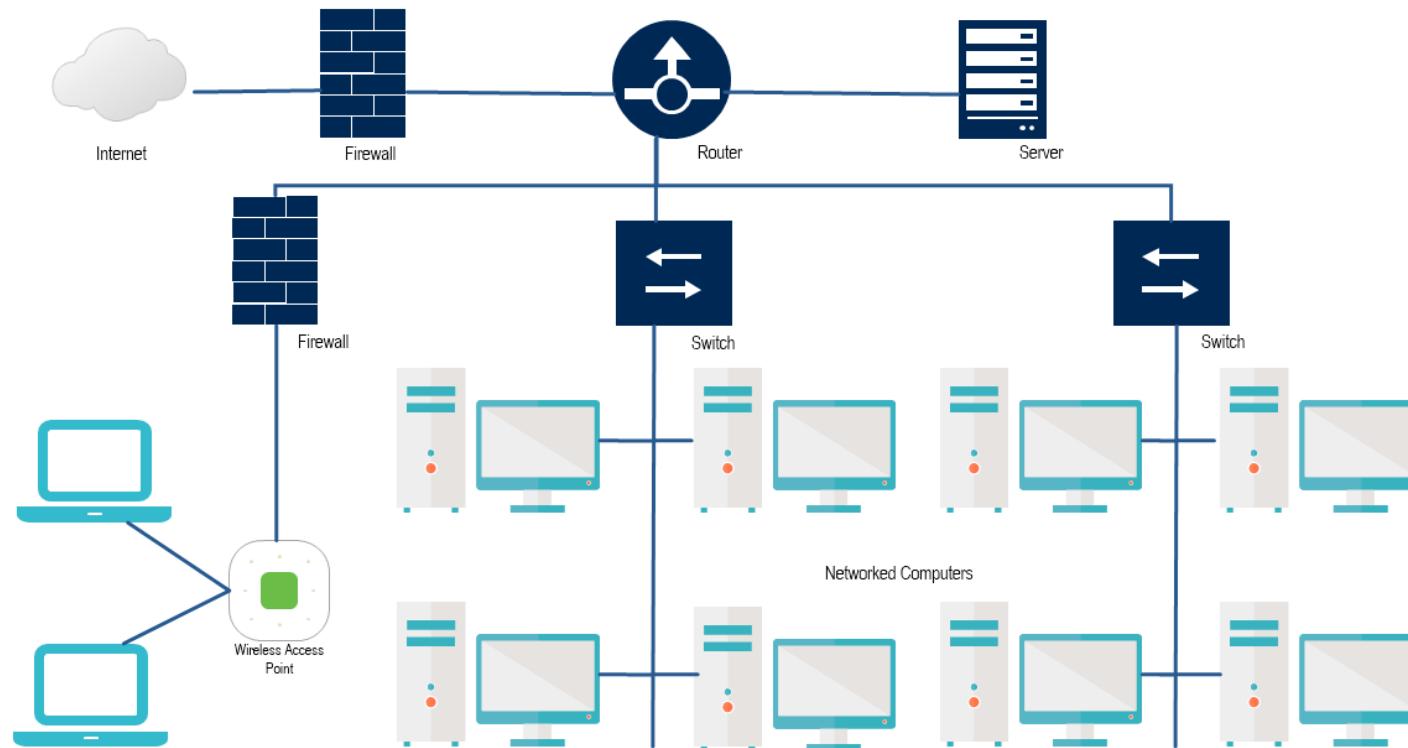
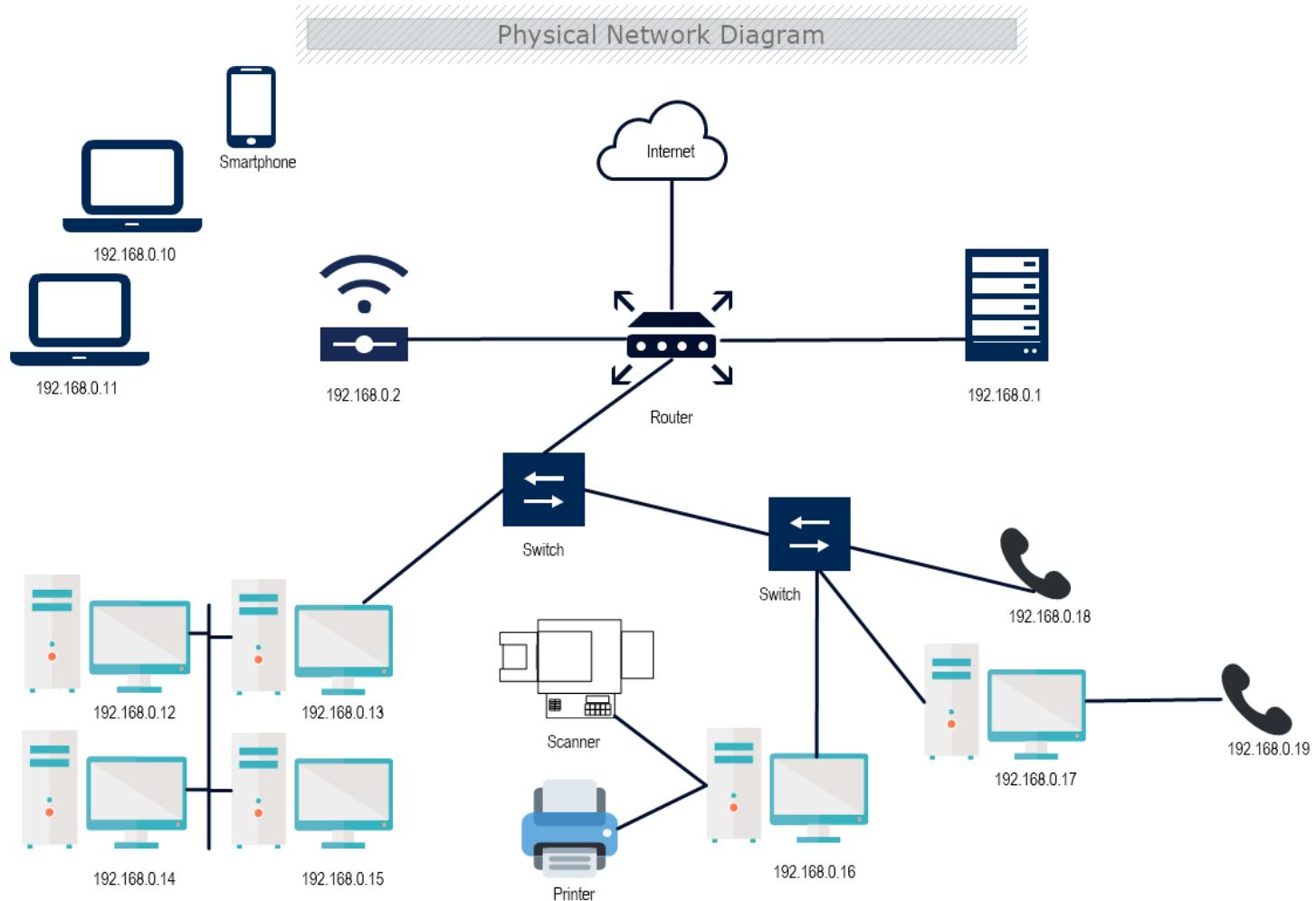


Figure 1.2 Data flow (simplex, half-duplex, and full-duplex)

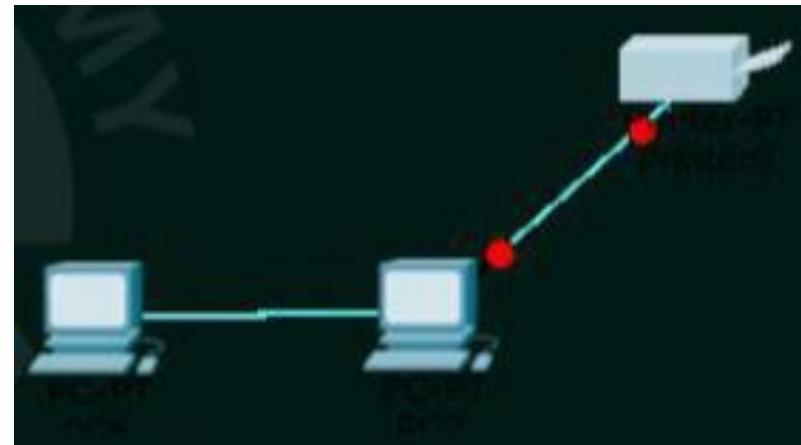
Logical Network Diagram





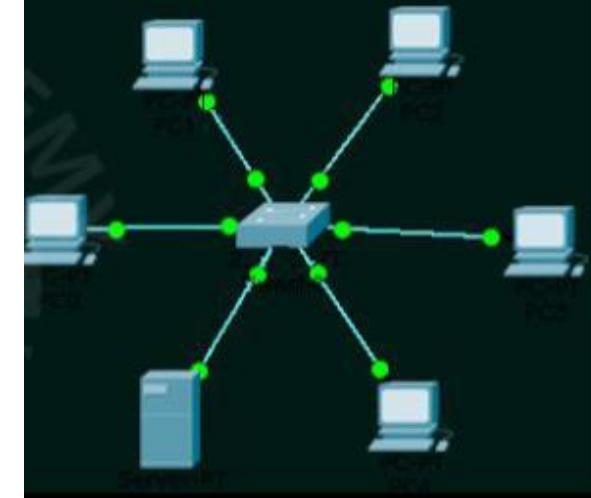
Peer to peer network

- No centralized administration
- All peers are equal
- Simple sharing applications
- Not scalable



Client Server network

- centralized administration
- Requested response model
- Scalable
- Server may be overloaded



Network Hardware (1)

- Personal area networks
- Local area networks
- Metropolitan area networks
- Wide area networks
- The Internet

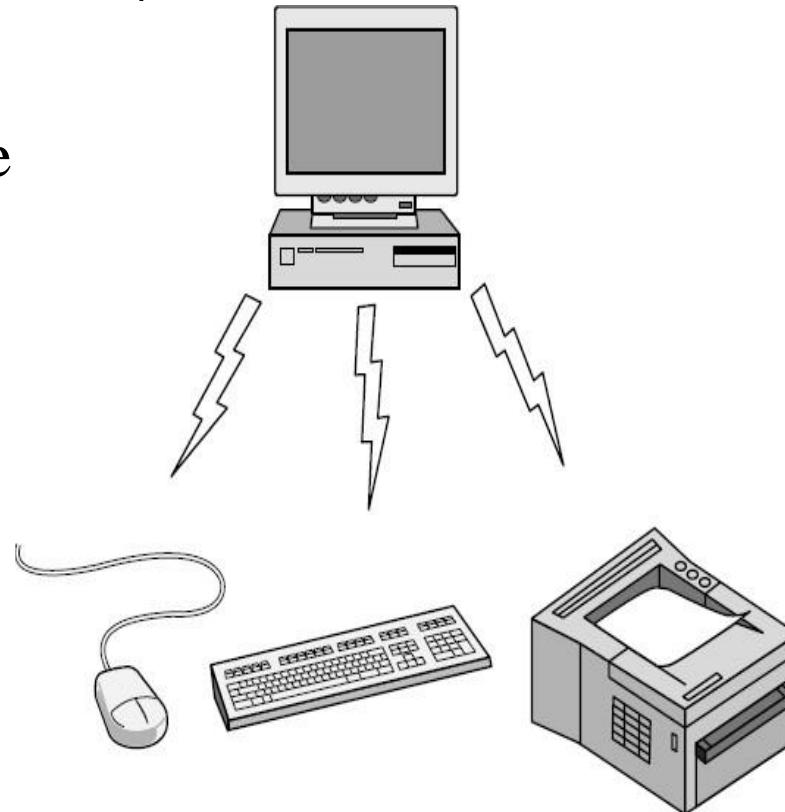
Network Hardware (2)

Classification of interconnected processors by scale.

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

Personal Area Network

- Connect devices over the range of a person
- Example of a Bluetooth (wireless) PAN:
 - PANs (Personal Area Networks) let device communicate over the range of a person.
 - To connect a Bluetooth mouse, a Bluetooth keyboard, a Bluetooth Printer with a computer.
 - To connect a Bluetooth earphone with a mobile phon
 - To use RFID to communicate with goods.



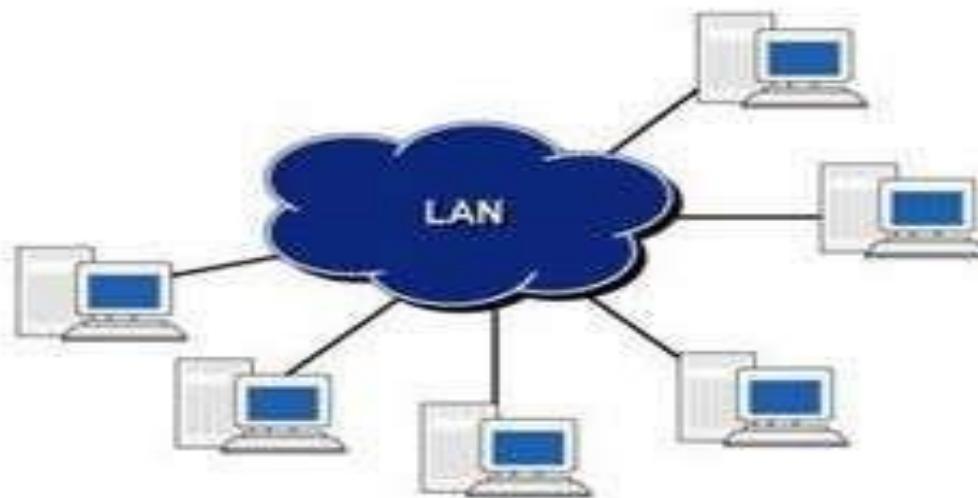
Categories or Types of Network

- There are Three Types:
 1. LAN - Local Area Network
 2. MAN - Metropolitan Area Network
 3. WAN – Wide Area Network

1. LAN - Local Area Network

A LAN is Designed by Local Area Connections such as:

- i) within Building
- ii) within office
- iii) within Campus
- iv) within Specific



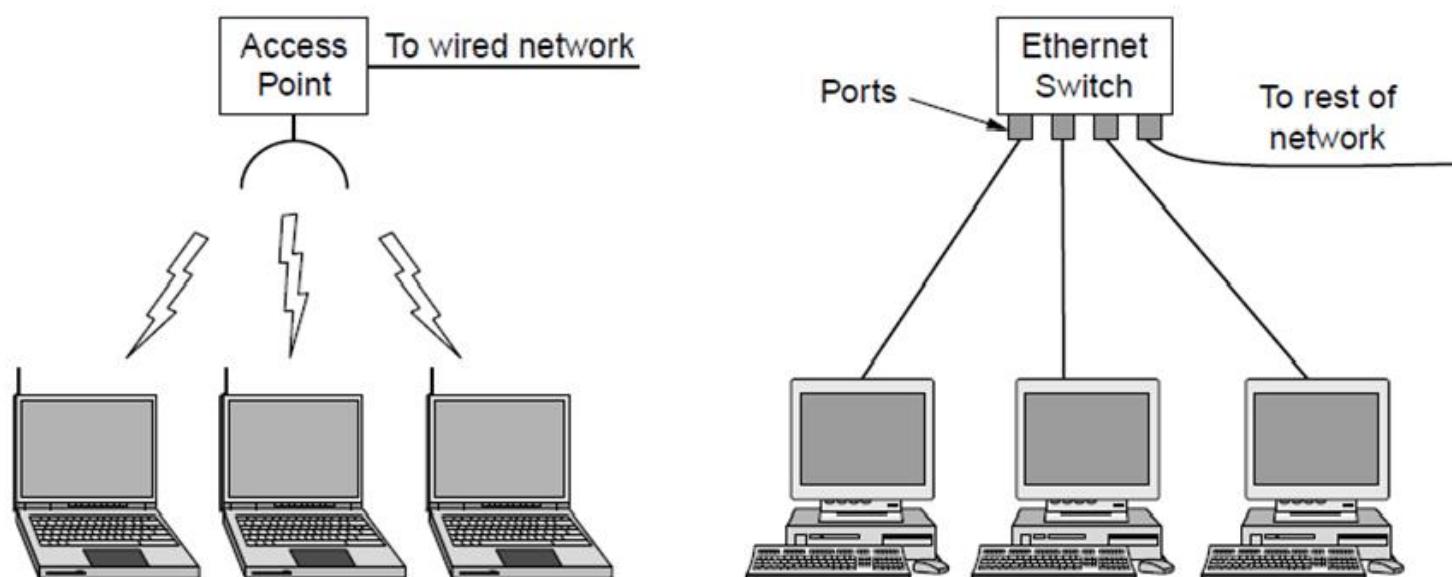
- LANs are privately-owned networks within a single building or campus of up to a few kilometers in size.
- LAN characteristics
 - The size is restricted → The worst-case transmission time is bounded and known in advance → Certain designs are possible and network management can be simplified.
 - Transmission technology → high speed → 10Gpbs
 - Topology (physical and local): Bus, Ring, Star (Hub)

Network Hardware · LAN

Wireless and wired LANs.

(a) 802.11.

(b) Switched Ethernet.



Advantages :

- 1) Sharing of Files.**
- 2) Sharing of Programs.**
- 3) Communication Exchange.**

Disadvantages :

- 1) Reliability.**
- 2) Capacity.**
- 3) High Cost.**

2. MAN - Metropolitan Area Network

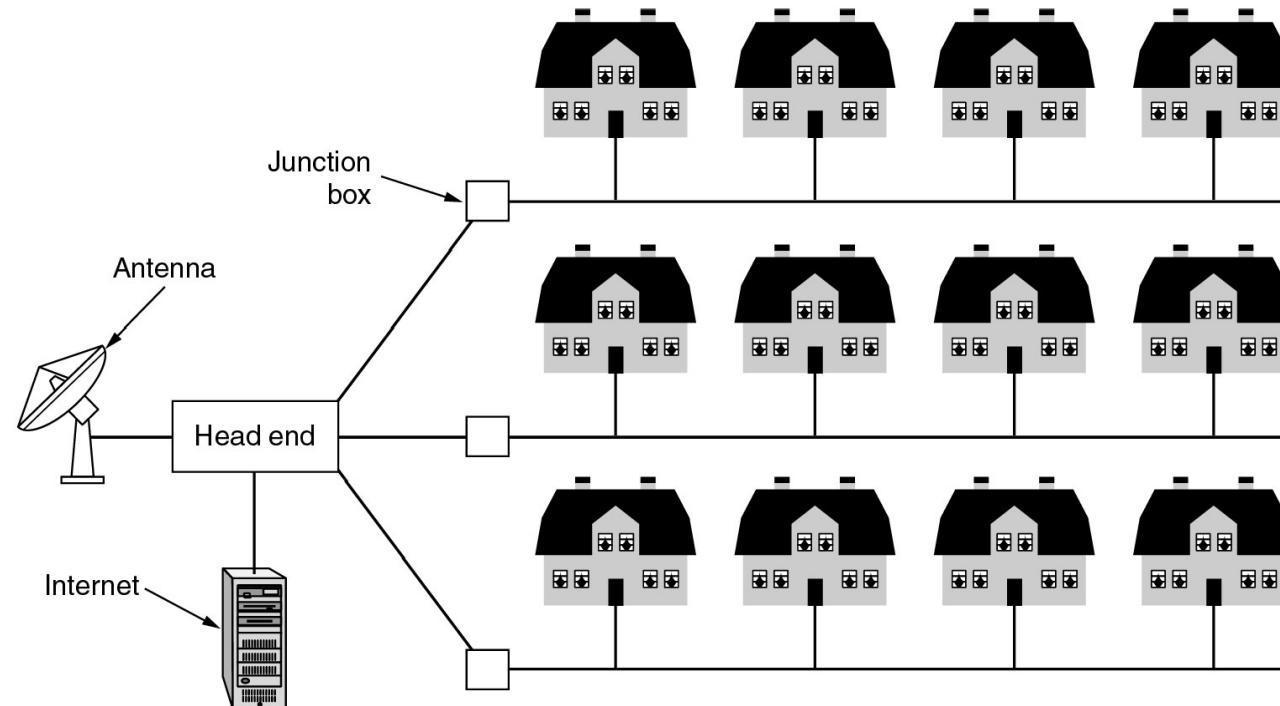
A Metropolitan Area Network (**MAN**) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN).

