FUNDAMENTALS OF NETWORKING

Chapter one : Introduction to Data Communications and computer networks

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Know Each Other

Name

Network related background

What do I expect from this course?

Chapter one : Introduction to Data Communications and computer networks

BASICS OF DATA COMMUNICATION

Data Communications are the exchange of data between two devices via some form of transmission.
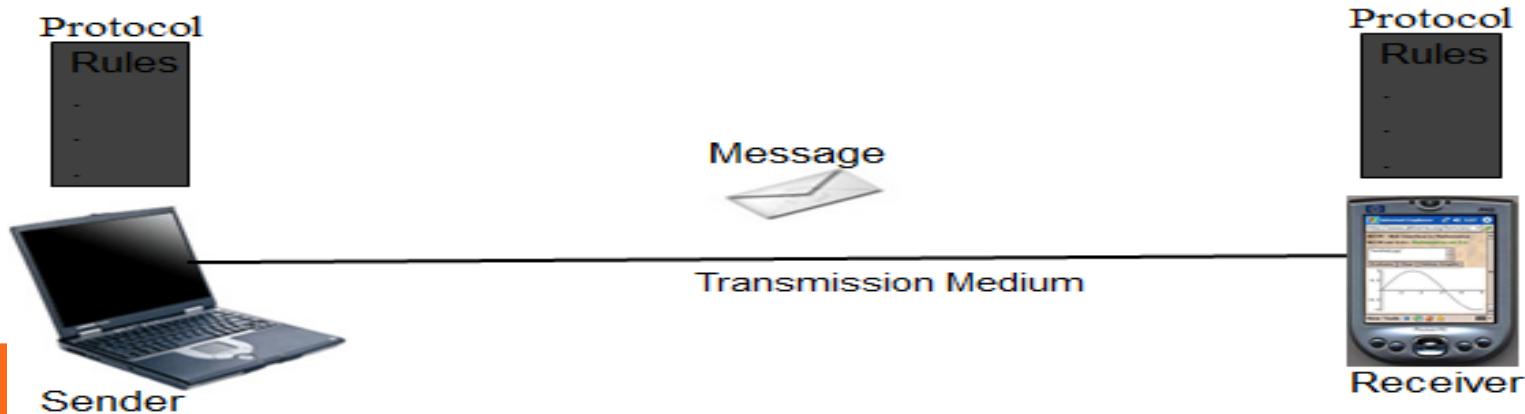
COMPONENT OF DATA COMMUNICATION

1. Message: data.

2. Sender: The device that send the message.

3. Receiver: The device that receive the message.

4. Transmission Medium: The physical path between sender and receiver, the message travel.

5. Protocol: Protocol is a set of rules that governs data communication. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating.

DATA COMMUNICATION CHARACTERISTICS

1. Delivery: The system must deliver data to the correct destination.

2. Accuracy:
   - Data delivered accurately.
   - Altered data which left uncorrected are unusable.

3. Timelines:

   The system must deliver data in timely manner without delay (real-time).
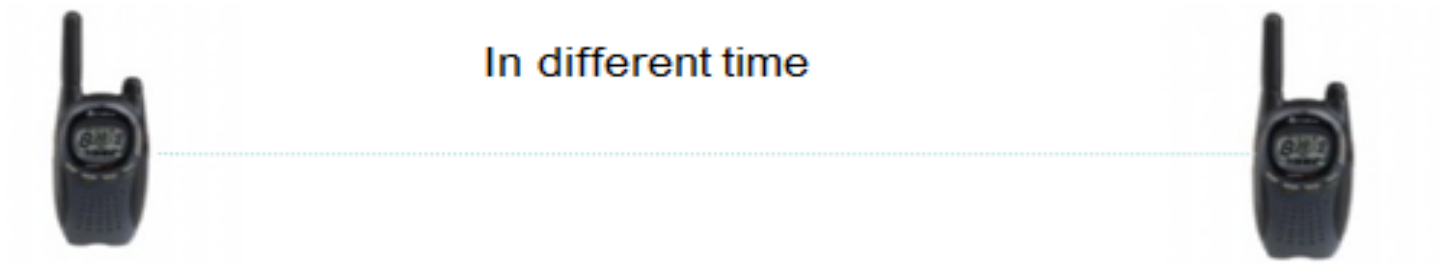
DATA FLOW IN COMMUNICATION

Simplex: one direction only. one side sender and another side receiver
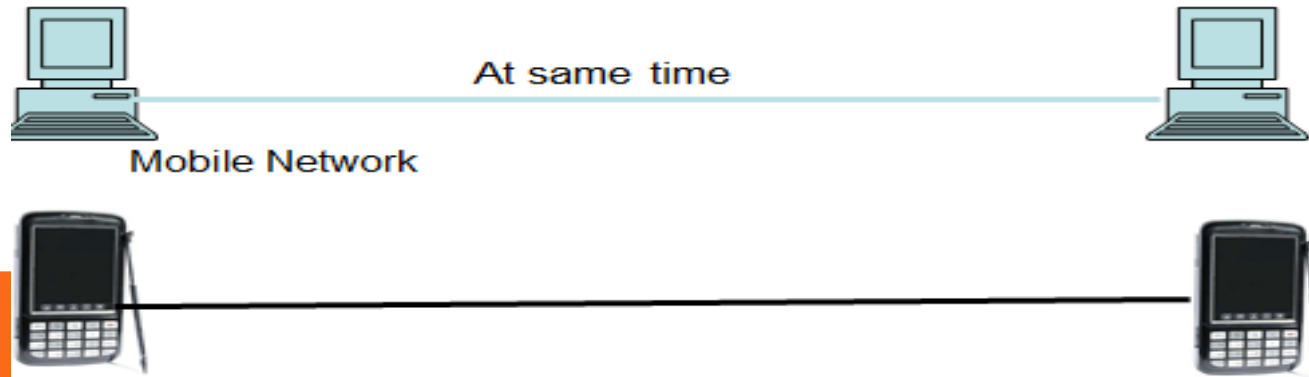
CONT…

Half-Duplex: **two-way alternate.**

In different time

Each side maybe sender or receiver but not a same time

CONT…

Duplex: two-way concurrent.

Computer network

At same time

Mobile Network

NETWORK

- A Network is a set of node connect together by communication link to sharing of resources and to transmit information.

- Node: Computer, Printer, Scanner, Software , PDA, etc.

- Information: text, voice, picture, etc

NETWORK SERVICES

Sharing (file, printer, application).

❑ Internet browsing.

❑ Fax Service.

❑ Telephony.

❑ Conferencing.

❑ Database.

❑ Backup.

NETWORK COMPONENTS

❑ Transmission media (wired, wireless).

❑ There are two types of transmission media, namely guided and unguided.

❑ Guided transmission media are cables like twisted pair cables, coaxial cables, and fiber optic cables.

❑ Unguided transmission media are wireless, such as infrared, radio waves, and microwaves

CONT…

❑	Network Operating System (NOS).

A network operating system (NOS) is a computer operating system (OS) that's designed primarily to support workstations, PCs and, in some instances, older terminals that are connected on a local area network (LAN)

❑ Network Interface Card (NIC). is a hardware component, typically a circuit board or chip, which is installed on a computer so it can connect to a network.

CONT…

❑ **Network Hardware:-**
1. Hubs.
2. Switches.
3. Routers.
4. Gateways.
5. Access Point.
6. Repeaters

NETWORK CLASSIFICATION

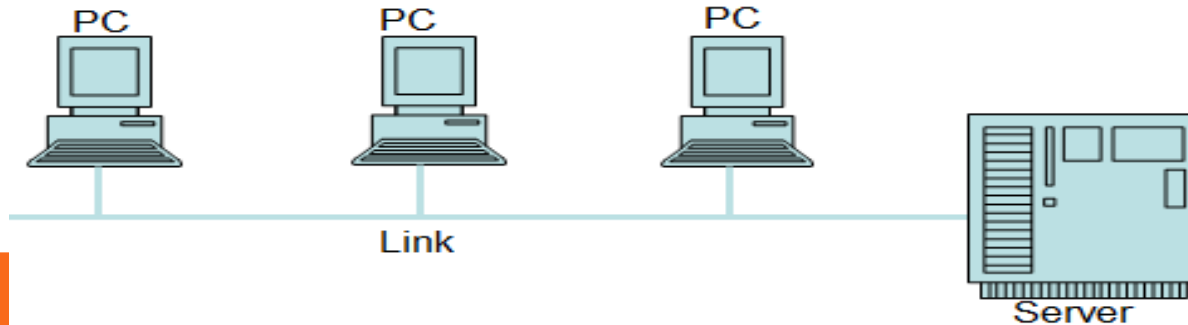Upon the transmission medium (type of connection):-

1. Point-to-point:

A pair of nodes connected together via dedicated link**.**

PC — Link — PC

CONT…

Multipoint

Number of node connected and share a single link

CONT…

Upon the scale (size):-

1. PAN (Personal Area Network).

2. LAN (Local Area Network).

3. CAN (Campus Area Network).

4. MAN (Metropolitan Area Network).

5. WAN (Wide Area Network).

CONT…

Upon the scale (size):-

1.   PAN (Personal Area Network).

➢   PAN is a short-distance network design to individual user (person).

PAN may be contain:- printer, mobile, computer, wireless printers , PDA, etc.

➢   components of PAN connected together via Bluetooth , USB cable ,IrDA (infrared), etc.