Network Hardware: MAN

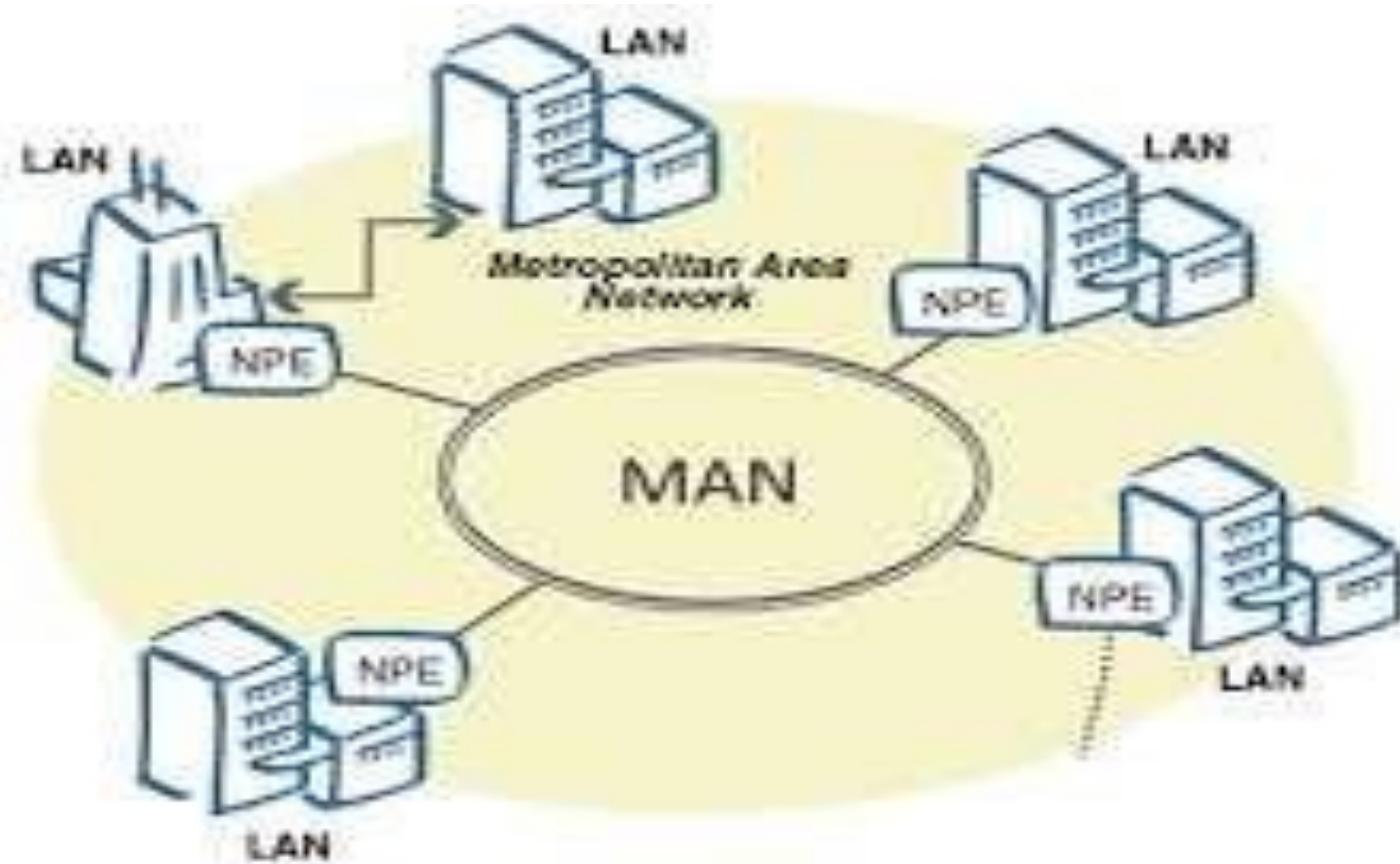
- A metropolitan area work, or, MAN (plural: MANs, not MEN) is basically a bigger version of a LAN and normally uses similar technology.
- Examples
 - One reason for distinguishing MANs as a special category is that a standard has been adopted for them. It is called DQDB ([Distributed Queue Dual Bus](#)) .
 - A MAN can be based on [cable TV](#) (See the next slide)
 - IEEE 802.16 ([WiMAX](#))
- A key aspect of MAN is that there is a broadcast medium to which all the computers are attached.

Network Hardware: MAN

A metropolitan area network based on cable TV.



- MAN supports up to 150 Kilometers Distance.
- Example:
 - Telephone Network
 - Cable TV



Advantages :

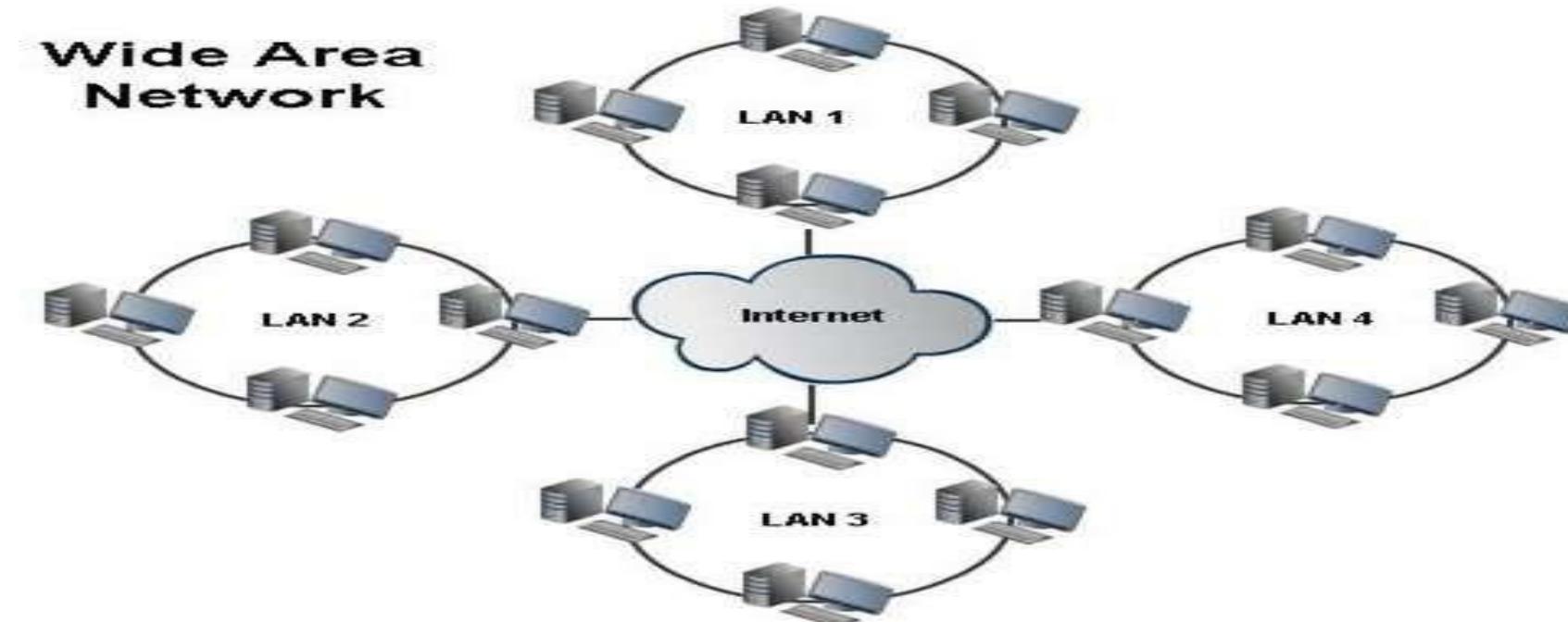
- 1) High Bandwidth.**
- 2) It support Large number of Clients.**
- 3) Reduce the Errors.**

Disadvantages :

- 1) Large Space Requirements.**
- 2) Slower Data Access.**
- 3) High Cost.**

3. WAN – Wide Area Network

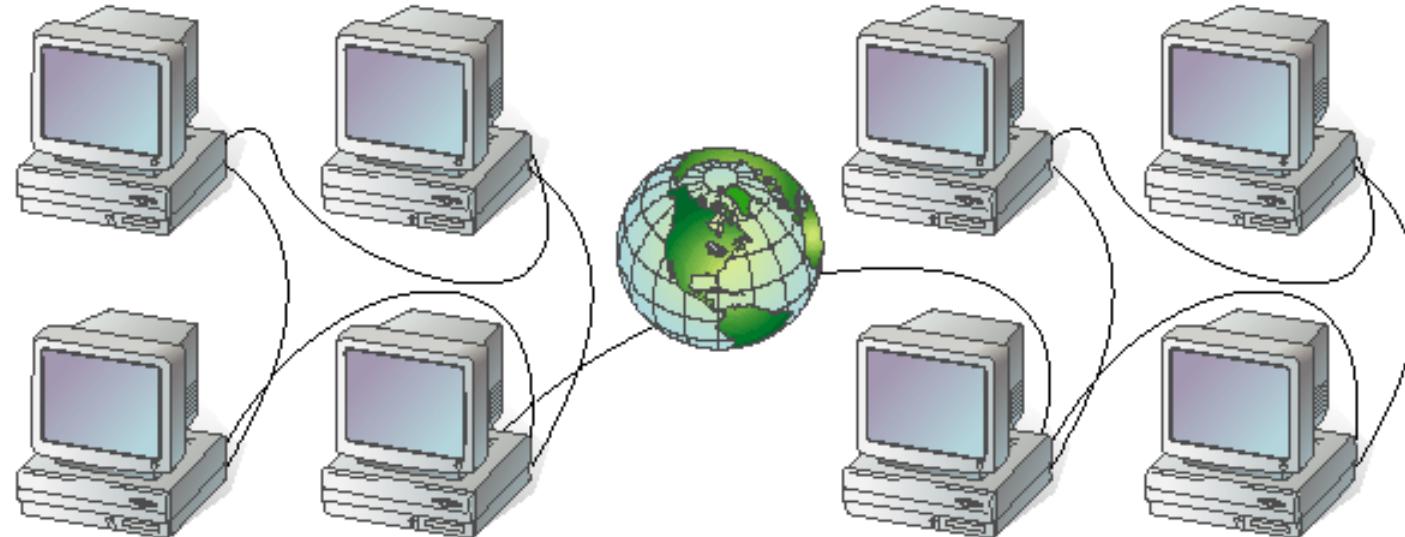
- WAN Provide a Long Distance Transmission of Data.
- By Using WAN Exchange the Information from one country to another country.



Network Hardware: WAN

- A WAN consists of a collection of machines intended for running user programs (hosts, end systems) and a pure communication subnet(subnet)
- The subnet consists of two distinct components:
 - Transmission lines (also called circuits, channels, or trunks) move bits between machines.
 - Switching elements (packet switching nodes, intermediate system, data switching exchanges, routers) are specialized computers used to connect three or more transmission lines. When data arrive on an incoming line, the switching element must choose an outgoing line to forward them on.

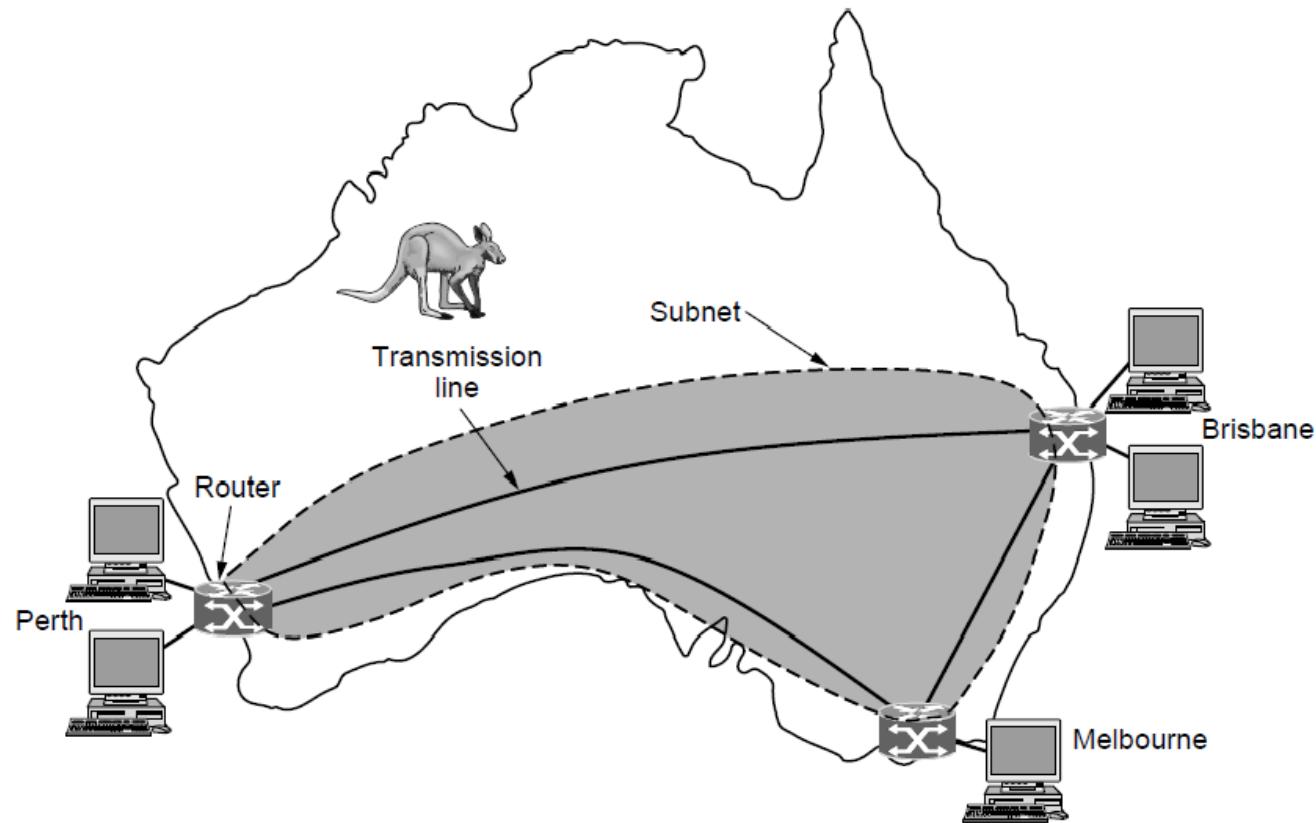
Classification by Network Geography



Wide area network

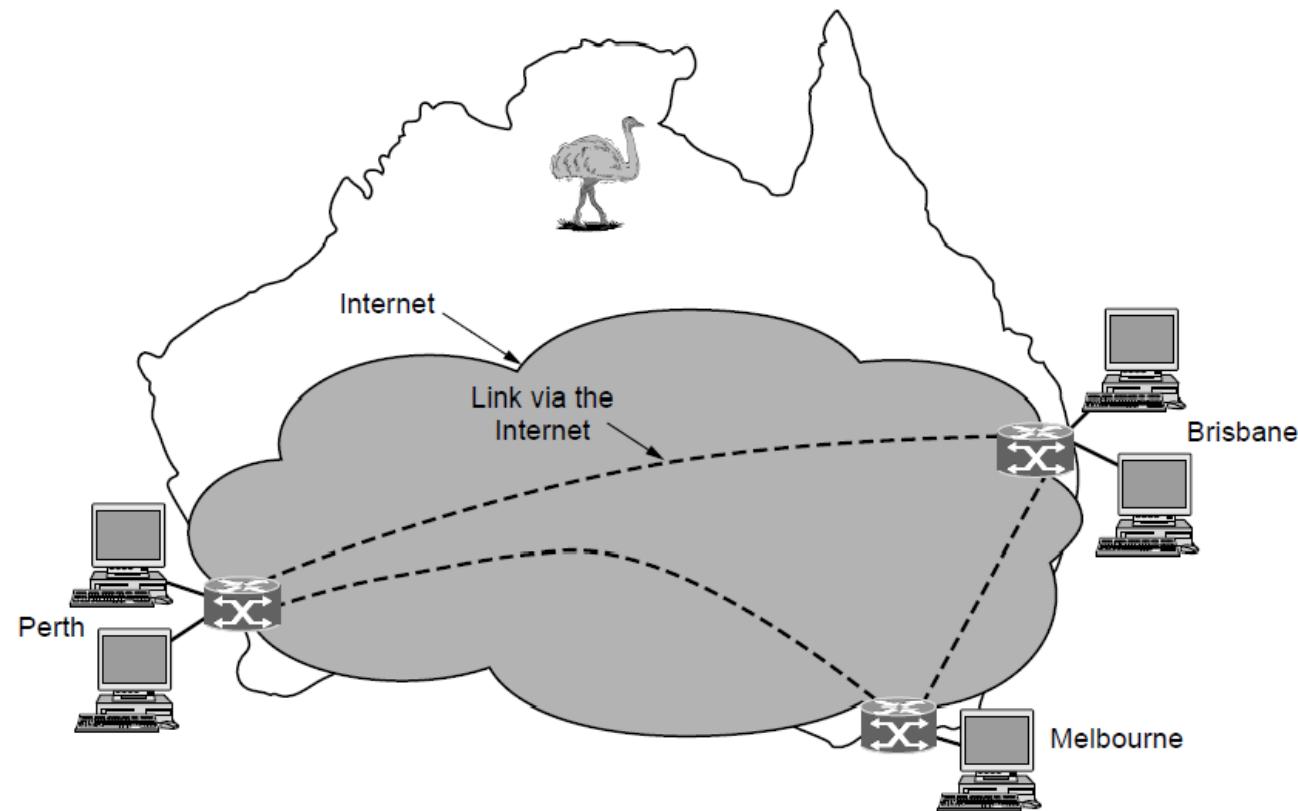
Network Hardware: WAN

WAN that connects three branch offices in Australia



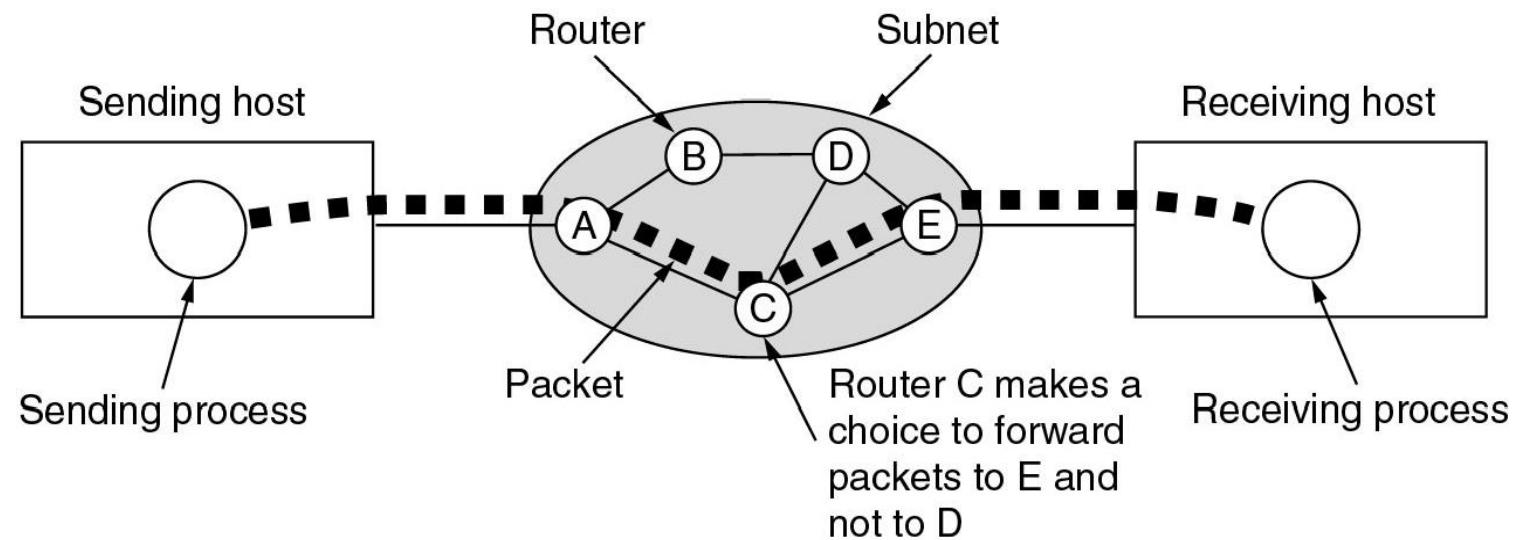
Network Hardware: WAN

WAN using a virtual private network.



Network Hardware: WAN

A stream of packets from sender to receiver.



Network Hardware:

- An internetwork or just internet is a collection of interconnected networks. (internet vs Internet)
- A common form of internet is a collection of LANs connected by a WAN.
- Differences among WANs, subnets, networks, and internetworks.
 - WAN = subnet + hosts
 - Subnet + hosts → WAN → network
 - Cable + hosts → LAN → network
 - Many interconnected networks → internetworks.
 - Different owners
 - Different technologies.

Networking Devices:

Networking devices are components used to connect computers or other electronic devices together so that they can share files or resources like printers or fax machines.

These are also called communicating devices.

The following are the various networking devices.

- Network Interface Card (NIC)
- Repeater
- Hub
- Bridge
- Switch
- Router
- Gateway
- Brouter
- Modem

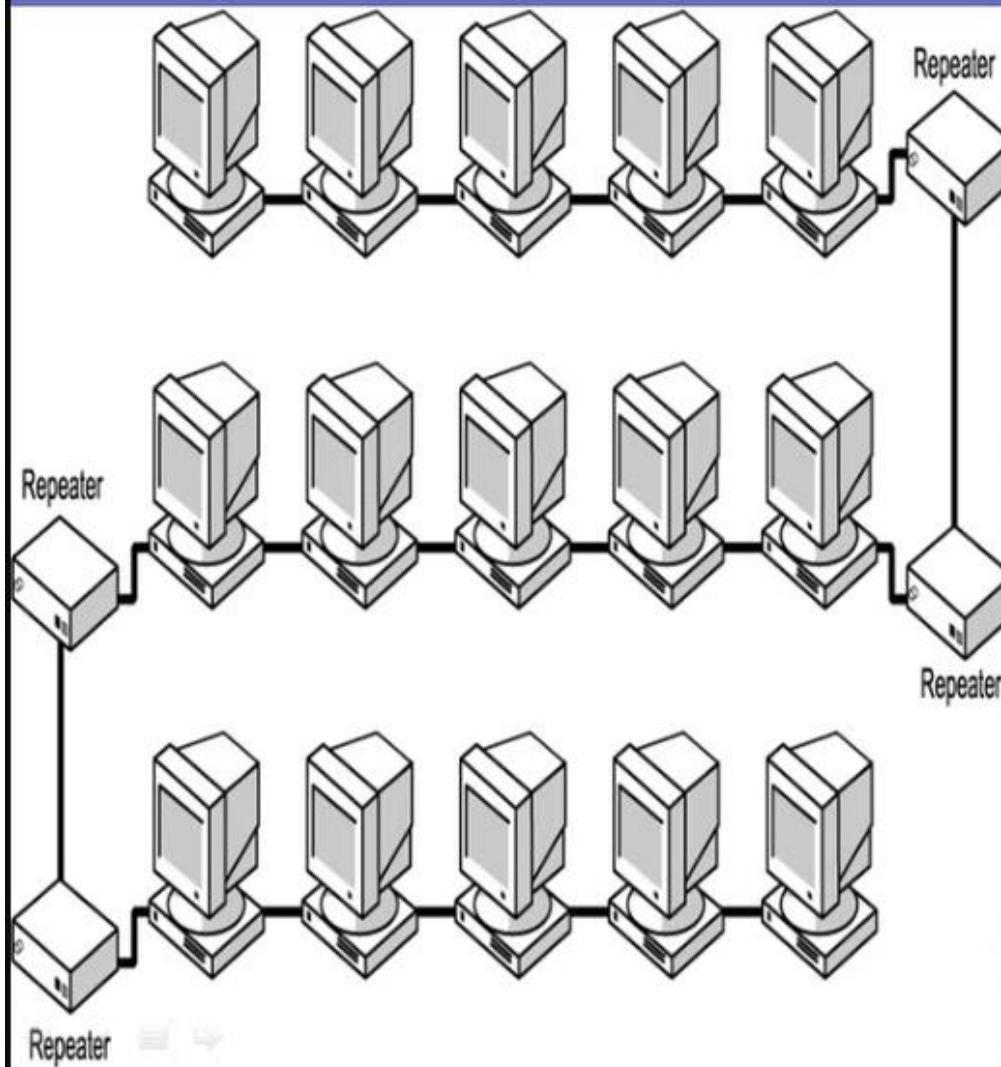
1. Network Interface Card (NIC):

- NIC provides physical interface between computer and cabling.
- NIC prepares data, sends data, and controls the flow of data.
- It can also receive and translate data into bytes for the CPU to understand.
- It has specific MAC address.

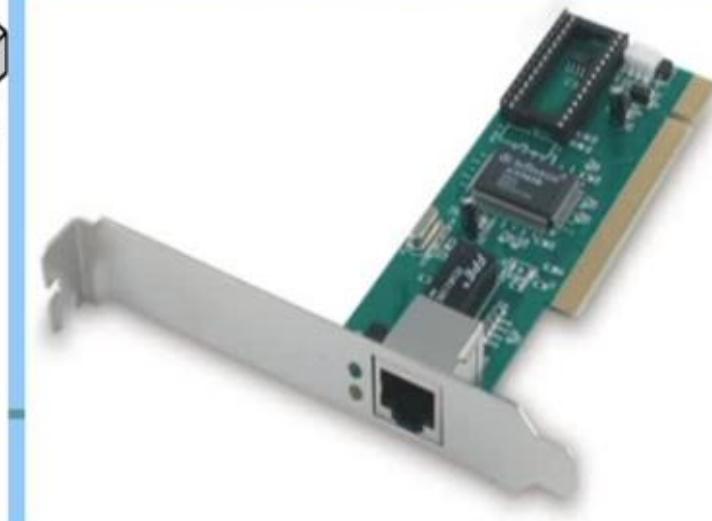
2. Repeater :

- A repeater operates at the physical layer. Its task is to regenerate the signal over the same network before the signal becomes too weak or corrupted.
- A repeater is a regenerator, OR amplifier the signal.
- When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength.
- It amplify the signal (these signals not only include the network).signals, but any noise on the wire as well
- It is 2 port device.

Repeaters



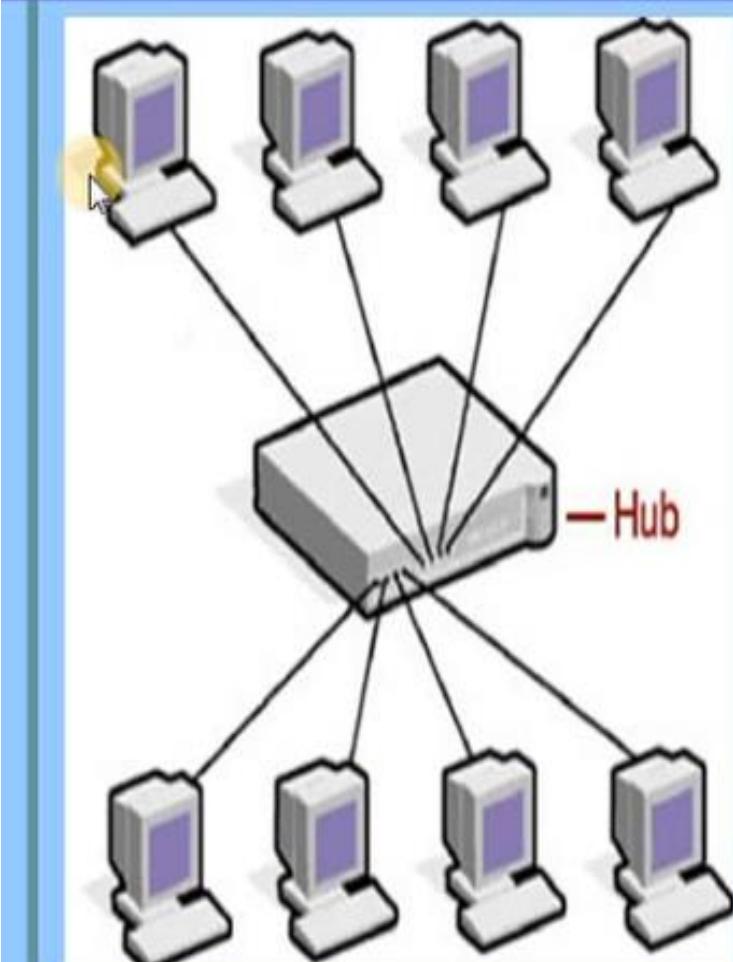
NIC IN WIFI & WIRED NETWORK



3. Hub :

- Hub works on Physical layer.
 - It is a multiport Repeater.
 - A hub is device used to connect several computers together.
 - Hubs cannot filter data, so data packets are sent to all connected devices.
 - Also, they do not have intelligence to find out best path for data packets which leads to inefficiencies and wastage.
- **Types of Hub**
 - **Active Hub** :- Active hubs use electronics to amplify and clean up the signal before it is broadcast to the other ports.
 - **Passive Hub** :- Passive hubs simply connect all ports together electrically and they are not powered.

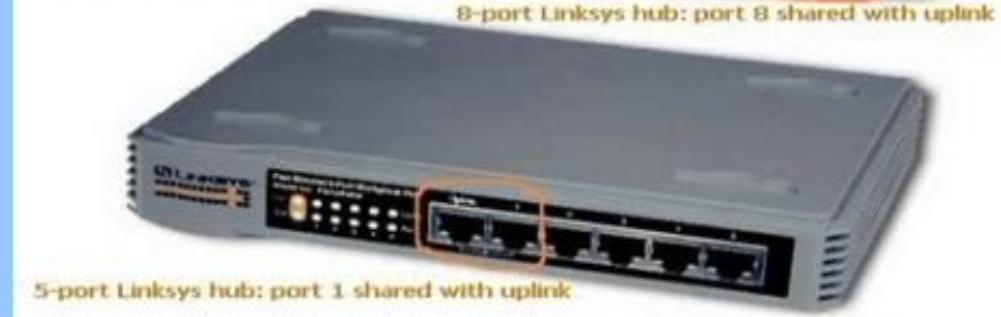
Hubs



16-port Linksys hub: port 16 shared with uplink



8-port Linksys hub: port 8 shared with uplink



5-port Linksys hub: port 1 shared with uplink



8-port SMC Hub: port 8 shared with uplink

4. Bridge:

- A bridge operates at Data link layer and Physical Layer.
 - A bridge is a repeater, with add on functionality of filtering content by reading the MAC addresses of source and destination.
 - **It is also used for interconnecting two LANs** working on the same protocol.
 - Bridges can filter out noise.
 - Bridge maintain the MAC address table to forward the packet to another LAN.
-
- **Types of Bridges.**

Static Bridge:

Dynamic Bridge(Transparent Bridge) .

MAC	Port
M1	P1
M2	P1
M3	P1
M4	P1
M5	P2
M6	P2
M7	P2
M8	P2

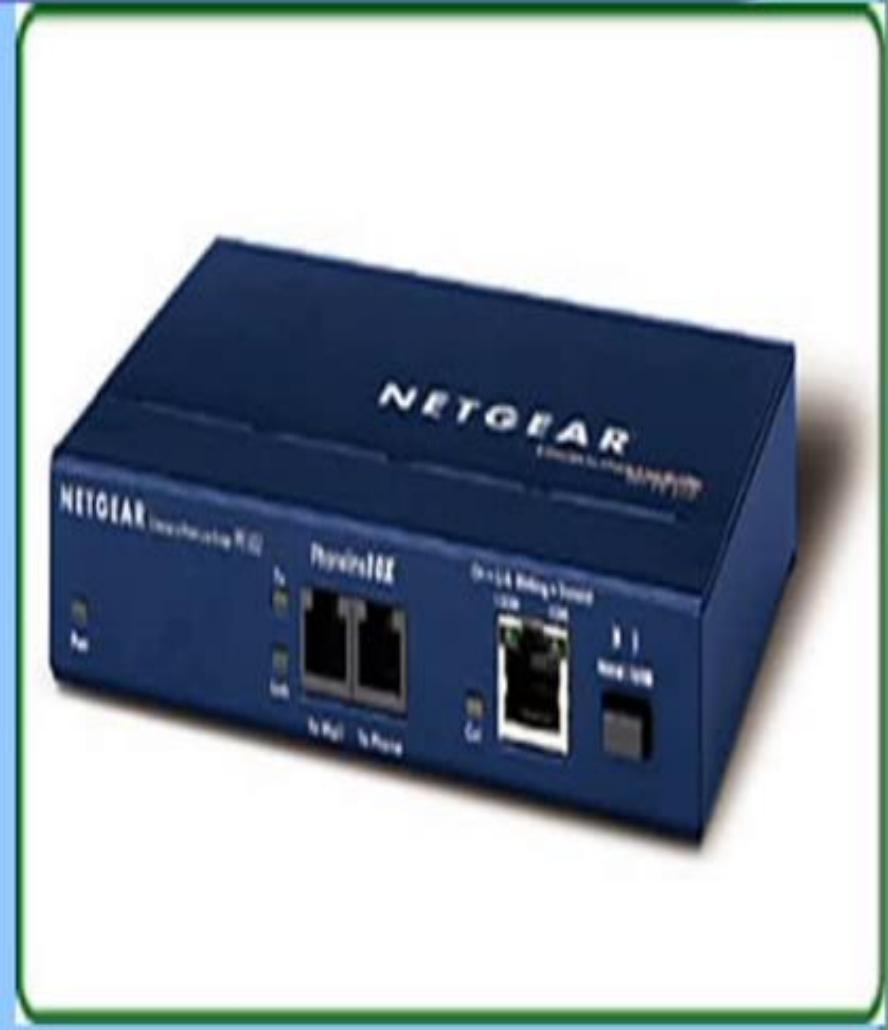
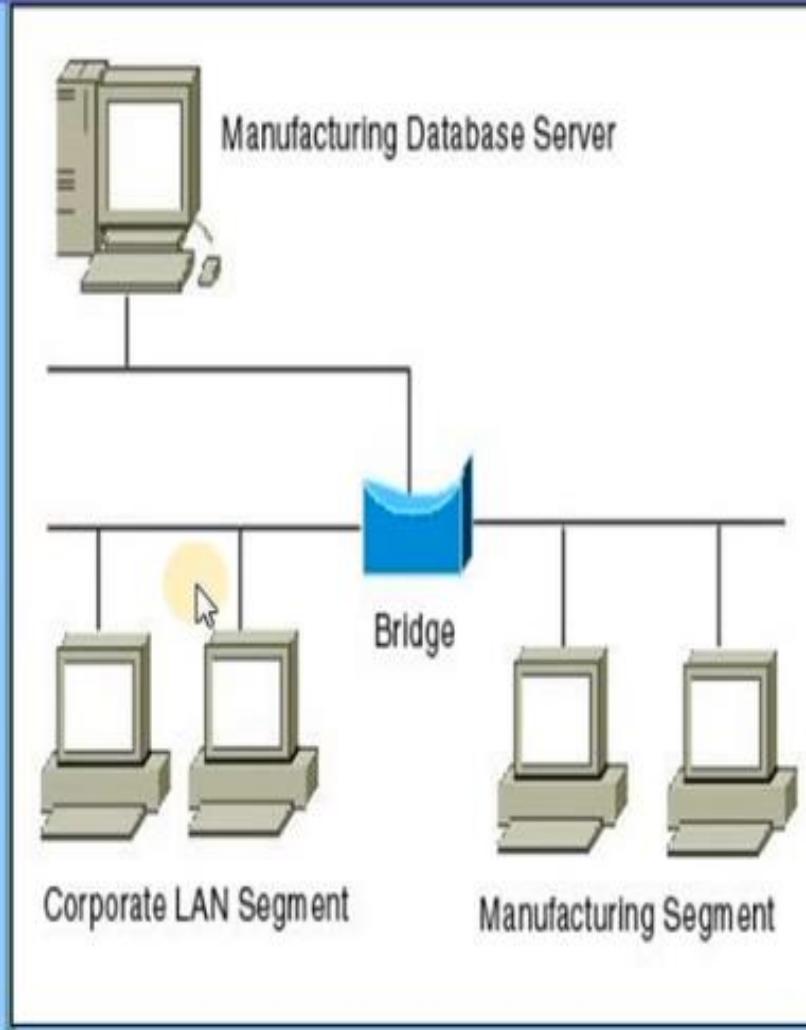
- **Static Bridge:**

MAC	Port
M1	P1
M2	P1
M3	P1
M4	P1
M5	P2
M6	P2
M7	P2
M8	P2

Dynamic Bridge(Transparent Bridge) .

MAC	Port
M1	P1
M6	P2
M7	P2
M4	P1
M5	P2
M	P
M	P
M	P

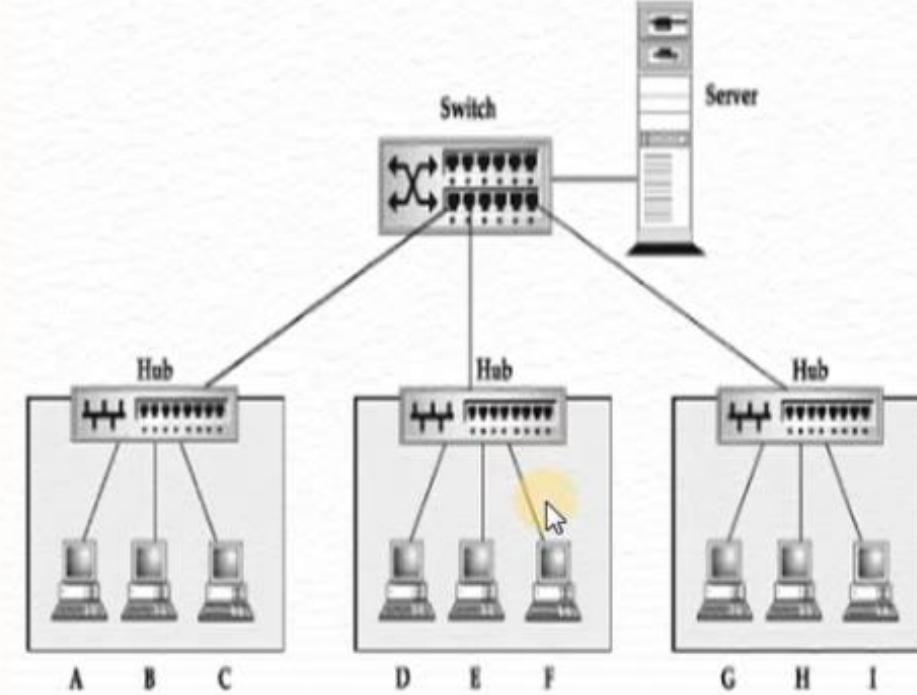
Bridges



4.5. Switch:

- A network switch is a computer networking device that connects network segments.
- Switch is data link layer device.
- Switch can perform error checking before forwarding data, that makes it very efficient as it does not forward packets that have errors and forward good packets selectively to correct port only.
- Multiport Bridge
- Full Duplex Links
- Traffic is minimal
- Collision Domain is zero.