CONT…

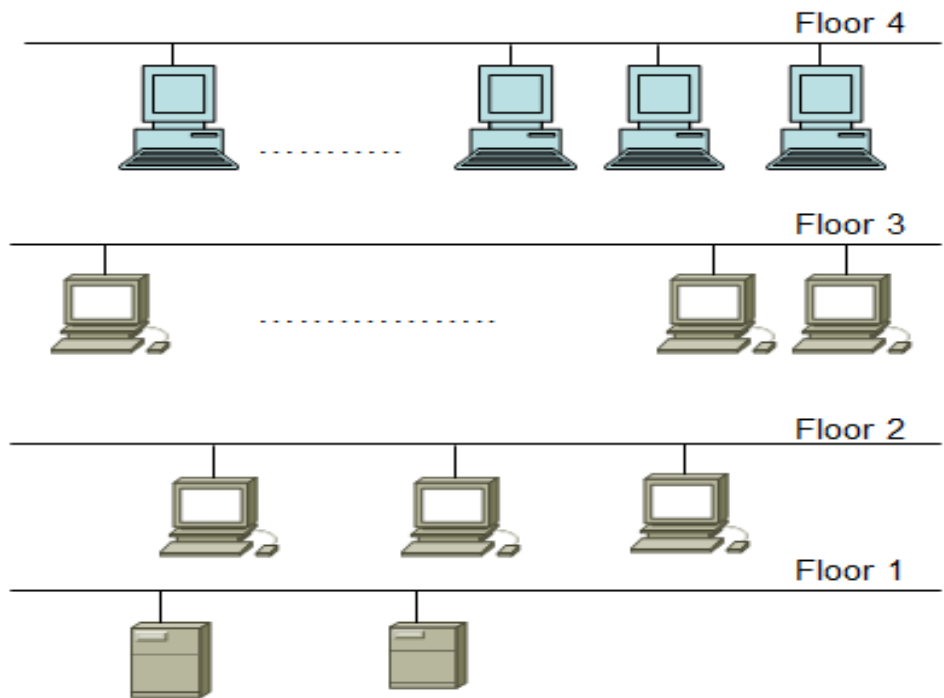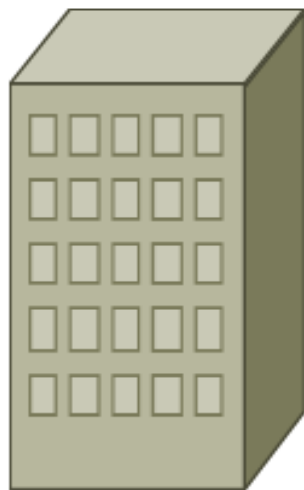Wireless Printer

Scanner

USB Cable

Bluetooth

IrDA

PDA

LAN (LOCAL AREA NETWORK)

➢ A LAN is a group of node connected together in a small specific area.

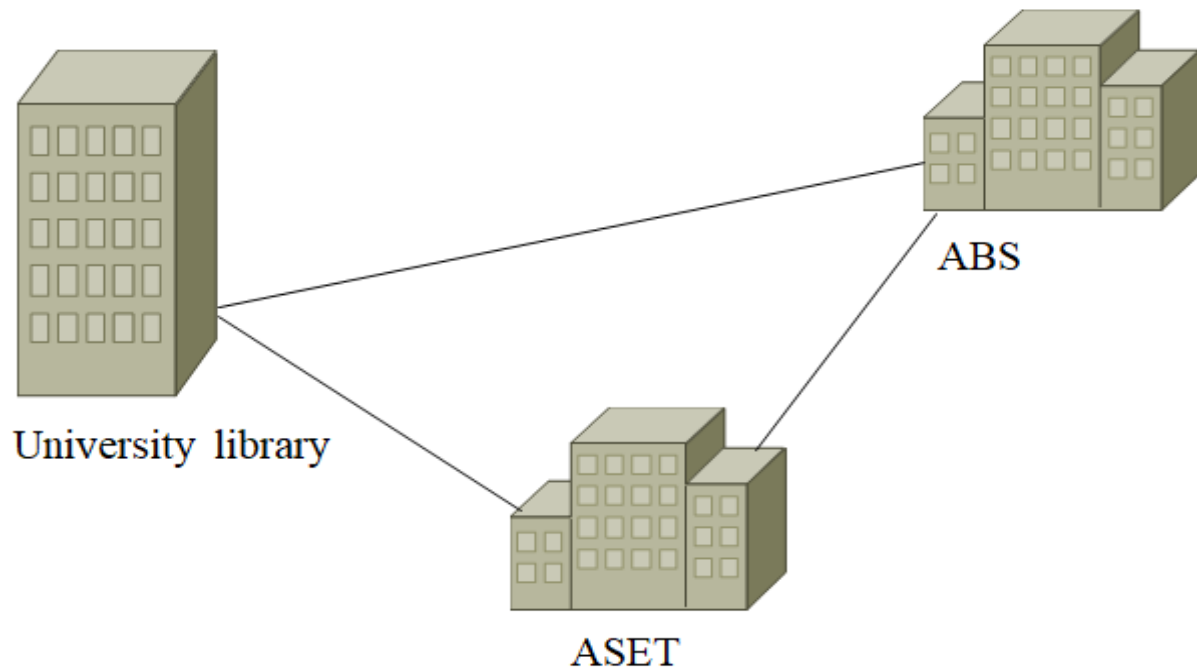➢ LAN may be contain workstations, computers, scanner, printers, servers, etc.

CONT…

CONT…

➢ A CAN is a group of interconnection LAN within limited geographical area.

➢ A CAN using in school campus, military base, university campus ,etc.
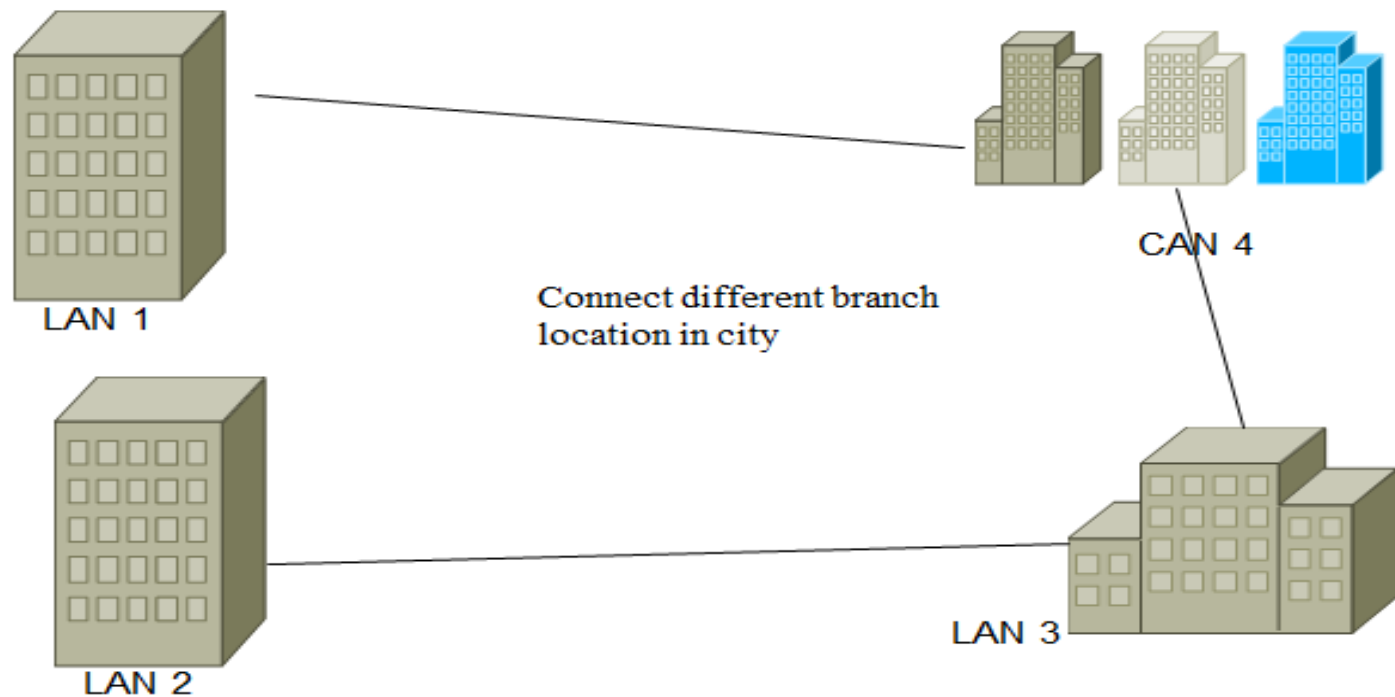
CONT…

University library

ABS

ASET

CONT…

➢ A MAN is a large computer network uses to connect between LAN in different location (cities).

➢ A MAN is a group of node connect together over city.

CONT…

Connect different branch location in city

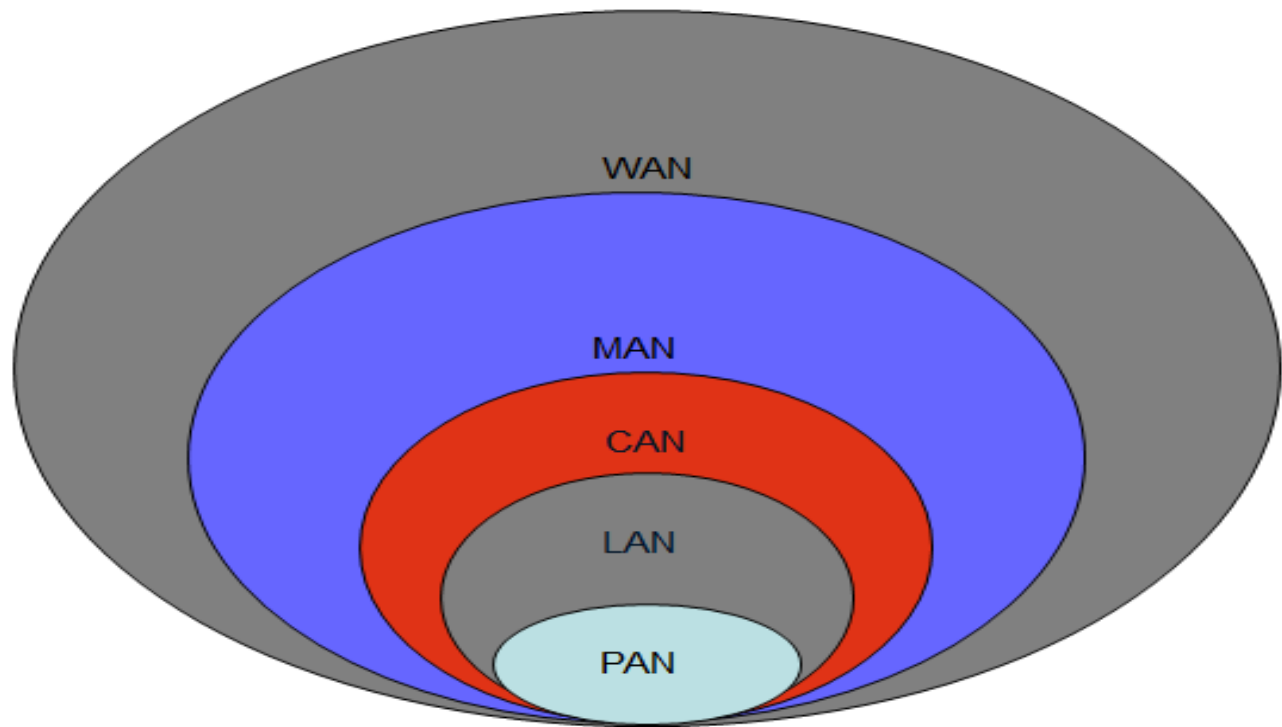LAN 1

LAN 2

LAN 3

CAN 4

CONT…

➢ A WAN is a computer network that covers large geographical area.