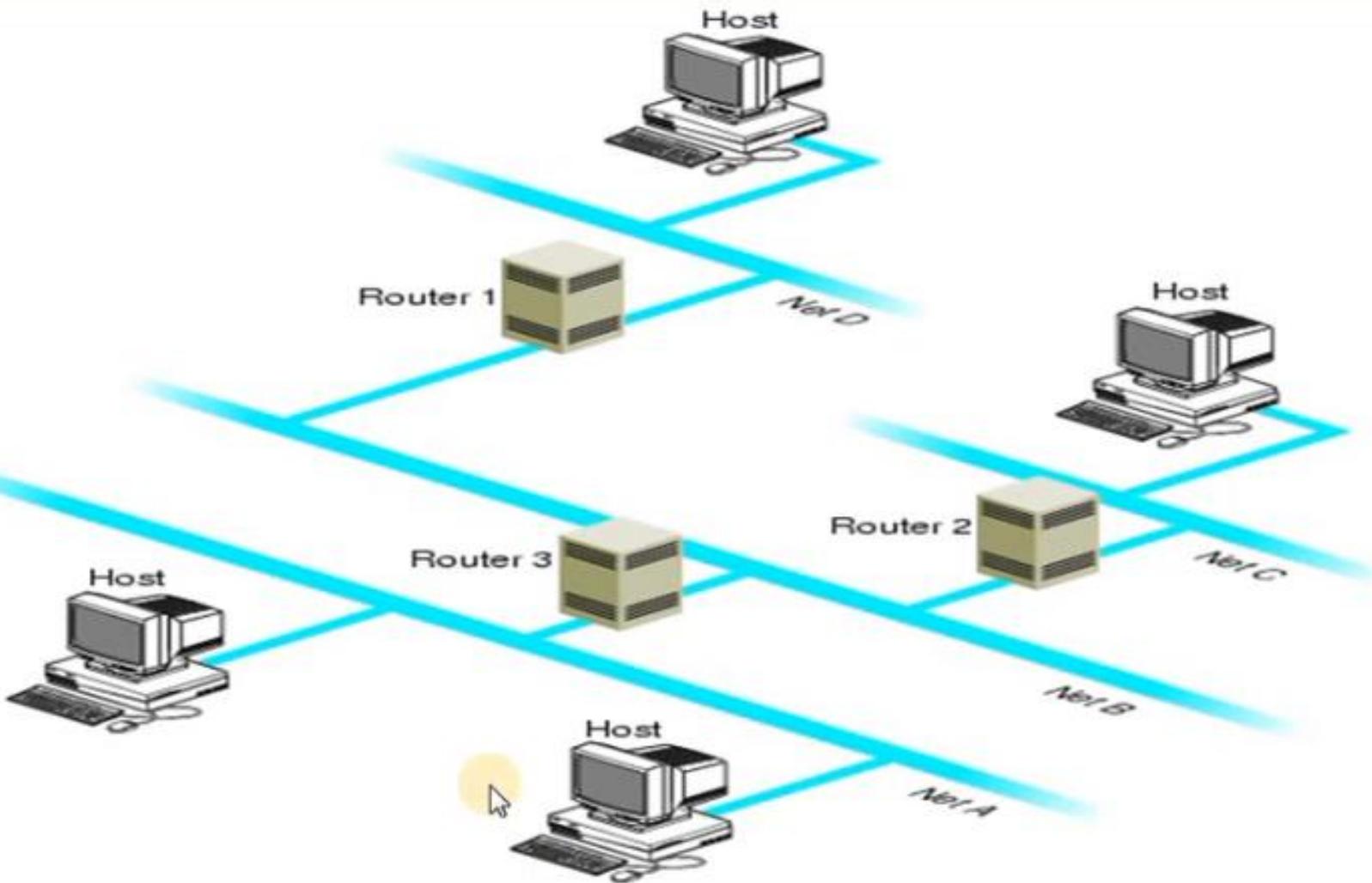
Switch



- **Routers:**

- A router is a device like a switch that routes data packets based on their IP addresses.
- Router is mainly a Network Layer device.
- Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets.

Routers



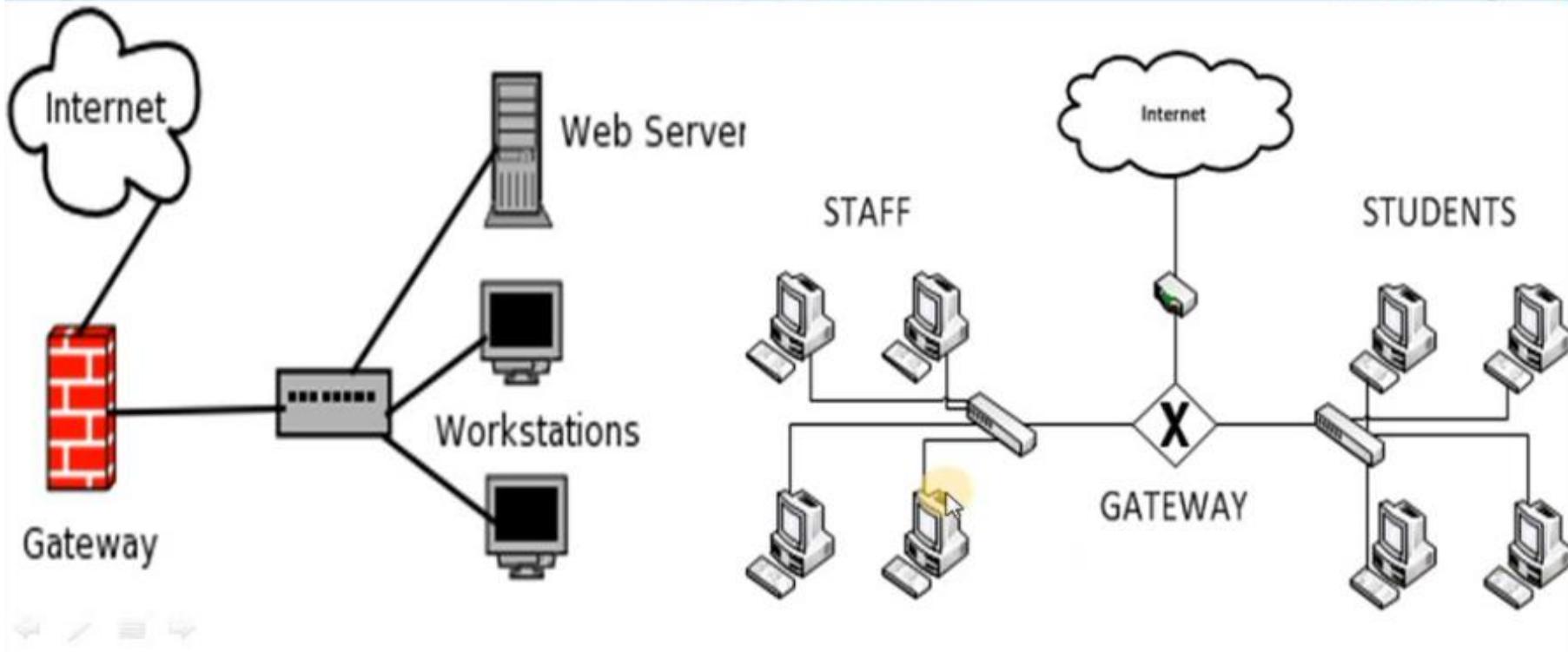
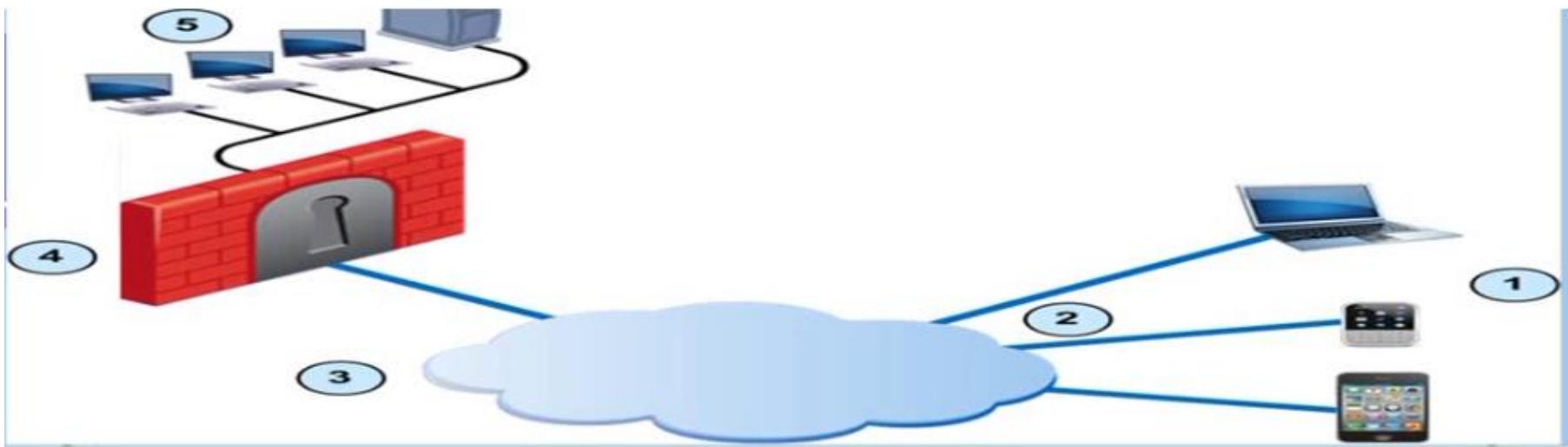
6. Gateway :

- A gateway is a passage to connect two networks together that may work upon different networking models.
- They basically work as the messenger agents that take data from one system, interpret it, and transfer it to another system.
- Gateways are also called protocol converters and can operate at any network layer.

7. Brouter:

It is also known as bridging router is a device which combines features of both bridge and router.

- It can work either at data link layer or at network layer.
- Working as router, it is capable of routing packets across networks; working as bridge, it is capable of filtering local area network traffic.

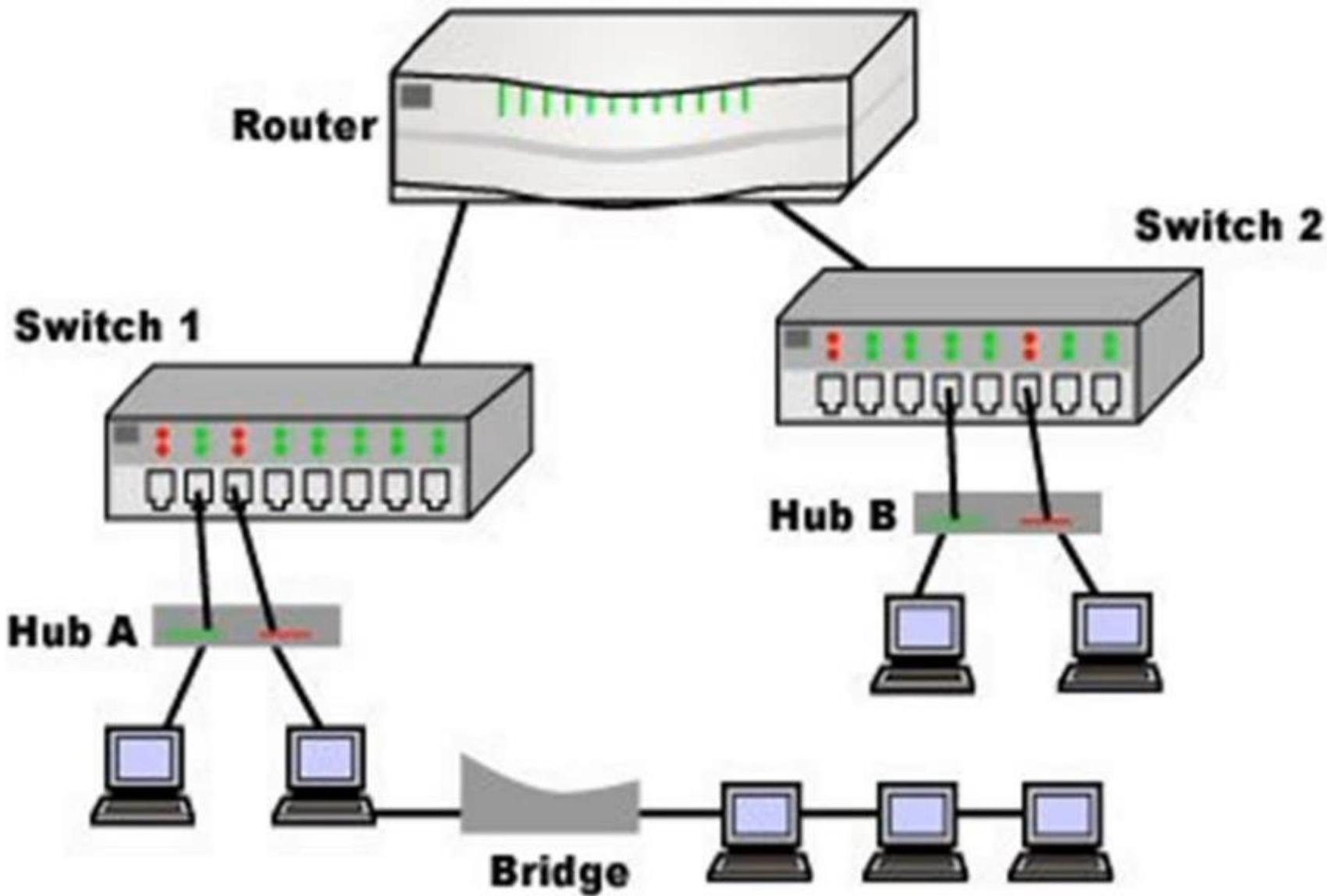


8. Modem :

- Modem means Modulator- Demodulator.
- Modulation : digital information to analog signals.
- Demodulation: Analog signal back into digital information.

COMPARISON OF NW NETWORK DEVICE

Criteria	Repeater	Hub	Bridge	Switch	Router	Gateway
Main Work	Regenerate the signal	Send Data to all node	Send Data	to send data @ destni port in Frame	To connect LAN - WAN and decide route	to connect different network architecture & Protocol for data send
Deal With	Signal (Bits)	Bits	Frame	Frame	Packet	Packet / message
Layer	Physical layer	Physical layer	Data Link Layer	Data Link Layer	Network layer	Network layer , Application Presentation , Session
Addressing	1-1 port	Broadcast	MAC Addressing	MAC Addressing	IP Address	IP Address
Routing Decision	no	no	no	no	yes	yes
Cost	Cheapest	low	low	medium	high	highest
Deal With						
Deployment	plug & Play	plug & Play	plug & Play	plug & Play	Installation, Administration	Installation, Administration
Broadcasting	no	yes (No controlling)	yes (No controlling)	yes (No controlling)	yes	yes
Filtering	no	no	yes (based on MAC Add)	yes	yes (based on IP Add)	yes (based on IP Add)
No. of Port	2 (1 for incoming & 1 for outgoing)	more than 2	2 (1 for incoming & 1 for outgoing)	Multi Port	more than 2	2 port
Intelligent device	no	no	no	yes (Moderate intelligent)	yes	yes



Network topology

- A *topology* is a way of “laying out” the network.
Topologies can be either physical or logical.
- *Physical topologies* describe how the cables are run.
- *Logical topologies* describe how the network messages travel

NETWORK TOPOLOGY

Arrangement of nodes of a computer network.

Topology = Layout.



PHYSICAL TOPOLOGY AND LOGICAL TOPOLOGY

Physical Topology - Placement of various nodes.

Logical topology - Deals with the data flow in the network.

Network Topology

- The network topology defines the way in which computers, printers, and other devices are connected. A network topology describes the layout of the wire and devices as well as the paths used by data transmissions.

Bus Topology

- Commonly referred to as a linear bus, all the devices on a bus topology are connected by one single cable.

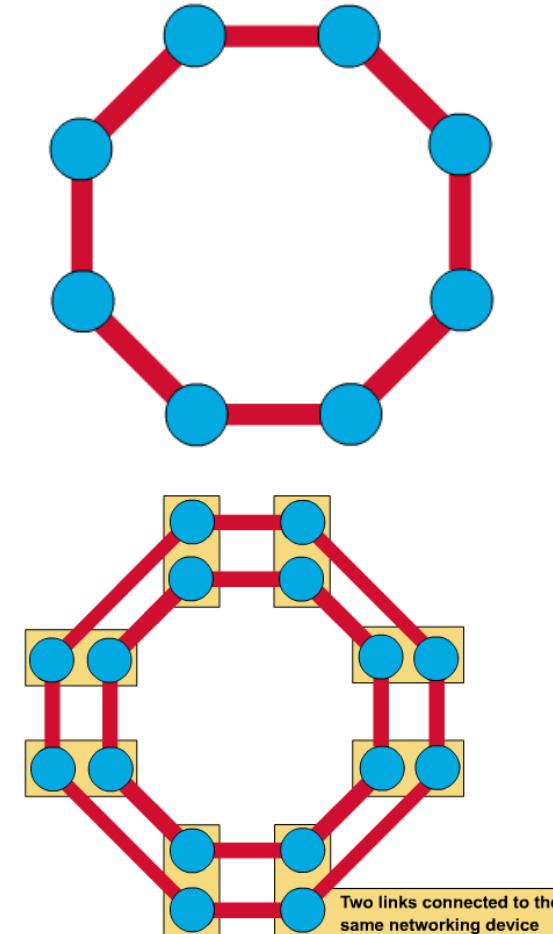
BUS TOPOLOGY

Advantages	Disadvantages
Only one wire – Less expensive.	Not fault tolerant (No redundancy).
Suited for temporary network.	Limited cable length.
Node failures does not affect others.	No security.



Ring Topology

- A frame travels around the ring, stopping at each node. If a node wants to transmit data, it adds the data as well as the destination address to the frame.
- The frame then continues around the ring until it finds the destination node, which takes the data out of the frame.
 - Single ring – All the devices on the network share a single cable
 - Dual ring – The dual ring topology allows data to be sent in both directions.



RING TOPOLOGY

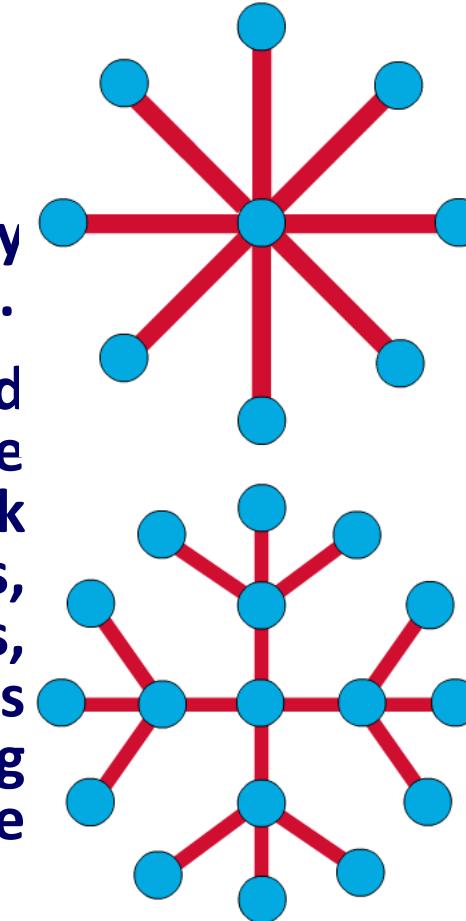
- ★ A ring topology is a bus topology in a closed loop.
- ★ Peer-to-Peer LAN topology.
- ★ Two connections: one to each of its nearest neighbors.
- ★ Unidirectional.
- ★ Sending and receiving data takes place with the help of a TOKEN.

Advantages	Disadvantages
Performance better than Bus topology.	Unidirectional. Single point of failure will affect the whole network.
Can cause bottleneck due to weak links.	↑ in load – ↓ in performance.
All nodes with equal access.	No security.