➢ WANs are used to connect types of networks together.

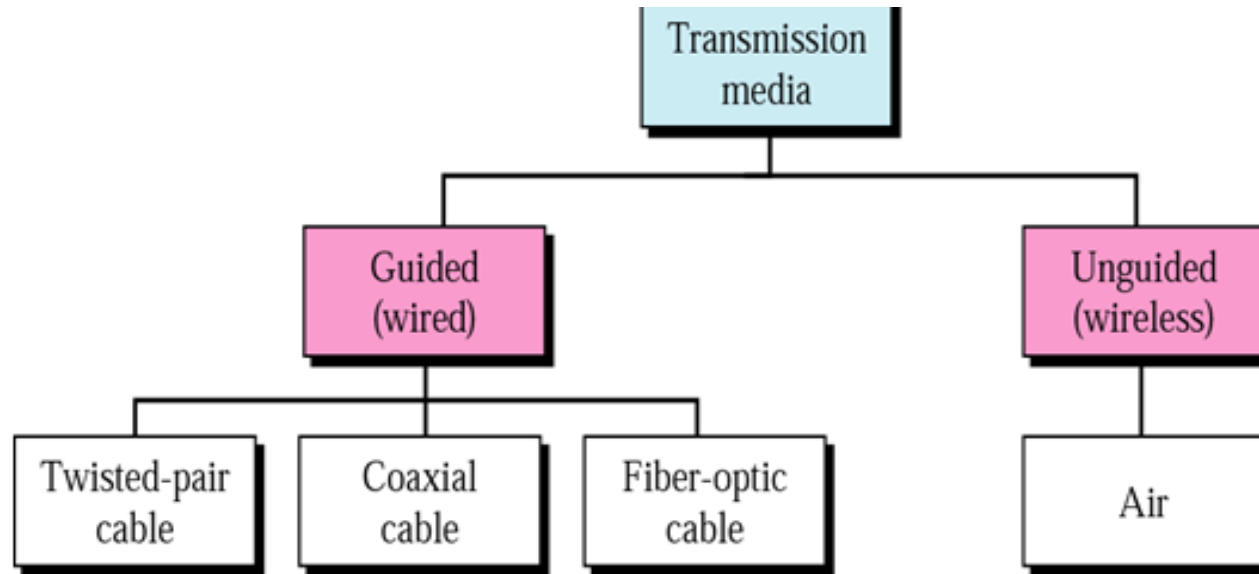# CONT...

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Fundamentals of Information Transmission Media and Coding

TRANSMISSION MEDIA

Transmission medium: the physical path between transmitter and receiver.

transmission media operates at Physical Layer of the OSI Model

TWISTED-PAIR CABLE

➢ Twisted-pair cable uses metallic (copper) conductors that accept and transport signals in the form of electric current.

➢ Twisted pair cables consist of one or more pairs of insulated copper wires that are twisted together and housed in a protective jacket.

Insulator

Conductors
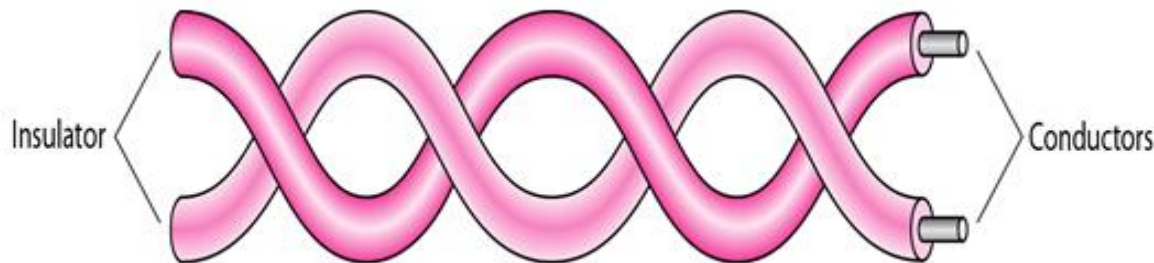
CONT…

Twisted pair cables have connectors at the end, known as RJ connectors (RJ-45, RJ-11)

RJ 11 Connector (phone)

RJ 45 Connector (ethernet)
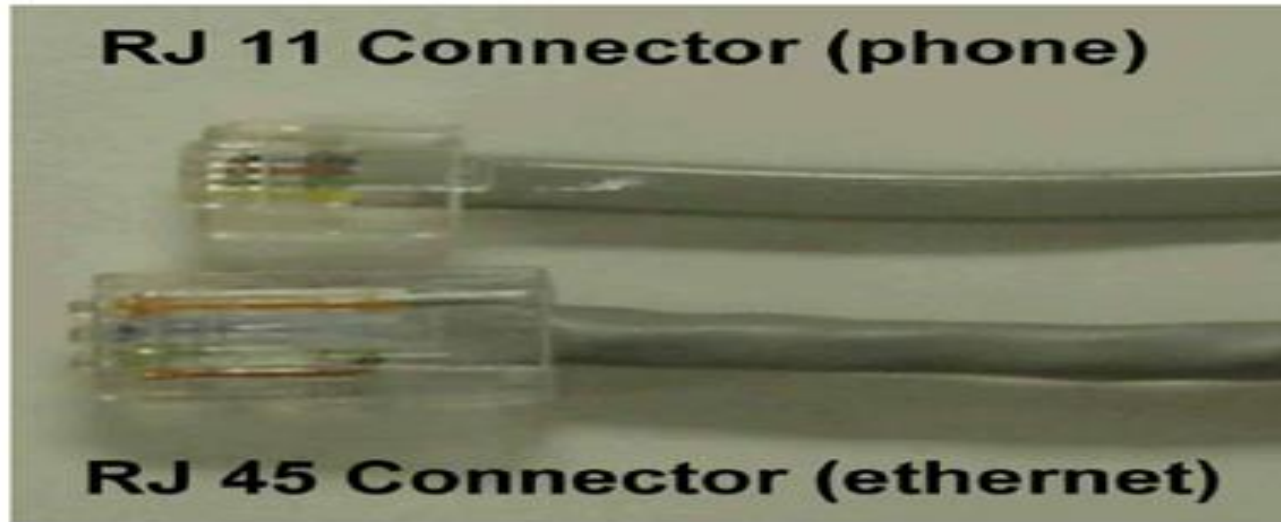
CONT…

✓ Application:

→ Twisted pairs can be used for transmitting either analog or digital signals.

- Telephone network (between house and local exchange)

- LAN (10 Mbps or 100 Mbps)

Advantages: Disadvantages:

Easy to work with(install)   - Low data   rate

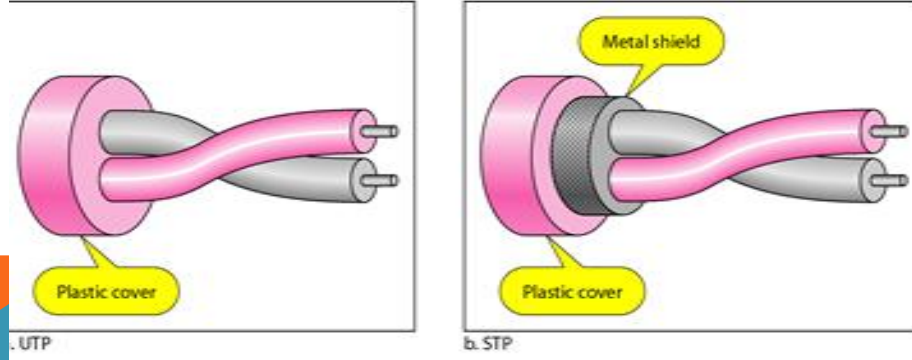   Less expensive   Short range

CONT…

✓ Types:

- Shielded twisted pair (STP): a metallic shield around the wire pairs minimizes the impact of the penetration of noise or crosstalk.

- Unshielded twisted pair (UTP)

CONT…

o Shielded Twisted Pair:

Cost: STP cable costs more than thin coaxial or unshielded twisted-pair cable. STP is less costly, however, than thick coax or fiber-optic cable.

Capacity: The most common data rate for STP cable is 16 Mbps, which is the top data rate for Token Ring networks

CONT…

<u>Attenuation:</u>

All varieties of twisted-pair cable have attenuation characteristics that limit the length of cable runs to a few hundred meters, although a 100-meter limit is most common

CONT…

Shielding Twisted-Pair (STP)

Two twisted pairs

Jacket/Sheath

Foil shielding
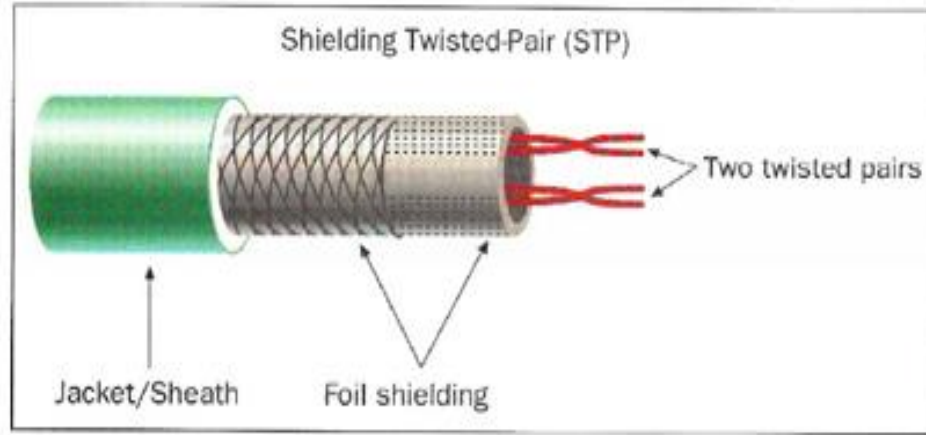
Note: Foil is a very thin sheet of metal→ Preventing the penetration of noise or crosstalk

CONT…
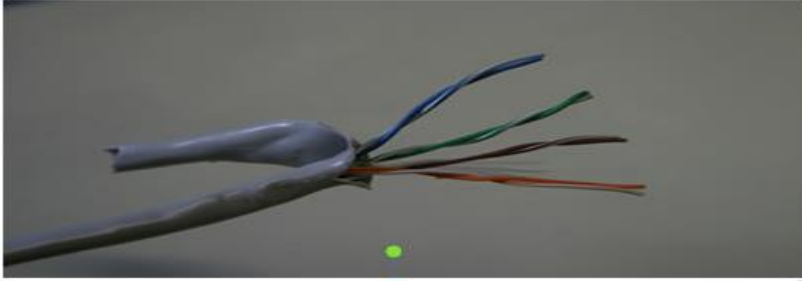
Unshielded Twisted Pair:

- The Electronic Industries Association-EIA has developed standards to classify UST cable to 7 categories. Categories are determined by cable quality, with 1 as the lowest and 7 as the highest.

Category	Bandwidth	Data Rate	Digital/Analog	Use
1	very low	< 100 kbps	Analog	Telephone
2	< 2 MHz	2 Mbps	Analog/digital	T-1 lines
3	16 MHz	10 Mbps	Digital	LANs
4	20 MHz	20 Mbps	Digital	LANs
5	100 MHz	100 Mbps	Digital	LANs
6	200 MHz	200 Mbps	Digital	LANs
7	600 MHz	600 Mbps	Digital	LANs

CONT…

Unshielded twisted pair
- Used for telephone wire
- Cheapest type of cable
- Easiest type to be installed
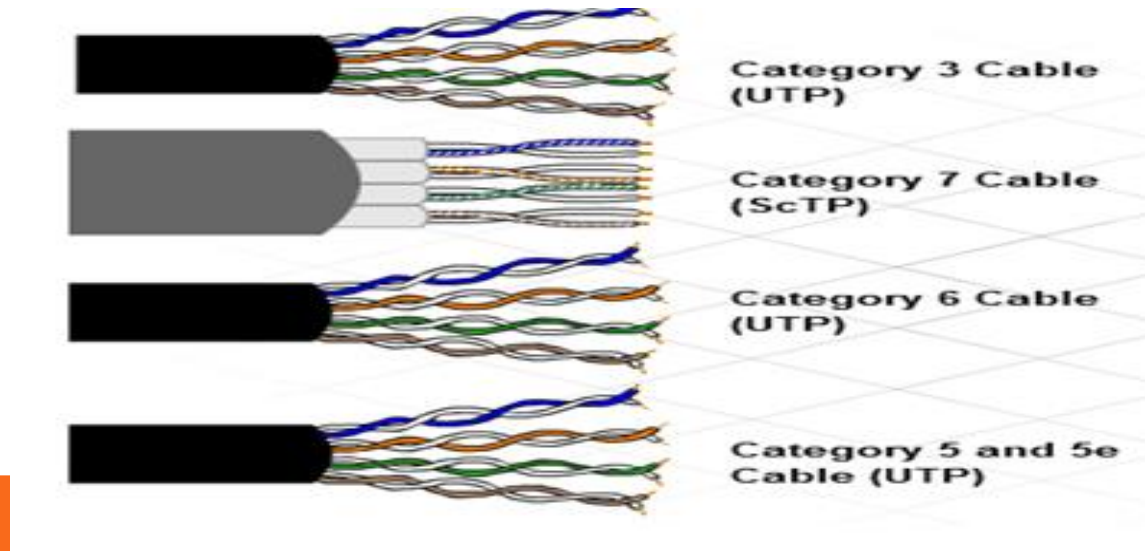- Suffers from external Electromagnetic (EM) interference

Shielded twisted
- Metal braid or covering that reduces interference
- More expensive
- Harder to handle (thick, heavy)
- Provide better performance than UTP

CONT…
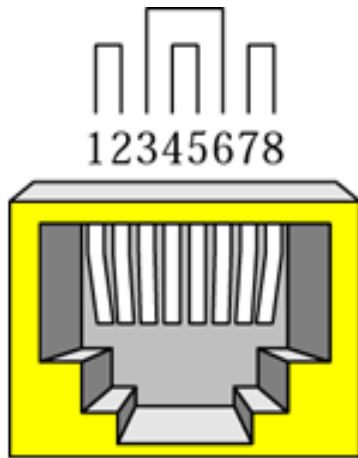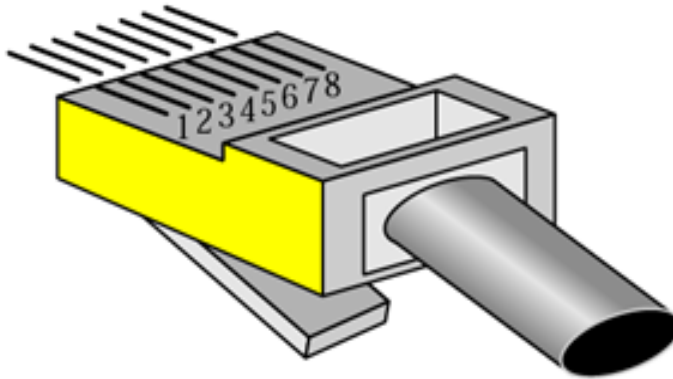
Unshielded Twisted Pair:

Category 3 Cable (UTP)

Category 7 Cable (ScTP)

Category 6 Cable (UTP)

Category 5 and 5e Cable (UTP)

CONT…

UTP connector :The most common UTP connector is RJ45 (RJ=Registered Jack)

RJ-45 Female

RJ-45 Male

CONT...

UTP connector :

Color code for   cable pairs

- **EIA organization defines two different patterns, or wiring scheme, called T568A and T568B.**

- **The two schemes are similar except two of the four pairs are reversed in the termination order. The graphic shows this color-coding and how the two pairs are reversed.**

- **On a network installation, one of the two wiring schemes (T568A or T568B) should be chosen and followed**
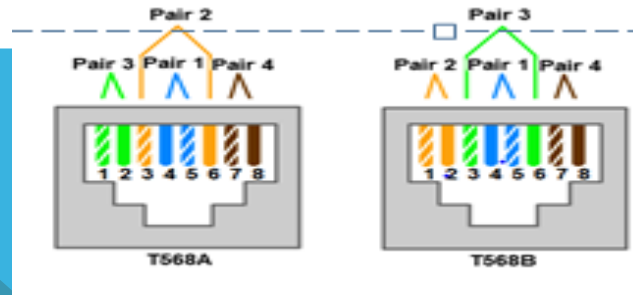
CONT...

Color code for cable pairs

- **Using the T568A and T568B wiring standards, two types of cables can be created: a straight-through cable and a crossover cable**

A straight-through cable:

is the most common cable type. It maps a wire to the same pins on both ends of the cable. In other words, if T568A is on one end of the cable, T568A is also on the other. If T568B is on one end of the cable, T568B is on the other. This means that the order of connections for each color is the exact same on both ends.
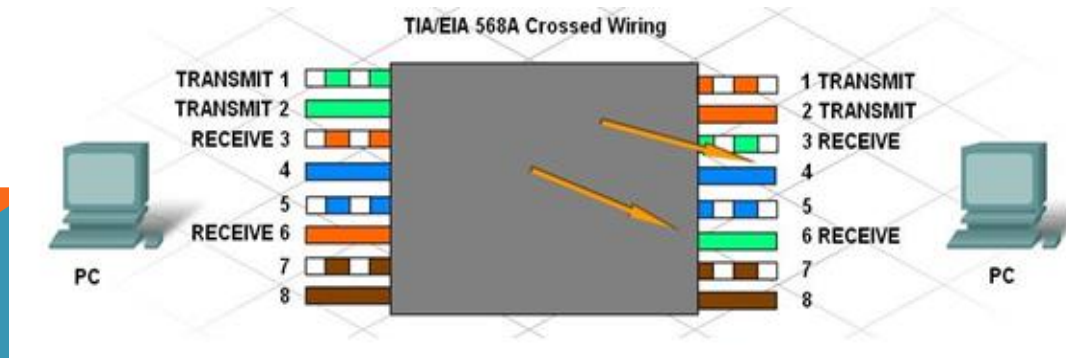
CONT...

UTP connector :

Crossover Cable:

A crossover cable uses both wiring schemes. T568A on one end of the cable and T568B on the other end of the same cable. This means that the order of connection on one end of the cable does not match the order of connections on the other

CONT...