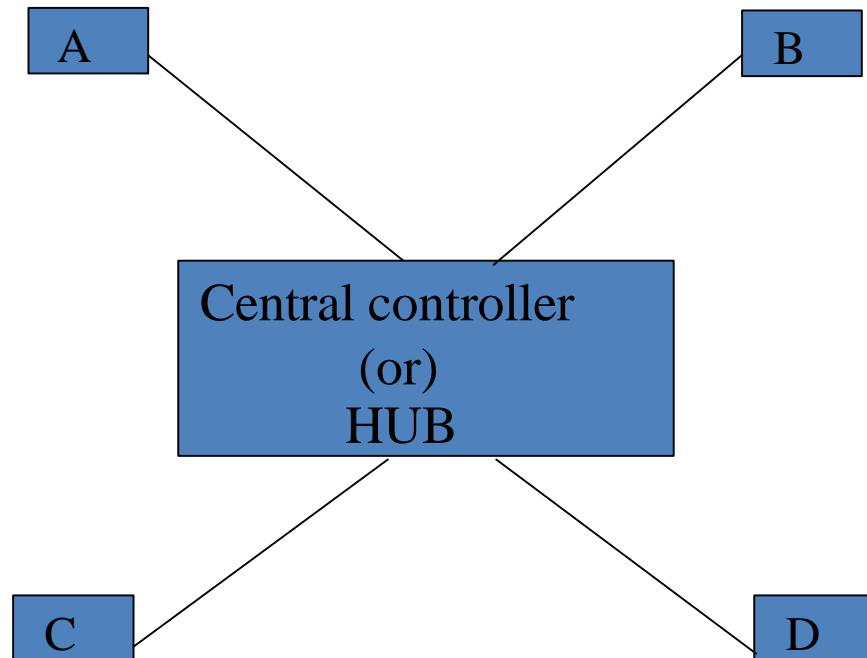
Star & Tree Topology

- The star topology is the most commonly used architecture in Ethernet LANs.
- When installed, the star topology resembles spokes in a bicycle wheel.
- Larger networks use the extended star topology also called tree topology. When used with network devices that filter frames or packets, like bridges, switches, and routers, this topology significantly reduces the traffic on the wires by sending packets only to the wires of the destination host.

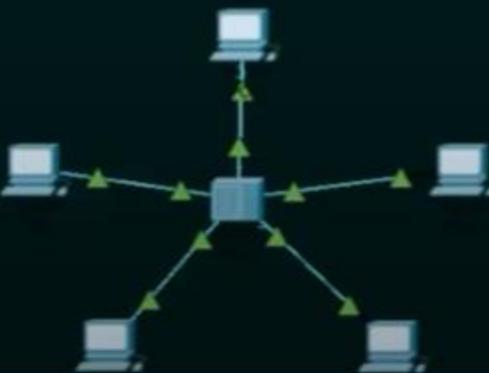


Star Topology

Star Topology Diagram:



- ★ Every node is connected to a central node called a hub or switch.
- ★ Centralized Management.
- ★ All traffic must pass through the hub or switch.



Advantages	Disadvantages
Easy to design and implement.	Single point of failure affects the whole network.
Centralized administration.	Bottlenecks due to overloaded switch/Hub.
Scalable.	Increased cost due to switch/hub.

Mesh Topology

- The mesh topology connects all devices (nodes) to each other for redundancy and fault tolerance.
- It is used in WANs to interconnect LANs and for mission critical networks like those used by banks and financial institutions.
- Implementing the mesh topology is expensive and difficult.

- ★ Each node is directly connected to every other nodes in the network.
- ★ Fault tolerant and reliable.

Advantages	Disadvantages
Fault tolerant.	Issues with broadcasting messages.
Reliable.	Expensive and impractical for large networks.

Mesh Topology

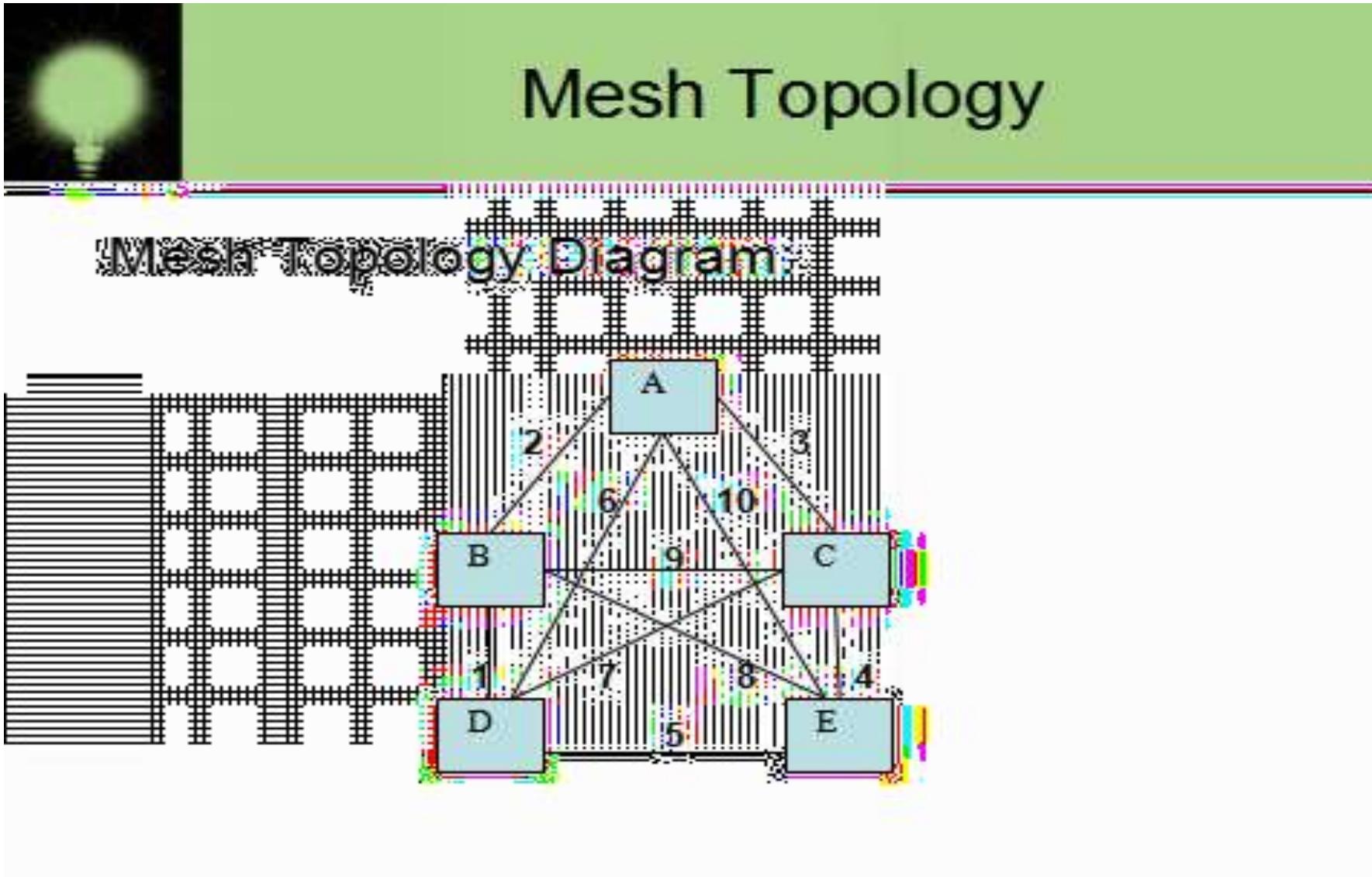
- Here every device has a direct point to point link between every other device.
- A fully connected mesh can have $n(n-1)/2$ physical channels to link n devices.

if $n=5$ (Number of Nodes)

$$5(5-1)/2 = 10 \text{ (Communication Links)}$$

- 5 Nodes are Connected by using 10 Communication Links

Mesh Topology



Mesh Topology

Advantages:

- It eliminates the traffic problem.
- It is robustness.
- It has privacy and security.
- Fault can be easily found.

Mesh Topology

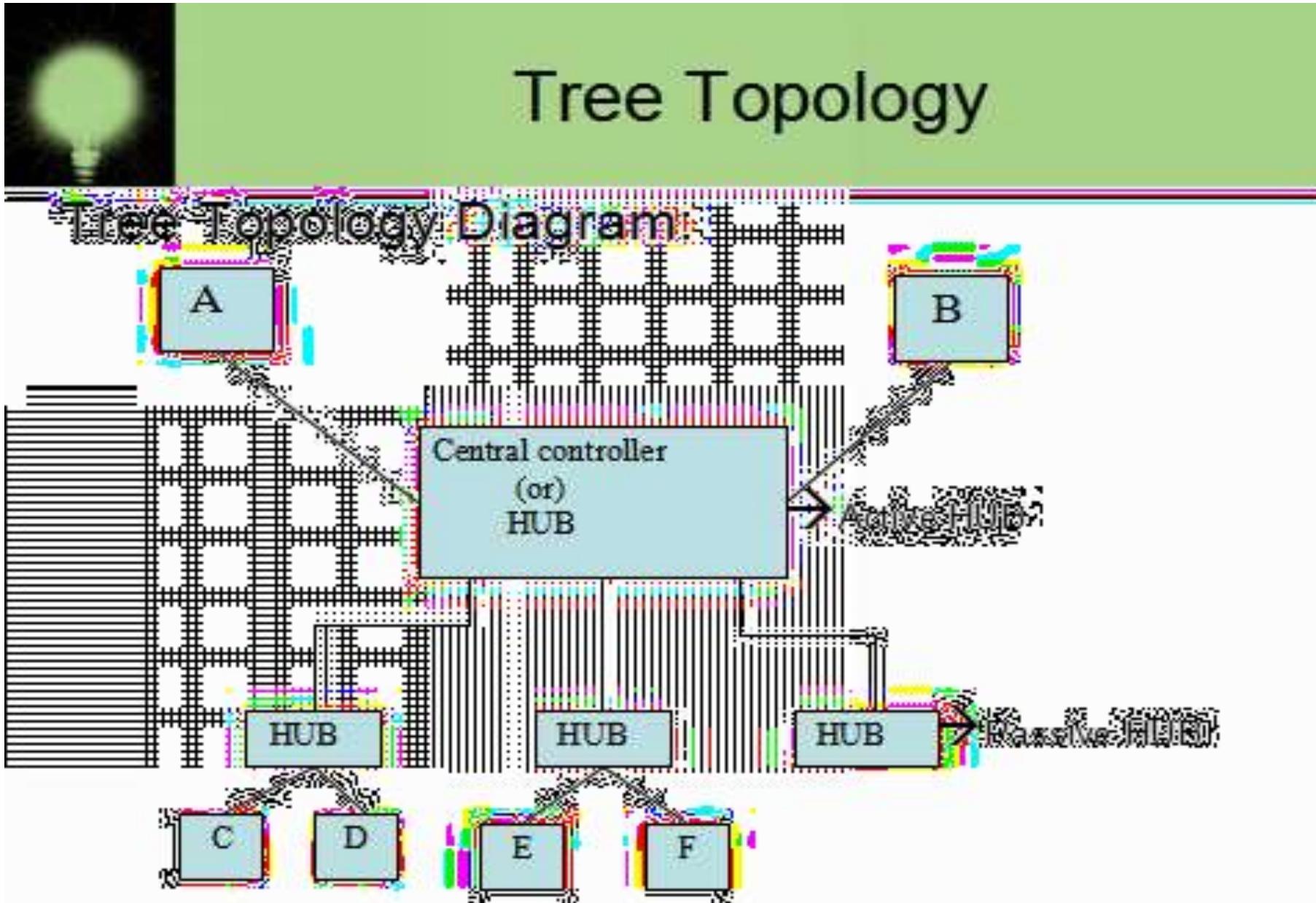
Disadvantages:

- More number of cables to be used.
- Every devices must be connected to some other devices. So installation process is very difficult.

Tree Topology

- Tree topology has some variation from star topology.
- The nodes in the tree are linked to the central controller.
- The primary HUB in the tree is represented by “Active Hub”.
- The secondary HUB in the tree is represented by “Passive Hub”.

Tree Topology



Tree Topology

Advantages:

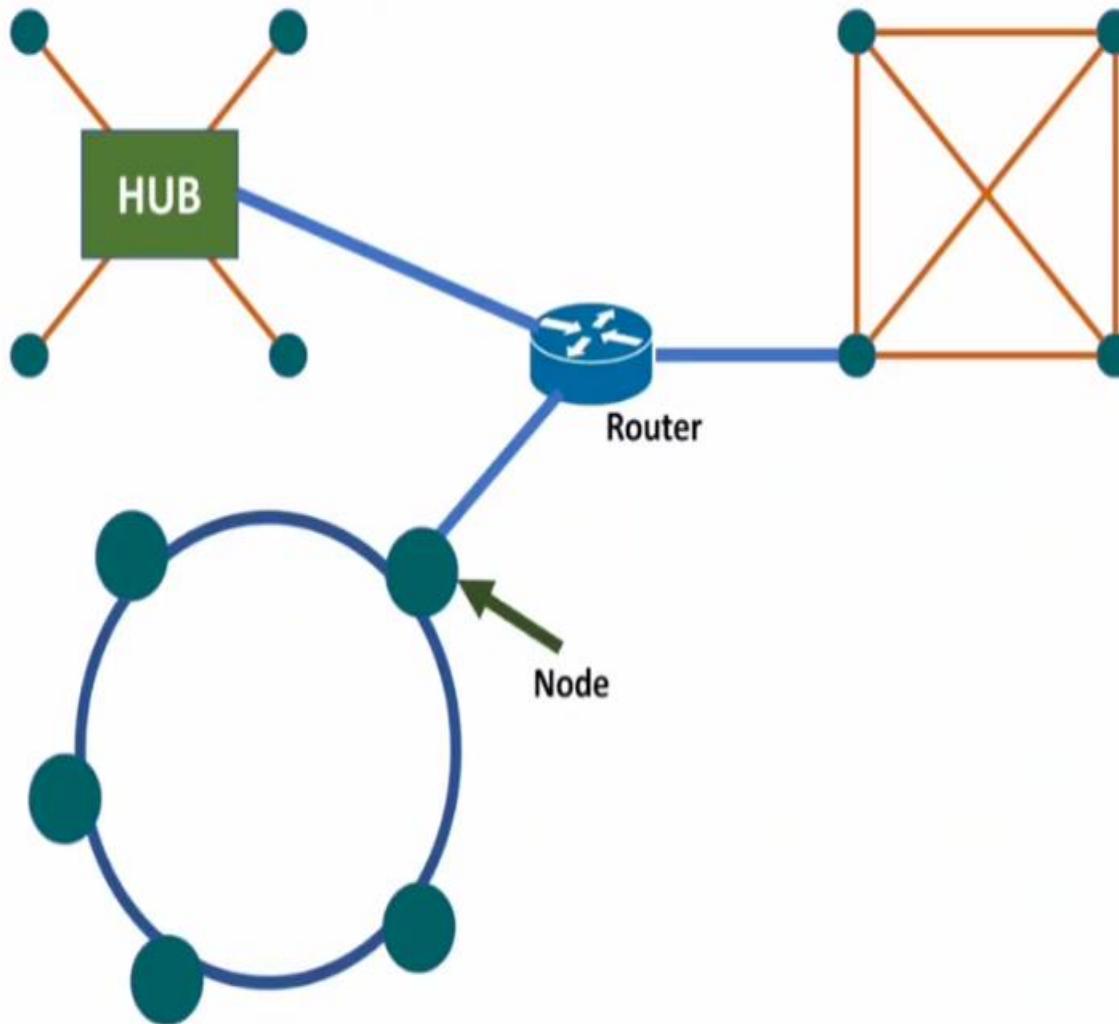
- It allows more devices to be attached in a **single central controller**.
- It allows the network to prioritize the communication.

Tree Topology

Disadvantages:

- Each device must be linked to central controller.
- It require more installation processes.
- If central controller failure means entire system should fail down.

Hybrid Topology in Computer Network



Advantages of Hybrid Topology in Computer Network

- ❖ This type of topology combines the benefits of different types of topologies in one topology.
- ❖ The speed of the topology becomes fast when two topologies are put together.
- ❖ It is easily scalable as Hybrid networks are built in a fashion which enables easy integration of new hardware components.
- ❖ Can be modified as per requirement.
- ❖ It is extremely flexible.
- ❖ It is very reliable.
- ❖ Error detecting and troubleshooting are easy.
- ❖ Handles a large volume of traffic.
- ❖ It is used to create large networks.

Disadvantages of Hybrid Topology in Computer Network

- ❖ Hubs which are used to connect two distinct networks are very costly. And hubs are different from usual hubs as they need to be intelligent enough to work with different architectures.
- ❖ There is a change in the hardware to connect one topology with another topology.
- ❖ Usually, hybrid architectures are larger in scale so they really hard in the installation process.
- ❖ It is a type of network expensive.
- ❖ The design of a hybrid network is very complex.
- ❖ Installation is a difficult process.

- Advantages and Disadvantages of Network Topologies

Topology	Advantages	Disadvantages
Bus	Cheap. Easy to install.	Difficult to reconfigure. Break in bus disables entire network.
Star	Cheap. Easy to install. Easy to reconfigure. Fault tolerant.	More expensive than bus.
Ring	Efficient. Easy to install.	Reconfiguration difficult. Very expensive.
Mesh	Simplest. Most fault tolerant.	Reconfiguration extremely difficult. Extremely expensive. Very complex.

Need for Networks

- A computer that operates independently from other computers is called a stand-alone computer.
- The process of printing or transferring data from one system to another using various storage devices is called sneakernet.

Need for Networks

- Enhance communication.
- Share resources.
- Facilitate centralized management.

Enhance Communication

- Computer networks use electronic mail (e-mail) as the choice for most of the communication.
- By using networks, information can be sent to a larger audience in an extremely fast and efficient manner.

Share Resources

- A copy of data or application stored at a single central location is shared over a network.
- Computer peripheral devices, referred to as additional components, can be attached to a computer and be shared in a network.

Share Resources

- Peripheral devices include faxes, modems, scanners, plotters, and any other device that connects to the computers.
- Equipments having common requirements can be shared in order to reduce maintenance cost.

Share Resources

- Important data can also be stored centrally to make it accessible to users, thereby saving storage space on individual computers.
- Computer applications, which take up a considerable amount of storage space, can be installed centrally on the network, saving storage space.

Facilitate Centralized Management

- Networks are used to assist in management tasks associated with their own operation and maintenance.
- Using networks results in increased efficiency and a resultant reduction in maintenance costs.

Facilitate Centralized Management

Software:

- Software is a set of instructions or programs that control the operation of a computer.
- Software can be installed at a central location using servers, where the installation files are made accessible over the network.

Classification of Networks

- Classification by network geography.
- Classification by component roles.

Classification by Network Geography

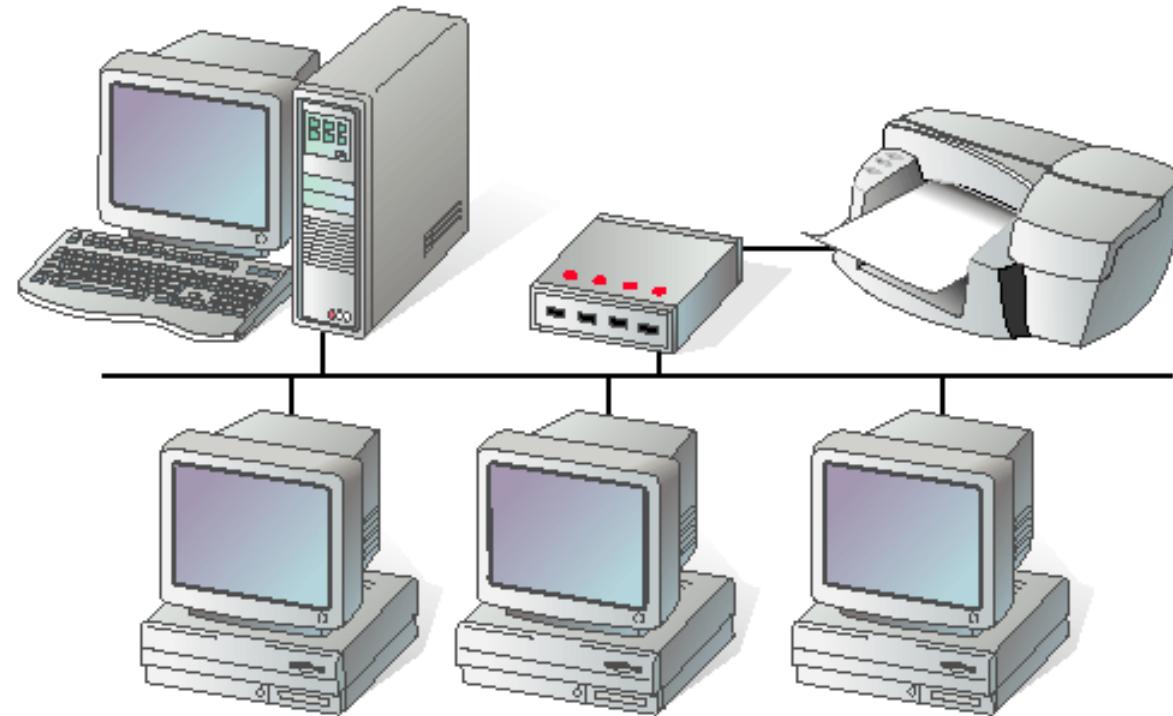
- Networks are frequently classified according to the geographical boundaries spanned by the network itself.
- LAN, WAN, and MAN are the basic types of classification, of which LAN and WAN are frequently used.