Color code for cable pairs

A straight-through cable:

- Connecting between unlike devices

→ Unlike Device:

The pins on the RJ-45 data connector of a PC have pins1 and 2 as transmit and pins 3 and 6 as receive.
The pins on the data connector of a switch have pins 1 and 2 as receive and pins 3 and 6 as transmit

Examples of unlike devices that require a straight-through cable include:

- Switch port to Router port

- Switch port to PC

- Hub port to PC
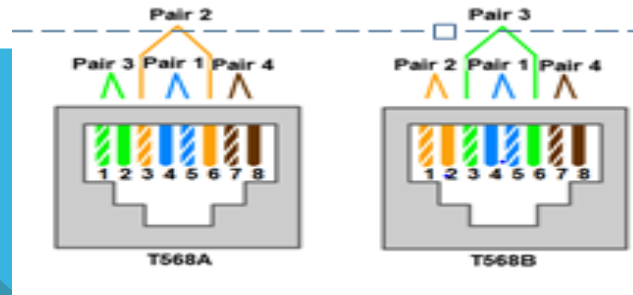
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Coaxial Cable

- Like twisted pair, coaxial cable (or coax) also carries data in the form of electrical signals.

- It provides improved shielding compared to UTP, so has a lower signal-to-noise ratio and can therefore carry more data

- Although coax has improved data carrying characteristics, most local area networking uses twisted pair because coax is physically harder to install and is more expensive.

CONT…

Coaxial Cable
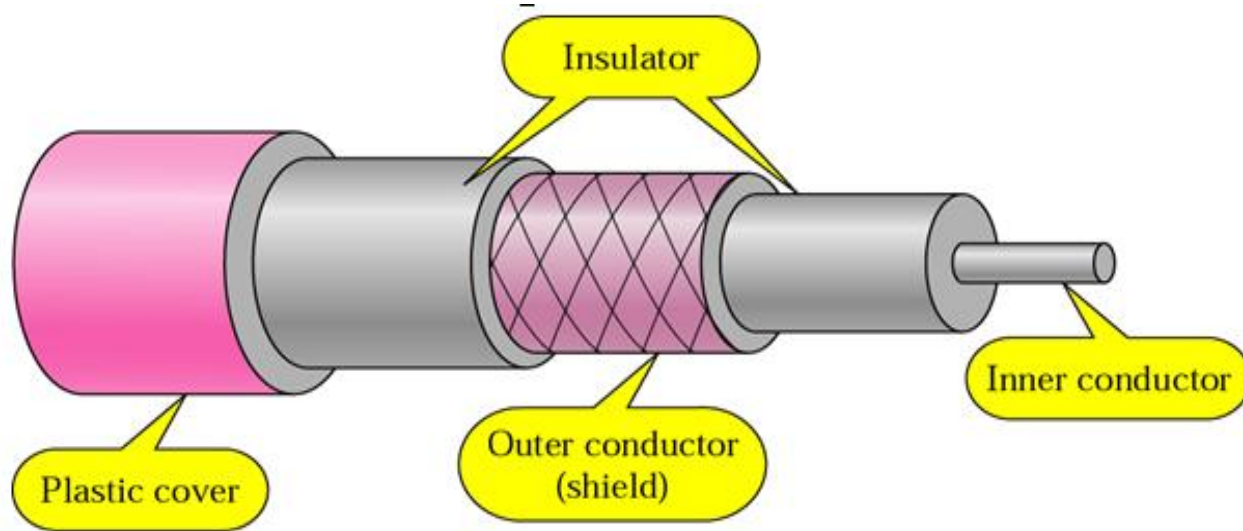
CONT…

Coaxial Performance:

❖ Higher bandwidth than twisted-pair

❖ However, attenuation is higher and requires frequent use of repeaters

Coaxial Cable Applications:

-- Television distribution

→ Cable TV

-- Long distance telephone transmission

→ Can carry 10,000 voice calls simultaneously

→ Being replaced by fiber optic

-- Short distance computer systems links

→ Local area networks

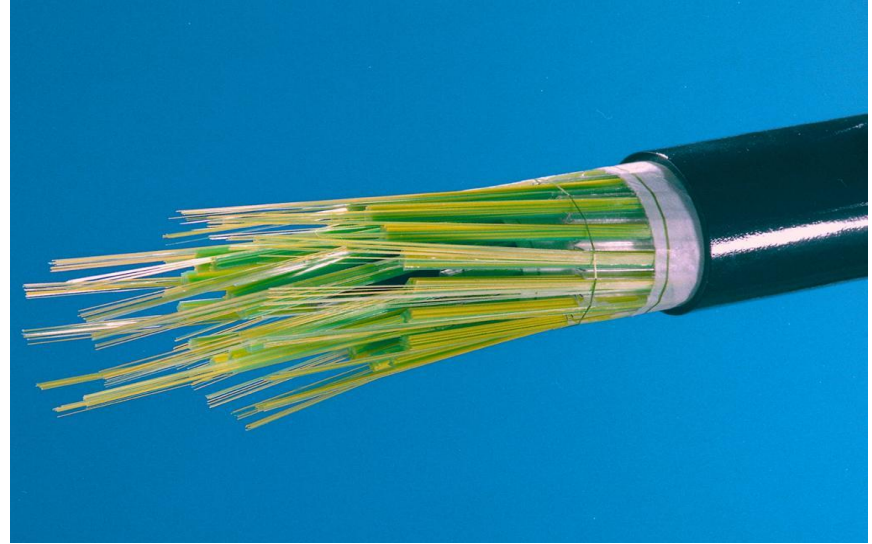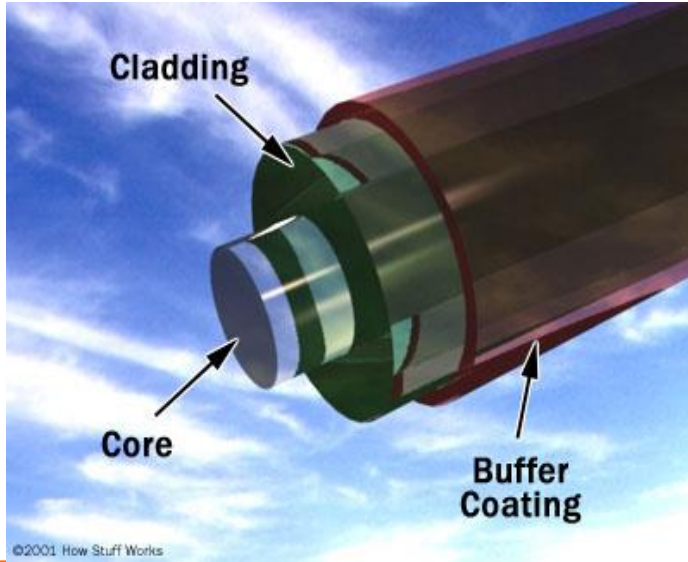# CONT…

❑ Fiber Optic Cable

- A fiber-optic cable is made of glass or plastic and transmits signals in the form of light.

- Light travels in a straight line as long as it is moving through a single uniform substance.

- If a ray of light traveling through one substance suddenly enters another substance (of a different density), the ray changes direction.

CONT…
❑ Fiber Optic Cable

CONT...

Advantages and Disadvantages of Optical Fiber:

❖ Advantages

Fiber-optic cable has several advantages over metallic cable (twisted-pair or coaxial).

- Higher bandwidth. Fiber-optic cable can support dramatically higher bandwidths (and hence data rates) than either twisted-pair or coaxial cable (*Data rates of hundreds of Gbps)*

- Less signal attenuation. Fiber-optic transmission distance is significantly greater than that of other guided media. A signal can run for 50 km without requiring regeneration. We need repeaters every 5 km for coaxial or twisted-pair cable.

- Immunity to electromagnetic interference. Electromagnetic noise cannot affect fiber-optic cables

CONT...

❖ **Disadvantages**

There are some disadvantages in the use of optical fiber.

- Installation and maintenance. Fiber-optic cable is a relatively new technology. Its installation and maintenance require expertise that is not yet available every where.

- Unidirectional light propagation. Propagation of light is unidirectional. If we need bidirectional communication, two fibers are needed.

- Cost is relatively more expensive than those of other guided media

Basic Data Communication Hardware

CONNECTING DEVICE

NIC:-A computer uses a network interface card (NIC) to become part of a network.

The NIC contains the electronic circuitry required to communicate using a wired connection (e.g., Ethernet) or a wireless connection (e.g., WiFi).

A network interface card is also known as a network interface controller, network adapter, or Local Area Network (LAN) adapter

CONT…

➢ Network connectivity is key for modern computers.

To connect to a network a computer uses a network interface card or controller (NIC). This is often built into the motherboard.

➢ The two most common types of network connections are Ethernet (wired) and WiFi (wireless

CONT...

MAC ADDRESS OF NIC

➢ Every network controller for an IEEE 802 network such as Ethernet, Wi-Fi, or Token Ring, has a unique *48-bit serial number called a MAC address*, which is stored in read-only memory.
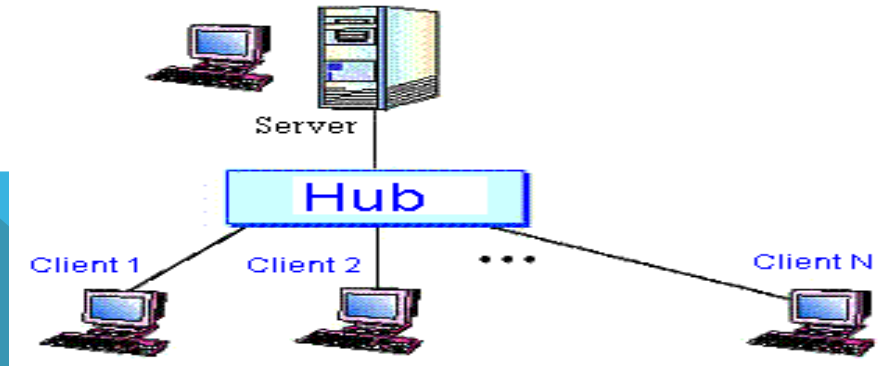
CONNECTING DEVICE

Hub/Switch

provides a central connection points for cables in a network and direct the data flow among them

A typical client-server configuration

- a cable connects the hub/switch to a server
- other computers are connected to the hub/switch