Classification by Network Geography

Local area network (LAN):

- A LAN covers a relatively small area such as a classroom, school, or a single building.
- LANs are inexpensive to install and also provide higher speeds.

Classification by Network Geography



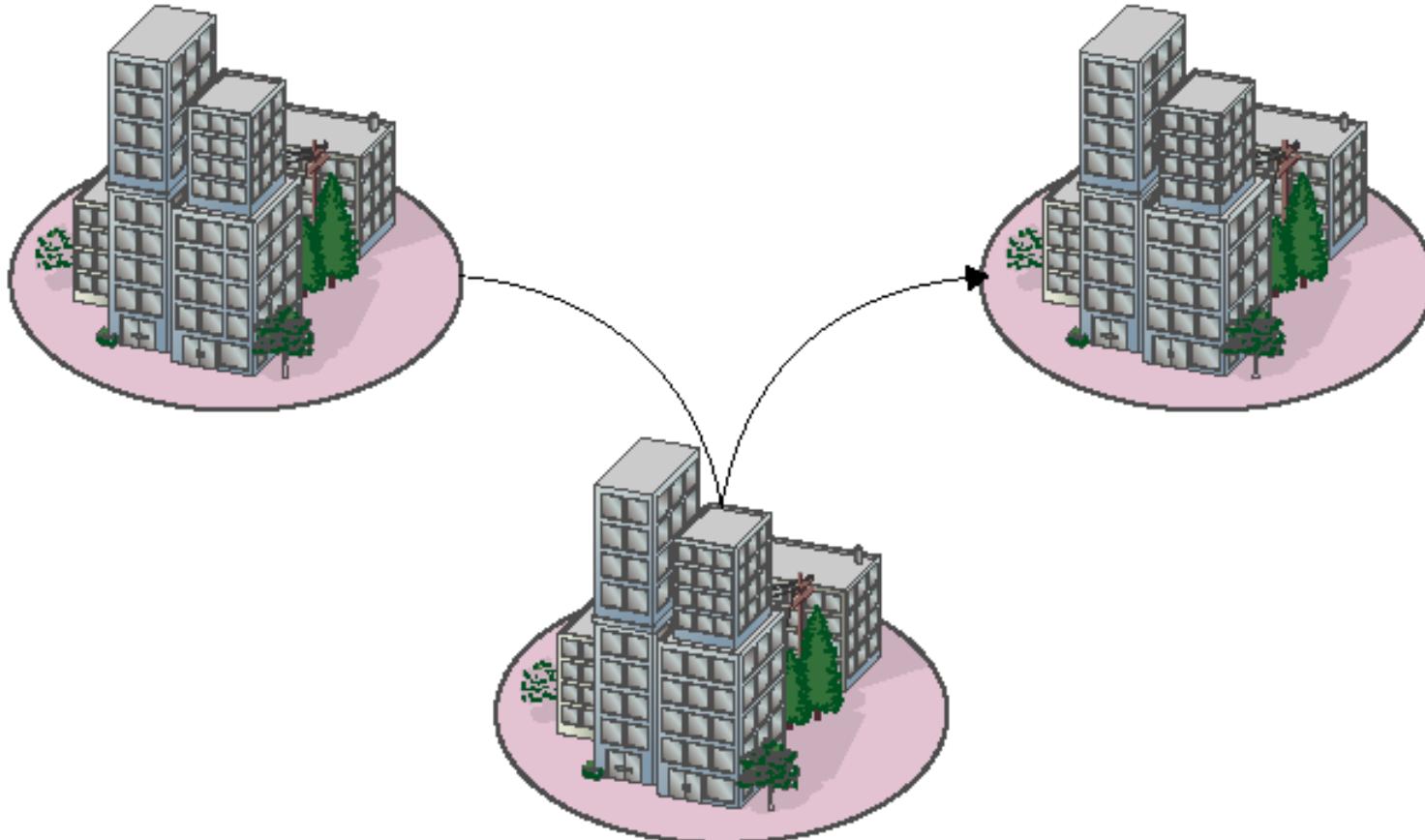
Local area network

Classification by Network Geography

Metropolitan area network (MAN):

- A MAN spans the distance of a typical metropolitan city.
- The cost of installation and operation is higher.
- MANs use high-speed connections such as fiber optics to achieve higher speeds.

Classification by Network Geography



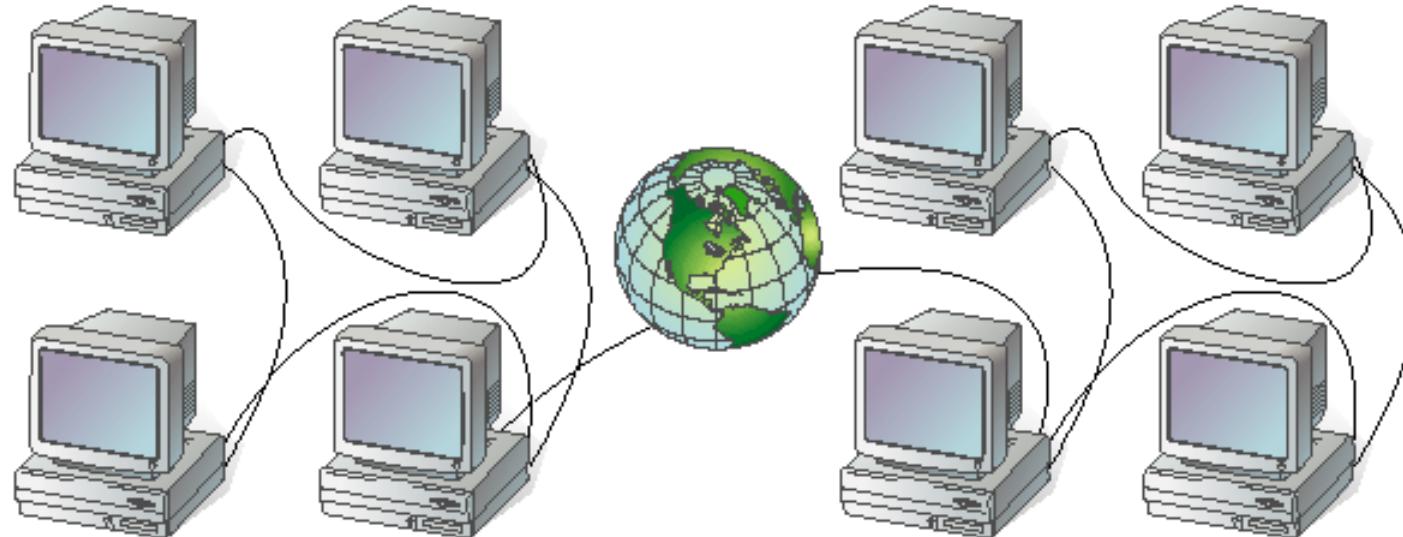
Metropolitan area network

Classification by Network Geography

Wide area network (WAN):

- WANs span a larger area than a single city.
- These use long distance telecommunication networks for connection, thereby increasing the cost.
- The Internet is a good example of a WAN.

Classification by Network Geography



Wide area network

Intranet and Internet Specifications

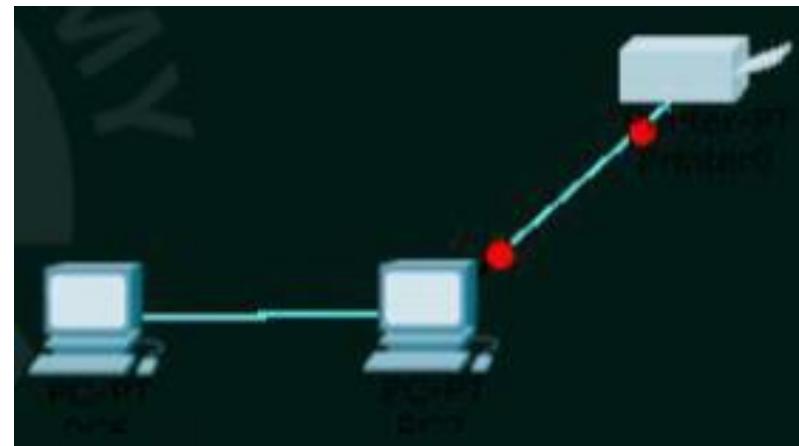
- **Intranet:** An intranet is a private network that is contained within an enterprise. It may consist of many interlinked local area networks and also use leased lines in the wide area network.
- An intranet uses [TCP/IP](#), [HTTP](#), and other Internet protocols and in general looks like a private version of the Internet. With [tunneling](#), companies can send private messages through the public network, using the public network with special encryption/decryption and other security safeguards to connect one part of their intranet to another.
- **Internet:** is a worldwide system of computer networks - a network of networks in which users at any one computer can, if they have permission, get information from any other computer (and sometimes talk directly to users at other computers).

Classification by Component Roles

- Networks can also be classified according to the roles that the networked computers play in the network's operation.
- Peer-to-peer, server-based, and client-based are the types of roles into which networks are classified.

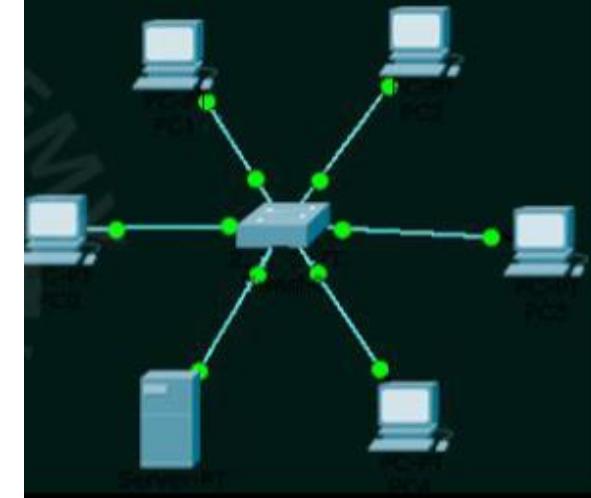
Peer to peer network

- No centralized administration
- All peers are equal
- Simple sharing applications
- Not scalable



Client Server network

- centralized administration
- Requested response model
- Scalable
- Server may be overloaded



Classification by Component Roles

Peer-to-peer:

- In a peer-to-peer network, all computers are considered equal.
- Each computer controls its own information and is capable of functioning as either a client or a server depending upon the requirement.
- Peer-to-peer networks are inexpensive and easy to install.
- They are popular as home networks and for use in small companies.

Classification by Component Roles

Peer-to-peer (continued):

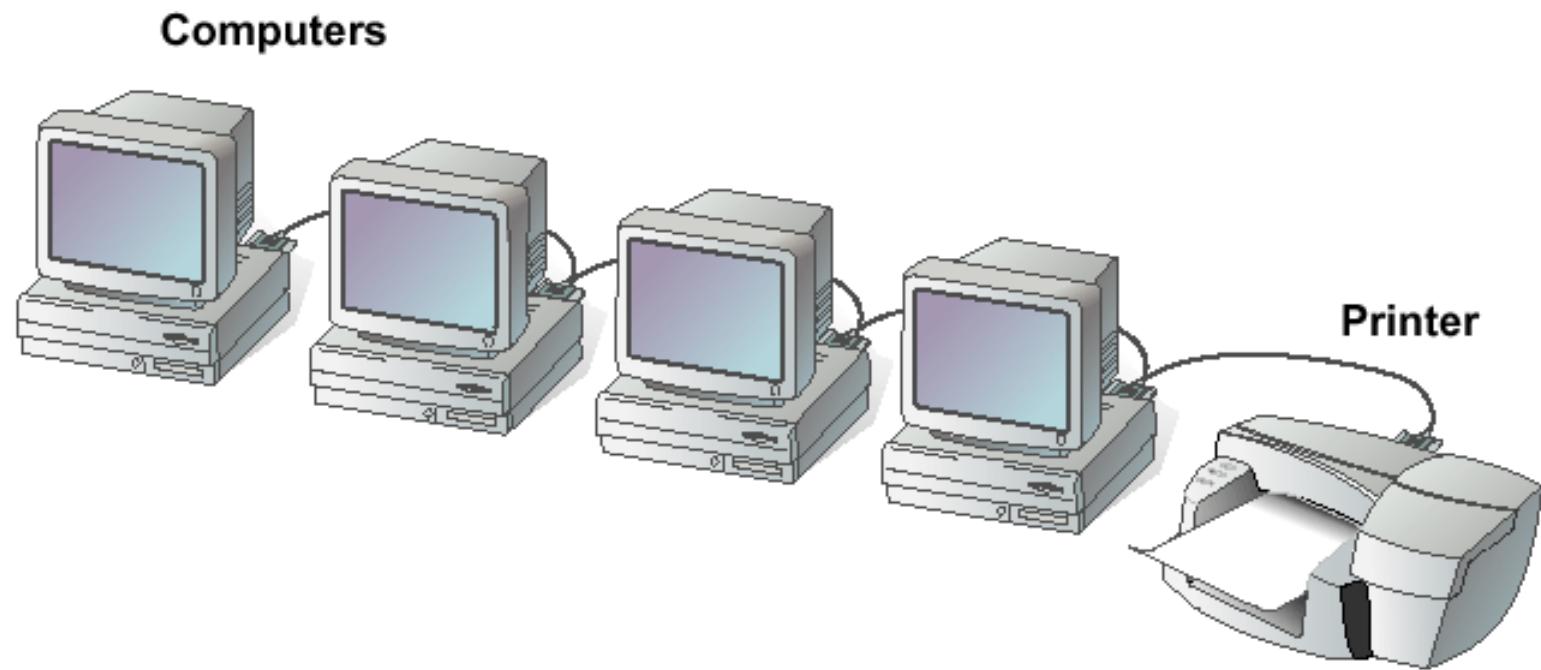
- Most operating systems come with built-in peer-to-peer networking capability.
- The maximum number of peers that can operate on a peer-to-peer network is ten.
- Each peer shares resources and allows others open access to them.

Classification by Component Roles

Peer-to-peer (continued):

- Peer-to-peer networks become difficult to manage when more security is added to resources, since the users control their security by password-protecting shares.
- Shares can be document folders, printers, peripherals, and any other resource that they control on their computers.

Classification by Component Roles



Peer-to-peer network

Classification by Component Roles

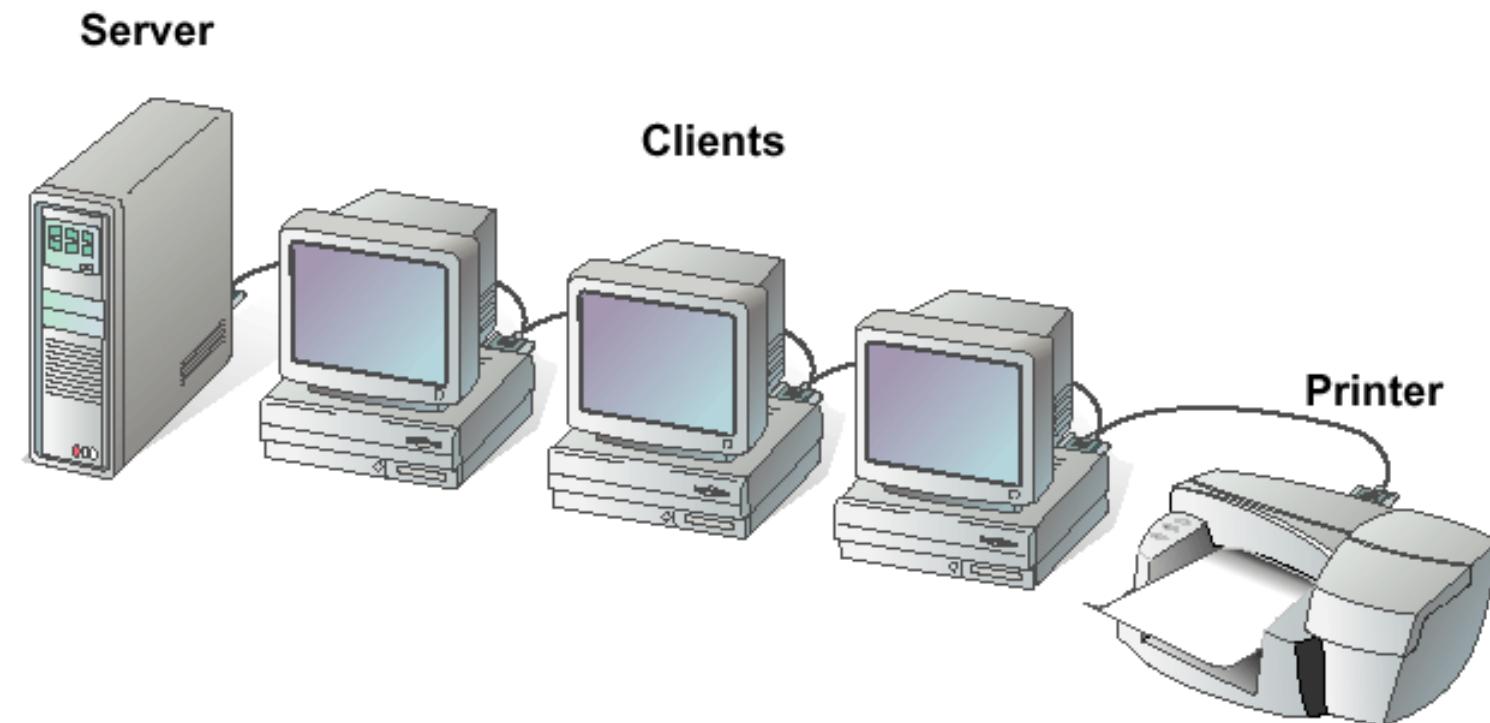
Server-based:

- A server-based network offers centralized control and is designed for secure operations.
- In a server-based network, a dedicated server controls the network.
- A dedicated server is one that services the network by storing data, applications, resources, and also provides access to resources required by the client.

Classification by Component Roles

Server-based (continued):

- These servers can also control the network's security from one centralized location or share it with other specially configured servers.

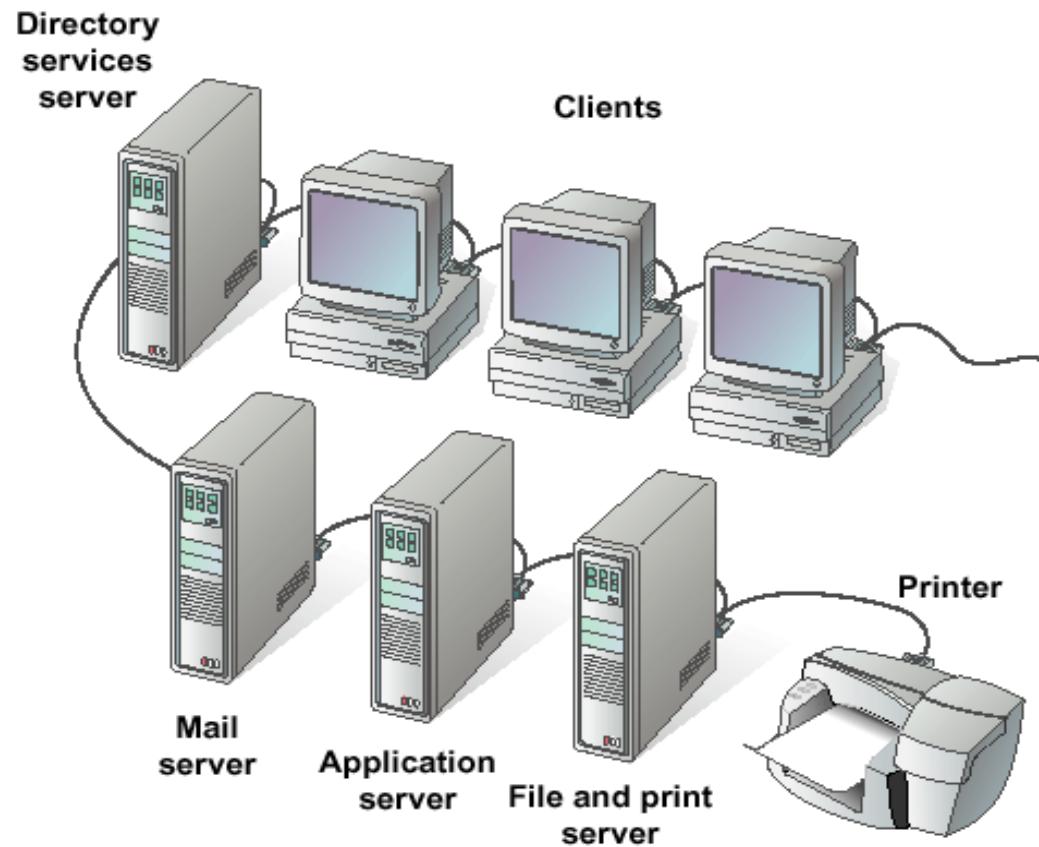


Classification by Component Roles

Client-based:

- Client-based network servers process requests from clients and return just the results.
- These networks take advantage of the powerful processing capabilities of both the client and the server.
- Application servers and communications servers are examples of client-based networks.

Classification by Component Roles



Client-based network

Computer networks is set of nodes connected by communication links

A node can be a computer , printer or any other device capable of sending /receiving data generated by other nodes in the network

Example of nodes

- 1.Computer
- 2.Server
- 3.Printer
- 4.Security camera
- 5.Many more (switches , bridges)

Characteristics of Network

3 Common characteristics

1. Size
2. Type
3. Effectiveness

Size:

1. Small Network

- Includes less no of nodes
- Covers small area

Example: PAN(Personal Area Network)

WPAN(Wireless PAN):Bluetooth

2. Large Network

- Includes more no of nodes
- Covers large area

Example: Internet

Types of Networks

1. Wired Network/connection oriented network

- 3 Phases of connection oriented network :

1. Connection Establishment

1. Physical

- Twisted Pair
- Coaxial Cable
- Fiber optics

2. Logical

- 3 Way Handshaking
- 4 Way Handshaking

2. Data Transfer

3. Connection Release

- Example : Telephone Network, Cable Network(Dish TV)

2. Wireless Network/Connectionless network

- No connection required
- Contain only one phase : Data Transfer Phase
- Example: Satellite Network, Mobile Network, Computer Network(Internet)

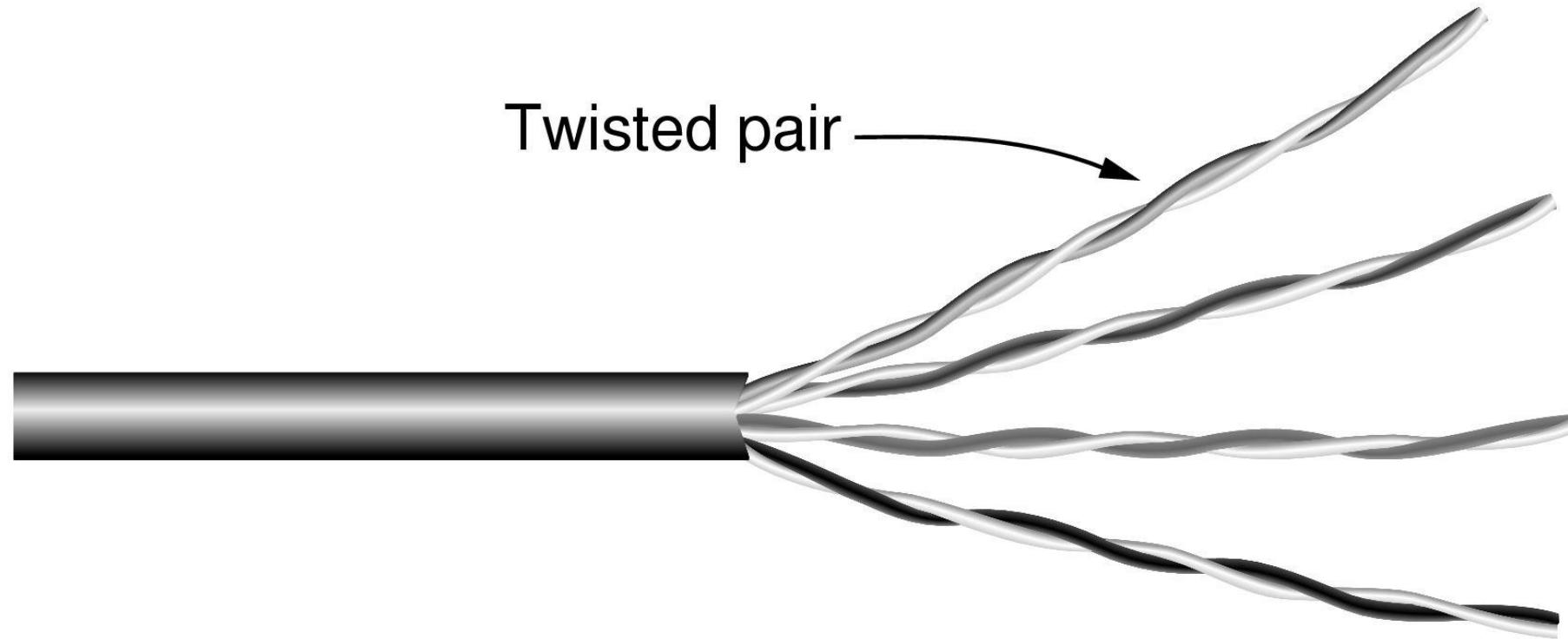
Guided Transmission Media

- Magnetic media
- Twisted pairs
- Coaxial cable
- Power lines
- Fiber optics

Magnetic Media

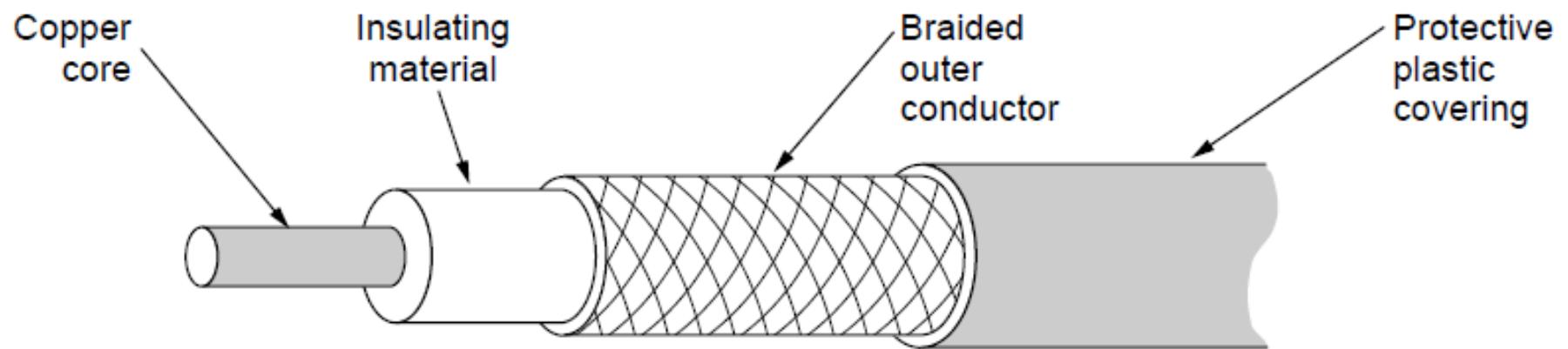
- Write data onto magnetic media
 - Disks
 - Tapes
- Data transmission speed
 - Never underestimate the bandwidth of a station wagon full of tapes hurtling down the highway.

Twisted Pairs



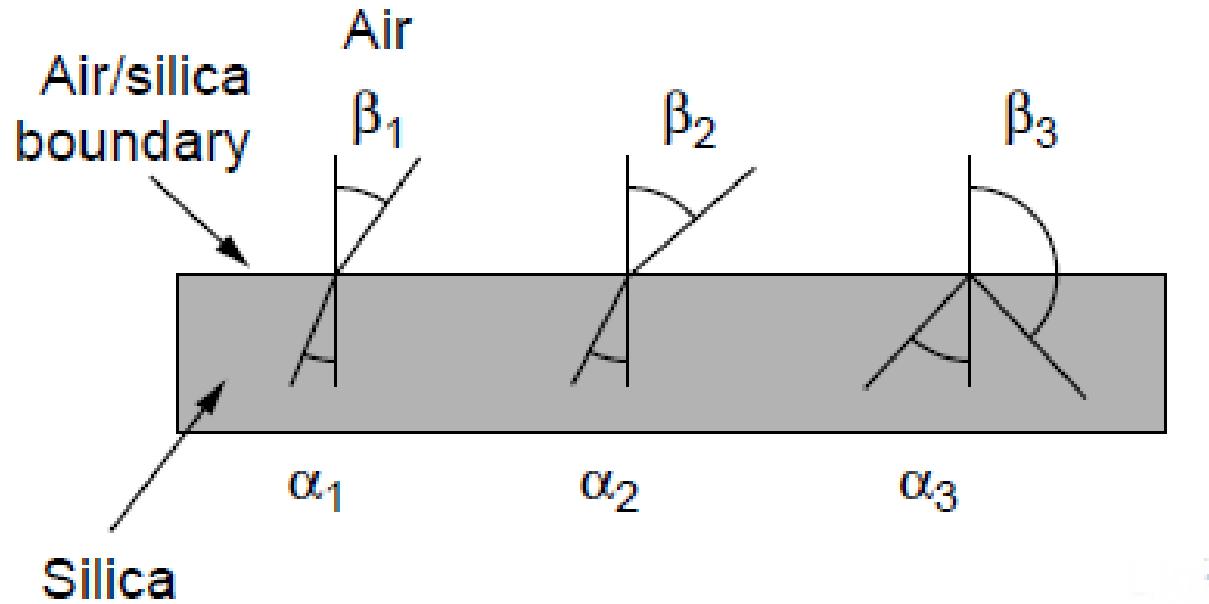
Category 5 UTP cable with four twisted pairs

Coaxial Cable



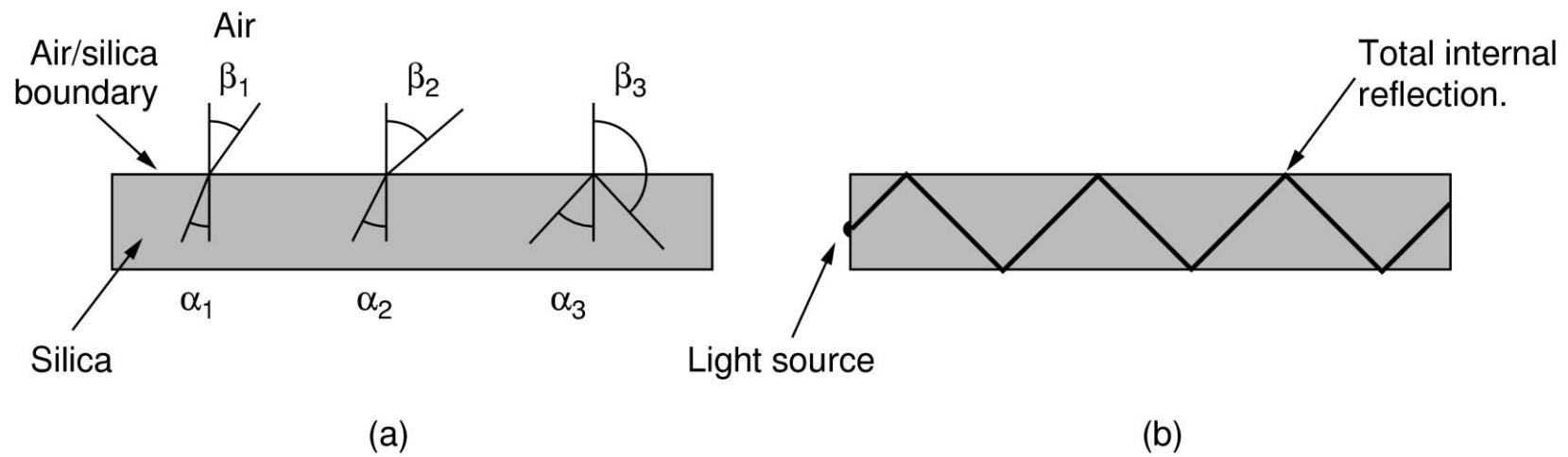
A coaxial cable

Fiber Optics (1)



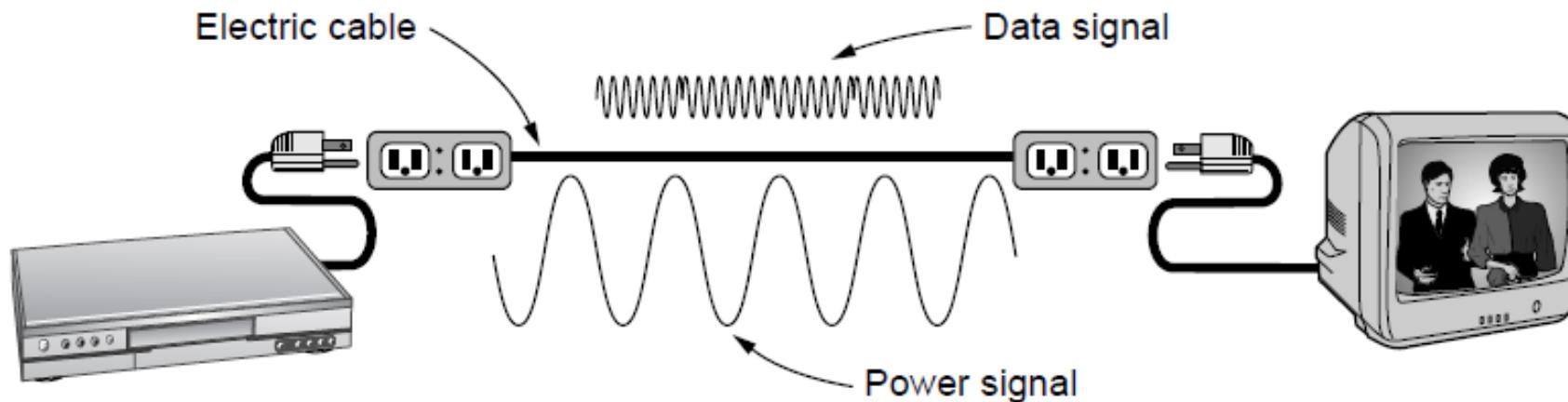
Three examples of a light ray from inside a silica fiber impinging on the air/silica boundary at different angles.

Fiber Optics (2)



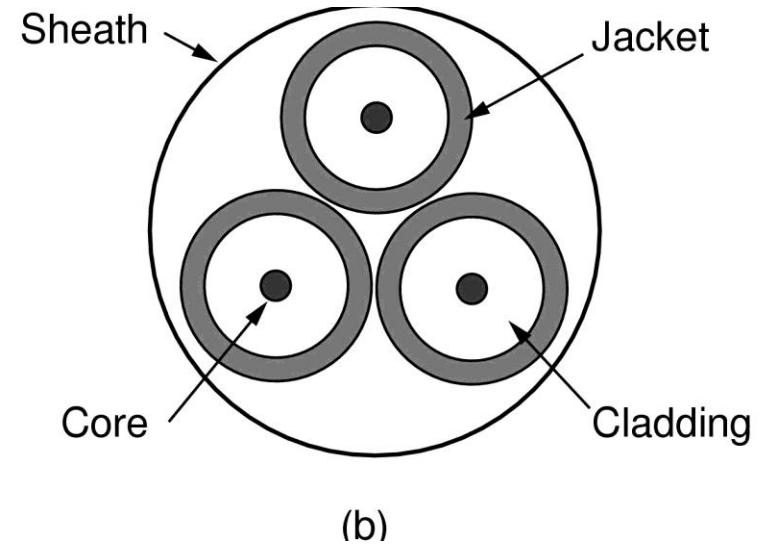
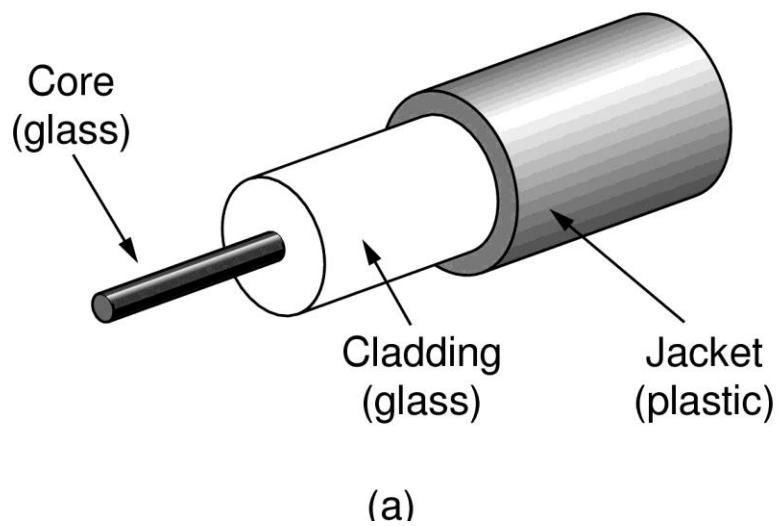
Light trapped by total internal reflection.

Power Lines



A network that uses household electrical wiring.