CONT…

HUBS AND SWITCHES

Hub :-Only one computer can talk at a time

Switch:-Computers can talk with each other

on private connections so that multiple

 conversations can be carried on at the same time

ROUTERS & MODEMS

Client-server network connected with a hub/ switch

Internet
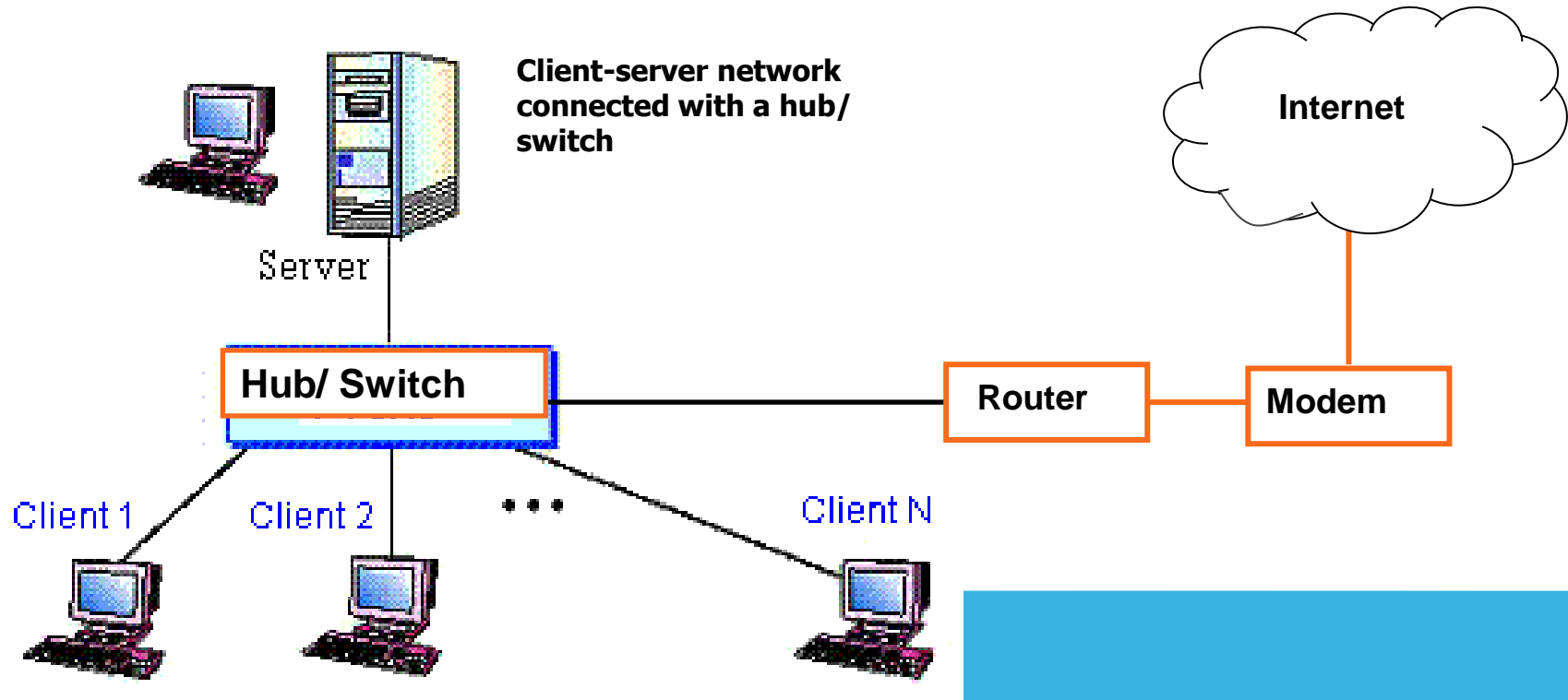
Server
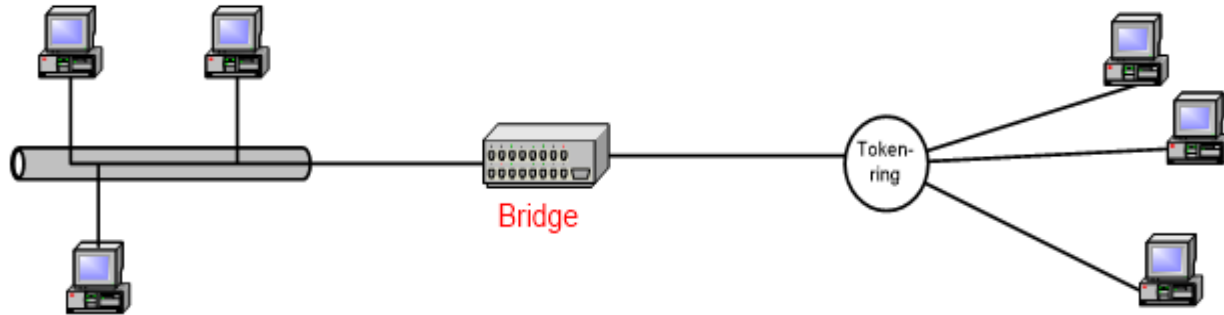
Hub/ Switch

Client 1 Client 2 ... Client N

Router **Modem**

BRIDGE

➢ A bridge connects segments of a LAN or LANs of the same type into an aggregated network.

➢ A bridge or LAN switch is a device that interconnects two or more Local Area Networks (LANs) and forwards packets between these networks

ROUTER

➢ A router connects a LAN to a different LAN

➢ A router is connected to another router. A huge network of routers connects the LAN's together to form the Internet.

➢ is needed to connect a LAN and the Internet (a WAN)

➢ Routes (forwards/ directs) packets (of data) between networks (LANs). i.e. direct data flow.

➢ Most home-use routers have LAN ports and also act as hubs/switch. (router + hub/switch)

ROUTER

Home Network
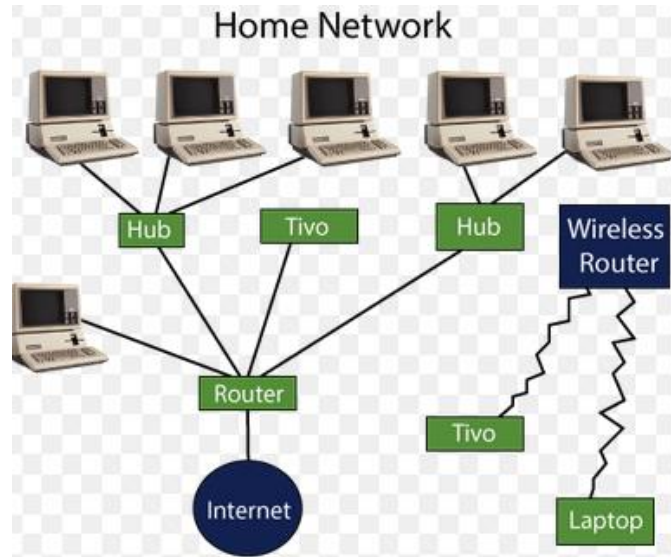
BRIDGE VS ROUTER

bridge:

simple, link up to form a aggregated LAN

router:

- complicated, direct traffic between two different LANs

- idea: one LAN is not under control of the other LAN

      (ip address)

Basic Network Topologies

WHAT IS TOPOLOGY

- Topology

▪ Physical and logical network layout of the network.

Physical

– actual layout of the computer cables and other network   devices

Logical

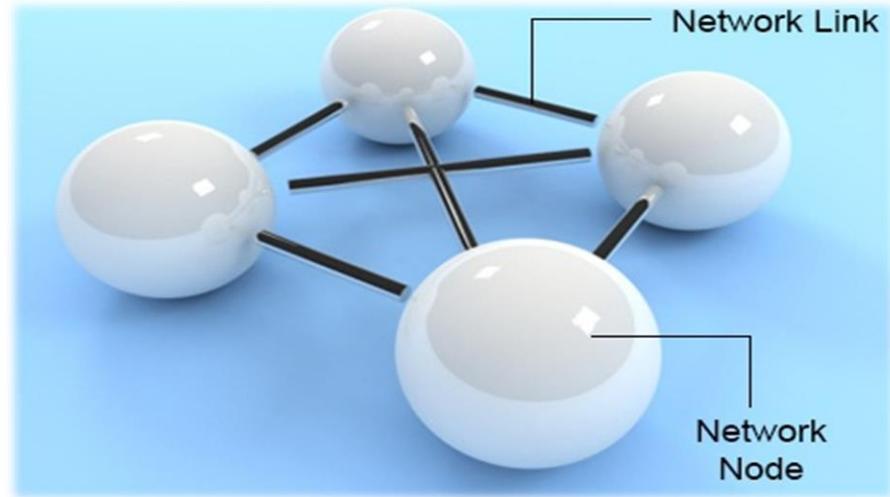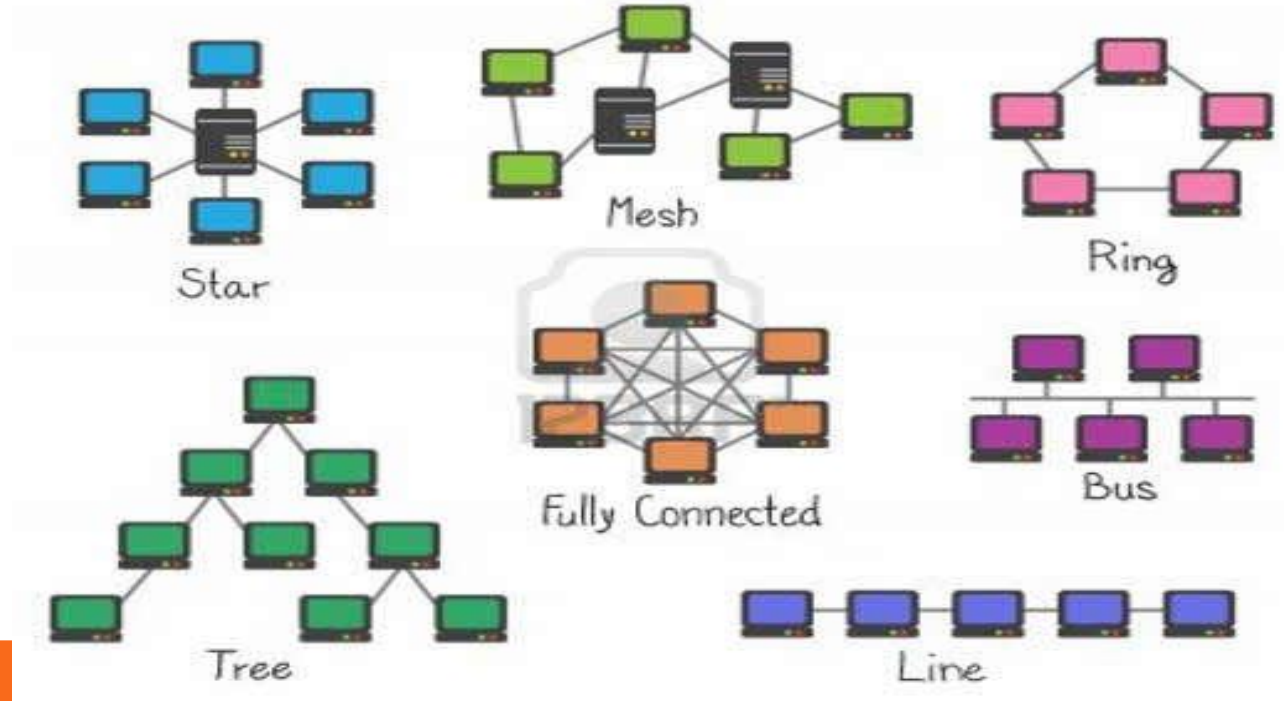– the way in which the network appears to the devices that use it.

▪

NETWORK TOPOLOGIES

Network topologies are categorized into the following basic
    types:

- Bus
- Ring
- Star
- Tree

- Mesh .

Network Link

Network Node

NETWORK TOPOLOGIES

BUS TOPOLOGIES

A bus topology is a type of network setup where each computer and network device are connected to a single cable or backbone.

A bus topology is multipoint.
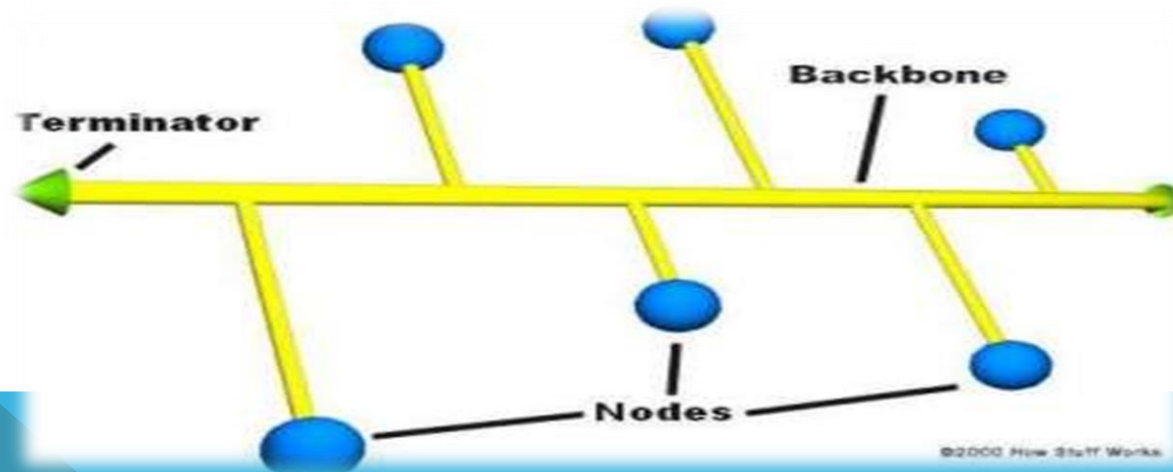
HOW BUS TOPOLOGY WORKS

➢ The bus is the data link in a bus network.

The bus can only transmit data in one direction, and if any network segment is severed, all network transmission ceases.

➢ A host on a bus network is called a *station* or *workstation*. In a bus network, every station receives all network traffic.

The traffic generated by each station has equal transmission priority

ADVANTAGE OF BUS TOPOLOGY

Easy to connect a computer or peripheral to a linear bus

Requires less cable length than a star topology

It works well for small networks.
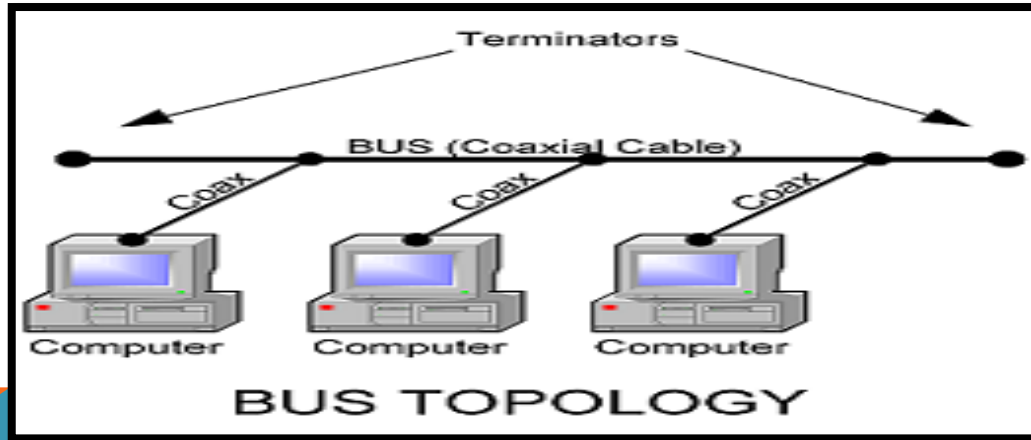
DISADVANTAGE OF BUS TOPOLOGY

➢ Entire network shuts down if there is a break in the main cable

➢ Terminators are required at both ends of the backbone cable

➢ Difficult to identify the problem if the entire network shuts down

➢ Not meant to be used as a stand-alone solution in a large building

➢ It is slow when more devices are added into the network

➢ If a main cable is damaged then network

APPLICATION OF BUS TOPOLOGY

➢ Used for broadcasting the message.

➢ Most Computer Motherboards.

➢ Used in LAN.

STAR TOPOLOGY
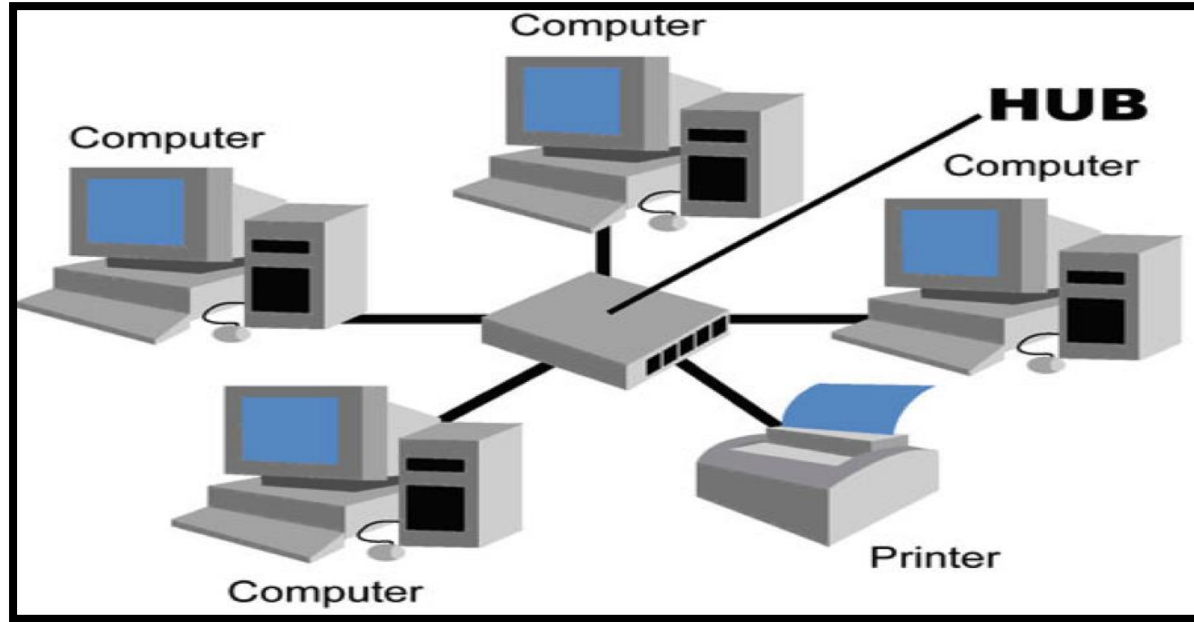
STAR TOPLOGY

➢ All the components of network are connected to the central device called "hub" which may be a hub, a router or a switch.

➢ There is no direct traffic between devices.

➢ The switch is the server and the peripherals are the clients.

➢ The star topology reduces the damage caused by line failure by connecting all of the systems to a central node

ADVANTAGE OF STAR TOPOLOGY

➢ better performance.

➢ Performance of the network is dependent on the capacity of central hub.

➢ Easy to connect new nodes or devices.

➢ In star topology new nodes can be added easily without affecting rest of the network.

➢ Components can also be removed easily.

➢ Centralized management. It helps in monitoring the network.

➢ Failure of one node or link doesn't affect the rest of network..

➢ Easy to detect the failure and troubleshoot it.

DISADVANTAGE OF STAR TOPOLOGY

➢ Too much dependency on central device has its own drawbacks.

➢ If hub fails whole network goes down.

➢ The use of hub, a router or a switch as central device increases the overall cost of the network.

➢ Performance and number of nodes which can be added in such topology is depended on capacity of central device

APPLICATION OF STAR TOPOLOGY

➢ Star Topology used in Local Area Network (LAN).

➢ High speed LAN often use Star Topology.