Fiber Cables (1)



Views of a fiber cable

Fiber Cables (2)

Item	LED	Semiconductor laser
Data rate	Low	High
Fiber type	Multi-mode	Multi-mode or single-mode
Distance	Short	Long
Lifetime	Long life	Short life
Temperature sensitivity	Minor	Substantial
Cost	Low cost	Expensive

A comparison of semiconductor diodes
and LEDs as light sources

Wireless Transmission

- The Electromagnetic Spectrum
- Radio Transmission
- Microwave Transmission
- Infrared Transmission
- Light Transmission

WIRELESS MEDIA

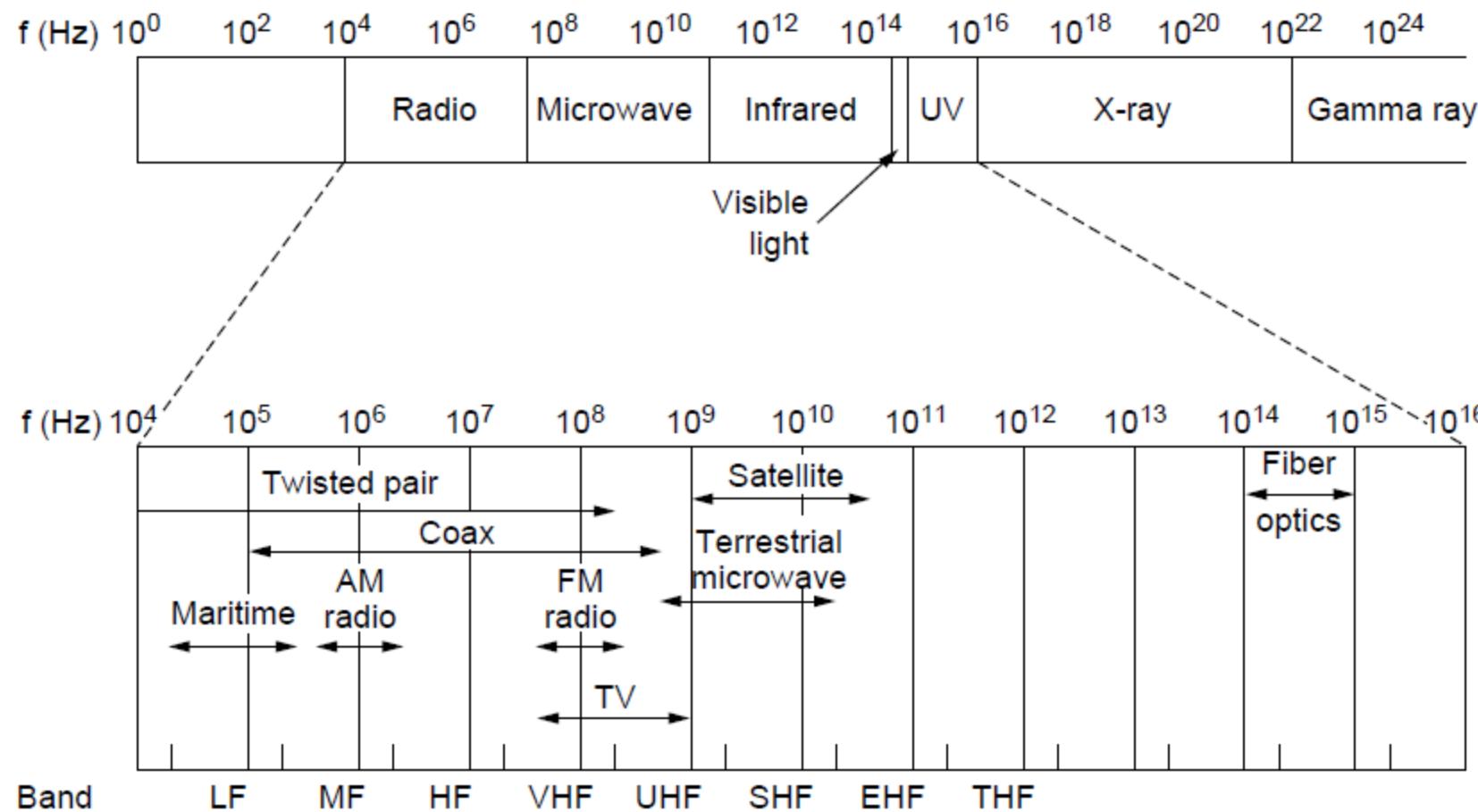
Infrared (Example: short range communication - TV remote control)

Radio (Example: Bluetooth, Wi-Fi)

Microwaves (Example: Cellular System)

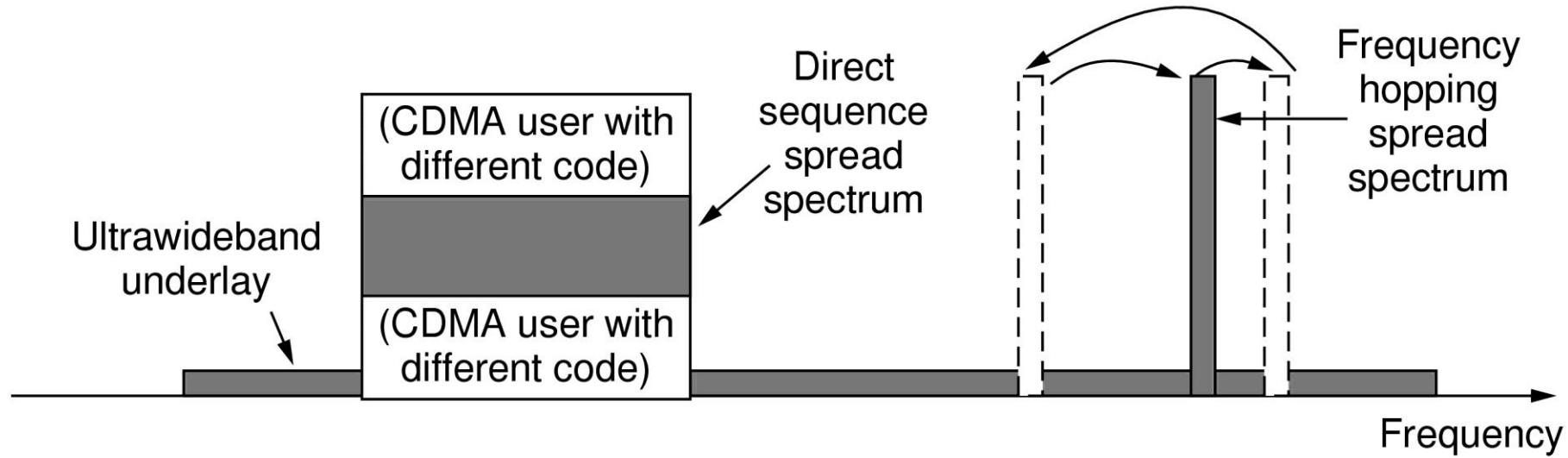
Satellite (Example: Long range communication - GPS)

The Electromagnetic Spectrum (1)



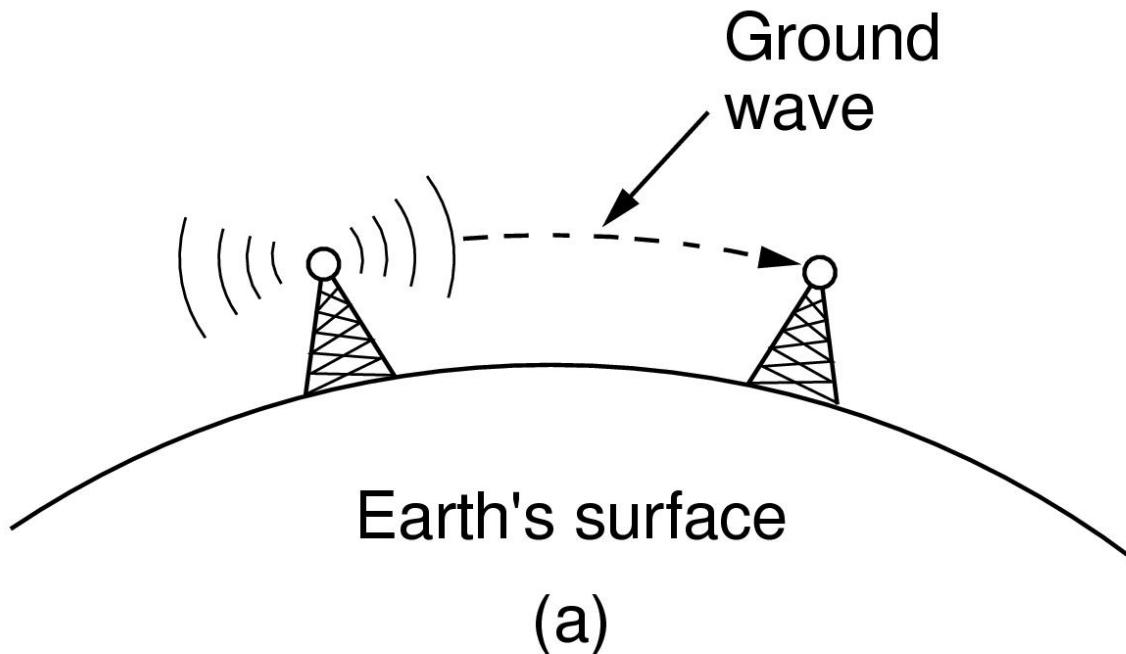
The electromagnetic spectrum and
its uses for communication

The Electromagnetic Spectrum (2)



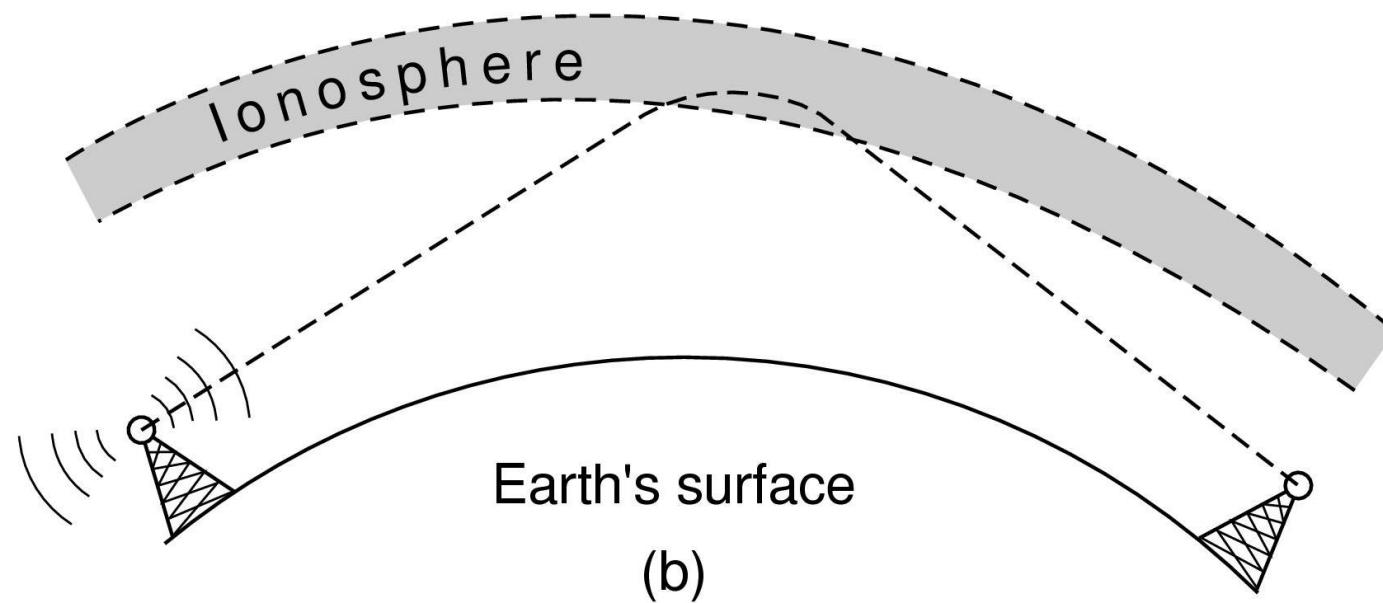
Spread spectrum and ultra-wideband
(UWB) communication

Radio Transmission (1)



In the VLF, LF, and MF bands, radio waves follow the curvature of the earth

Radio Transmission (2)



In the HF band, they bounce off the ionosphere.

Communication Satellites

- Geostationary Satellites
- Medium-Earth Orbit Satellites
- Low-Earth Orbit Satellites
- Satellites Versus Fiber

Network Components

- Physical Media
- Interconnecting Devices
- Computers
- Networking Software
- Applications

Networking Media

- Networking media can be defined simply as the means by which signals (data) are sent from one computer to another (either by cable or wireless means).

Networking Devices

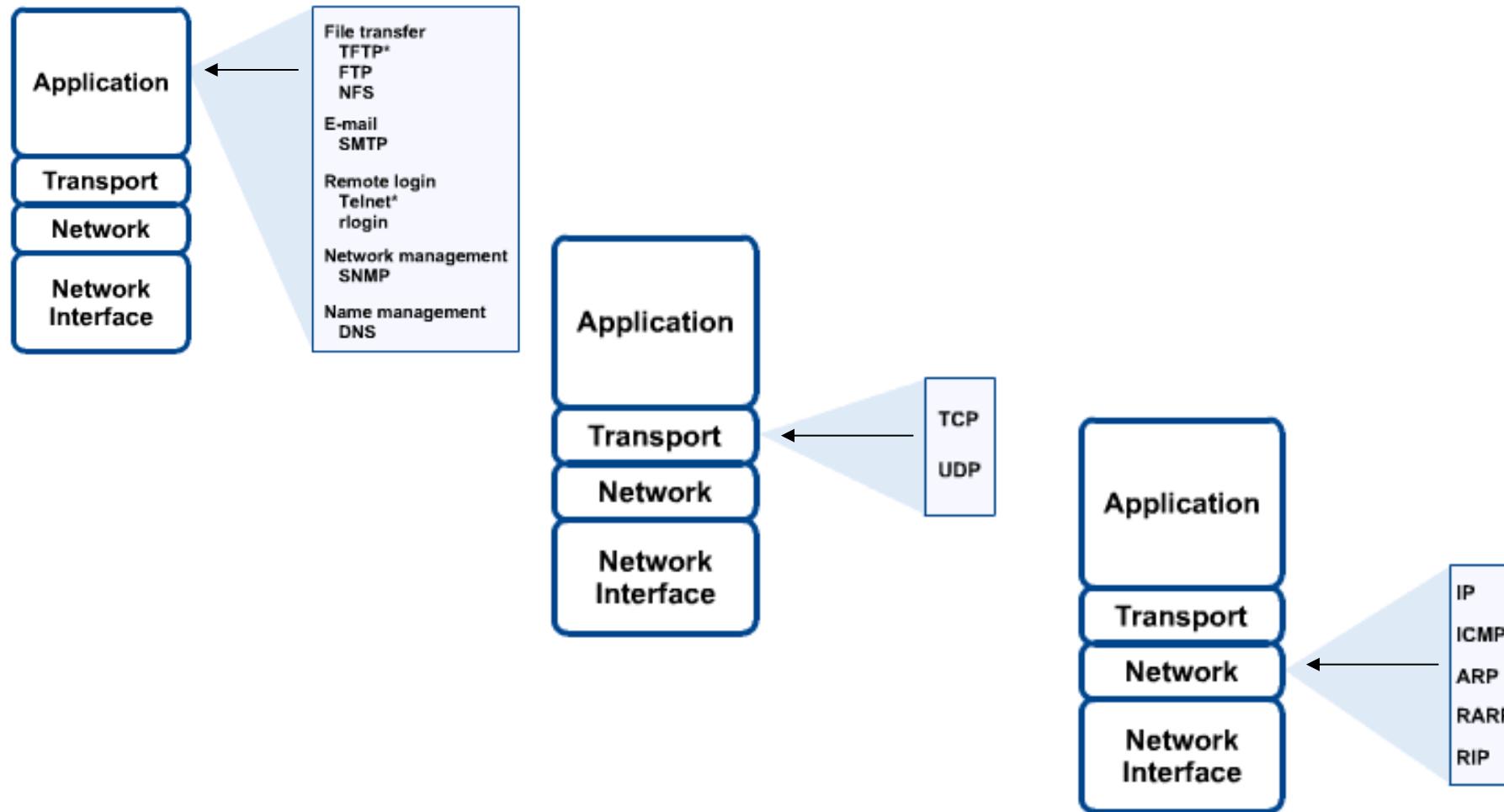
- HUB, Switches, Wireless Access Modems etc.
- Routers, Points,



Computers: Clients and Servers

- In a client/server network arrangement, network services are located in a dedicated computer whose only function is to respond to the requests of clients.
- The server contains the file, print, application, security, and other services in a central computer that is continuously available to respond to client requests.

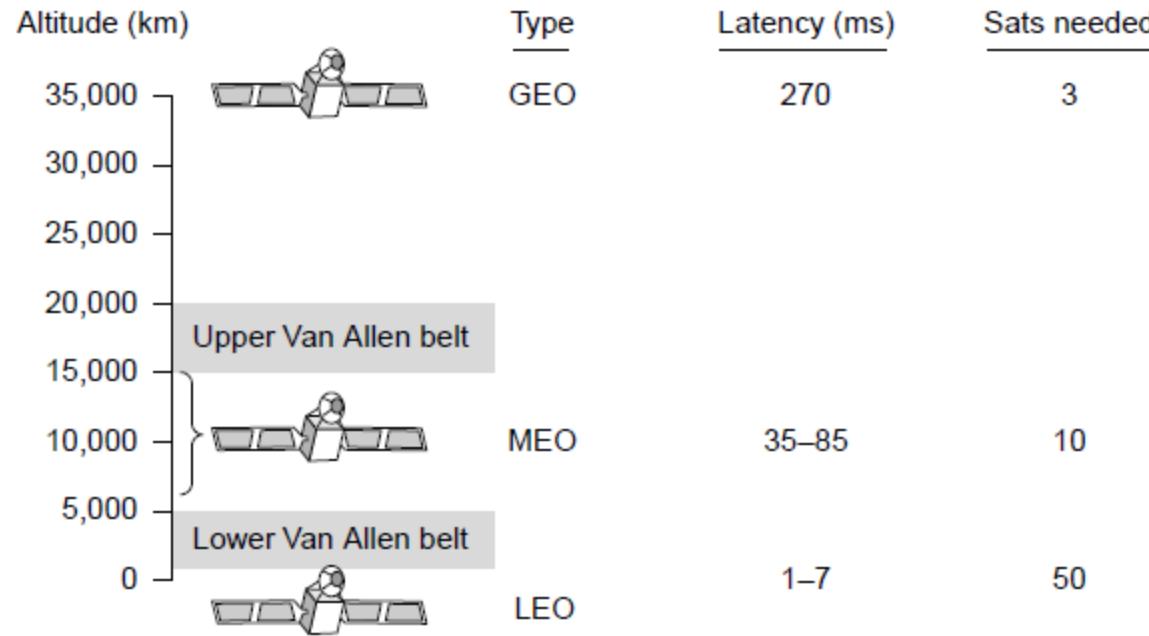
Networking Protocol: TCP/IP



Applications

- E-mail
- Searchable Data (Web Sites)
- E-Commerce
- News Groups
- Internet Telephony (VoIP)
- Video Conferencing
- Chat Groups
- Instant Messengers
- Internet Radio

Communication Satellites



Communication satellites, some properties, including:
altitude above earth, round-trip delay time, number of
satellites for global coverage.

Effectiveness: 1. Efficient Network

2. Inefficient Network

The effectiveness of a network depends on following parameters

- Delivery → is the data reached to intended Receiver or not?
- Accuracy → is the data reached to intended Receiver without error?
- Timeliness → is the network capable of transferring the data within time or not?

- Block Diagram of CN: Five Components

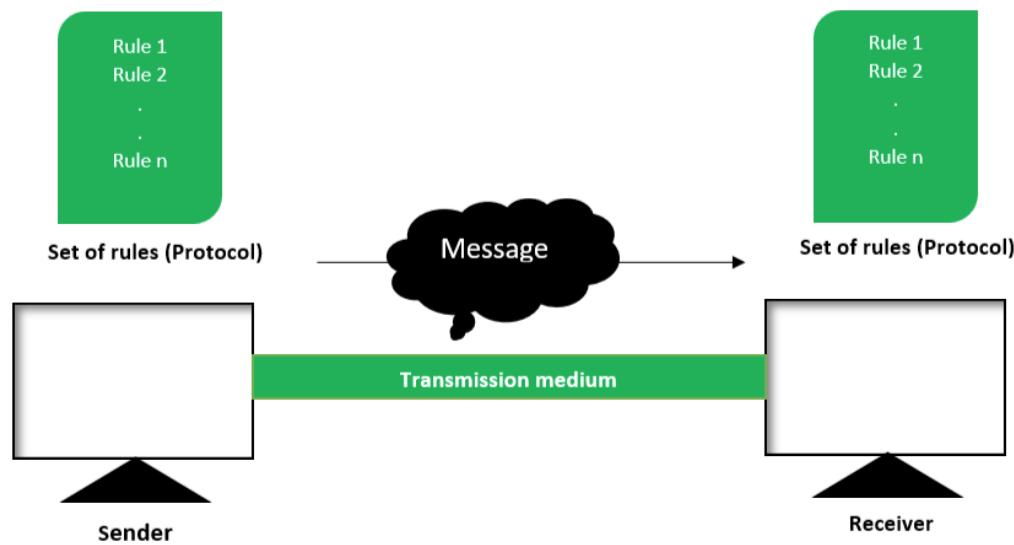
1.Sender

2.receiver

3.Message

4.Medium

5.Protocol



Computer Networks



- Computer network connects two or more autonomous computers.
- The computers can be geographically located anywhere.

LAN, MAN & WAN

- Network in small geographical Area (Room, Building or a Campus) is called LAN (Local Area Network)
- Network in a City is call MAN (Metropolitan Area Network)
- Network spread geographically (Country or across Globe) is called WAN (Wide Area Network)

Applications of Networks

- **Resource Sharing**
 - Hardware (computing resources, disks, printers)
 - Software (application software)
- **Information Sharing**
 - Easy accessibility from anywhere (files, databases)
 - Search Capability (WWW)
- **Communication**
 - Email
 - Message broadcast
- **Remote computing**
- **Distributed processing (GRID Computing)**

Summary

- The basic purpose of networks is to enable effective communication, share resources, and facilitate centralized management of data.
- Networks can be classified according to their geographical boundaries or their component roles.

Summary

- A network consists of two or more entities sharing resources and information.
- A computer network consists of two or more computers that are connected and are able to communicate.