RING TOPOLOGY
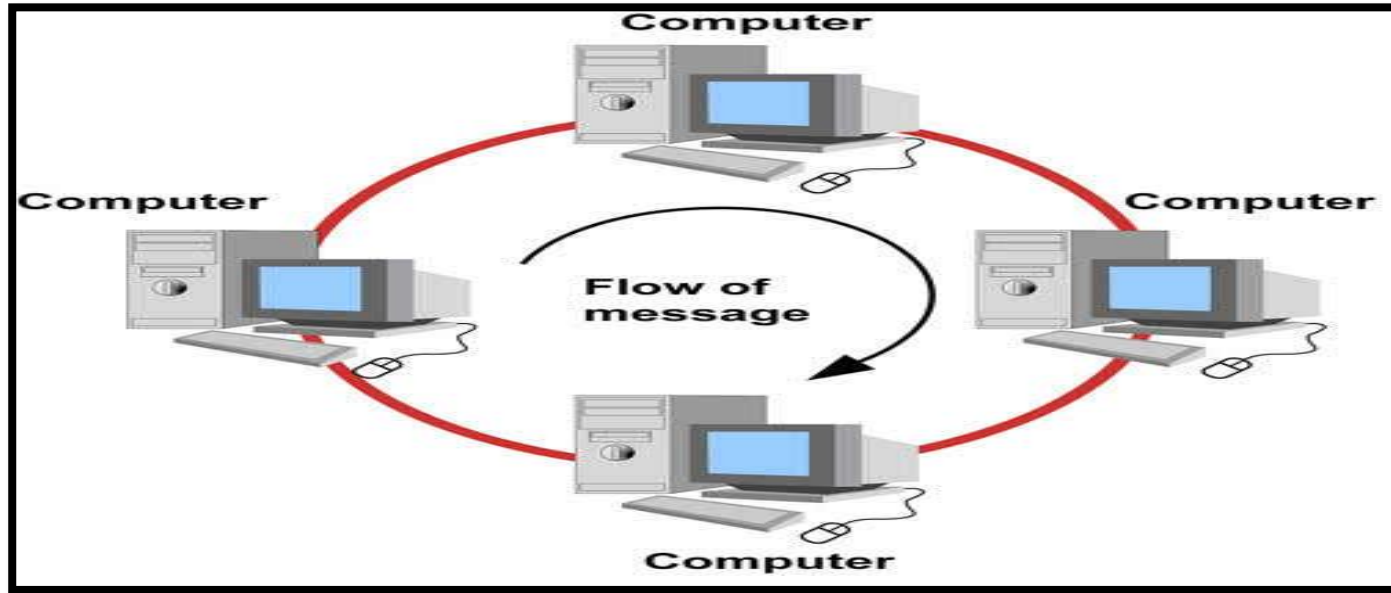
RING TOPOLOGY

➢ Devices are connected to each other in a circular shape.

➢ Each packet is sent around the ring until it reaches its final destination.

➢ Data travel from node to node, with each node along the way handling every packet

ADVANTAGE OF RING TOPOLOGY

➢ Ring Topology is very organized.

➢ Each node gets to send the data when it receives an empty token.

➢ This helps to reduces chances of collision.

➢ All the traffic flows in only one direction at very high speed.

➢ Better performance than Bus topology.

➢ There is no need for network server to control the connectivity between workstations.

➢ Additional components do not affect the performance of network.

➢ Each compute has equal access to resources.

DISADVANTAGE OF RING TOPOLOGY

➢ One broken workstation can create problems for the entire network.

➢ Moving, adding and changing the devices can affect the network.

➢ Communication delay is directly proportional to number of nodes in the network.

➢ Bandwidth is shared on all links between devices.

➢ More difficult to configure than a Star.

APPLICATION OF RING TOPOLOGY

➢ Ring Topologies are often found in office Buildings.

➢ Also used in Schools for networking.

➢ Today high speed LAN made this topology

MESH TOPOLOGY

Network Link
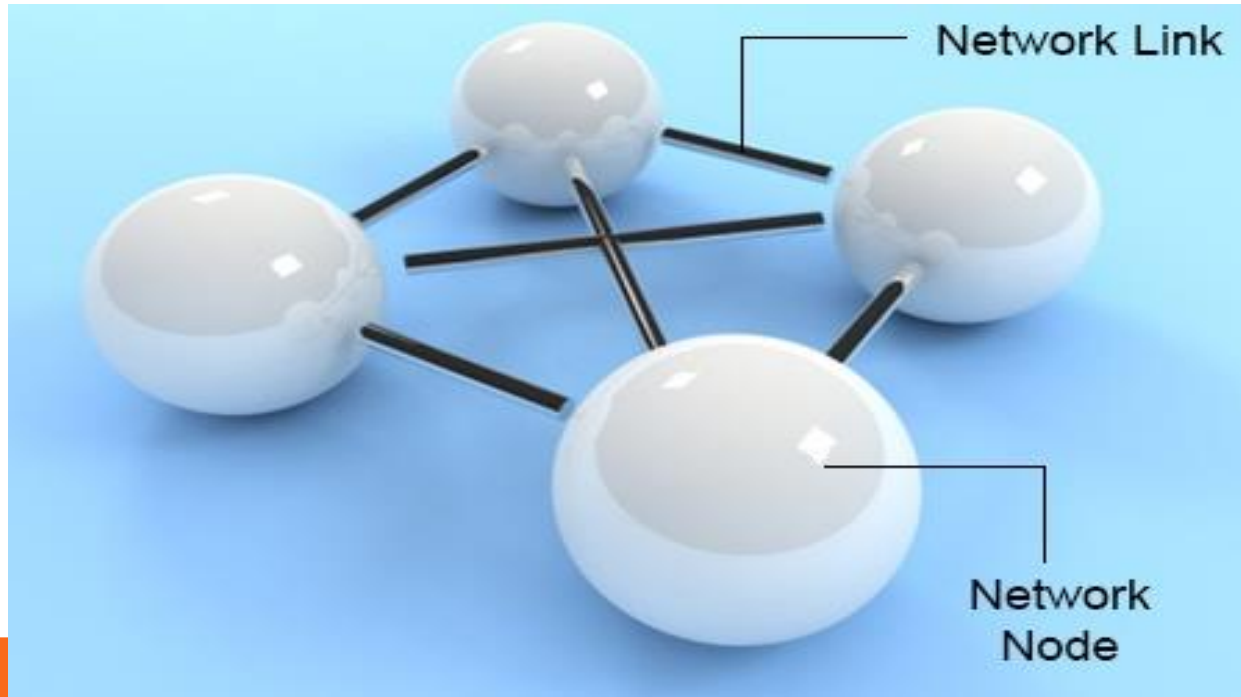
Network Node

MESH TOPLOGY

➢ A mesh network is a network topology in which each node (called a mesh node) relays data for the network.

➢ All nodes cooperate in the distribution of data in the network.

➢ A mesh network can be designed using a *flooding* technique or a *routing* technique.

ADVANTAGE OF MESH TOPOLOGY

➢ Data can be transmitted from different devices simultaneously.

➢ This topology can withstand high traffic.

➢ If one of the components fails there is always an alternative present.

➢ Data transfer doesn't get affected.

➢ Expansion and modification in topology can be done without disrupting other nodes.
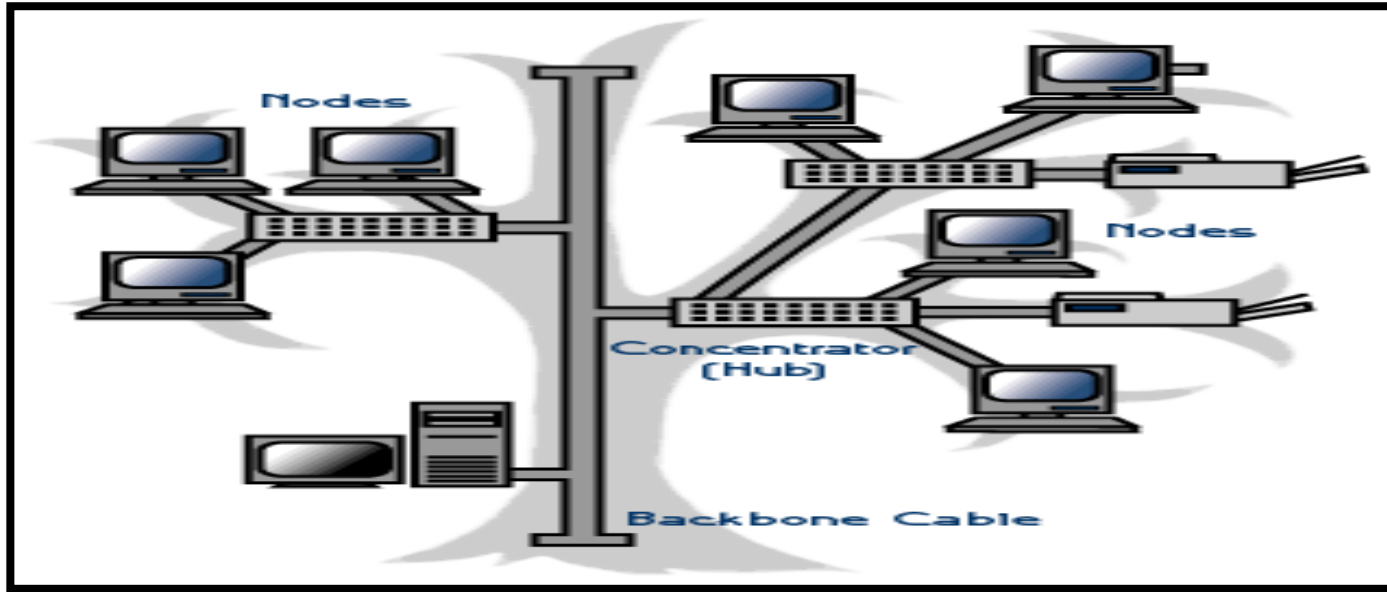
DISADVANTAGE OF MESH TOPOLOGY

➢ There are high chances of redundancy in many of the network connections.

➢ Overall cost of this network is way too high as compared to other network topologies.

➢ Set-up and maintenance of this topology is very difficult

APPLICATION OF MESH TOPOLOGY

➢ Telephone Regional Office.

➢ Wide Area Network
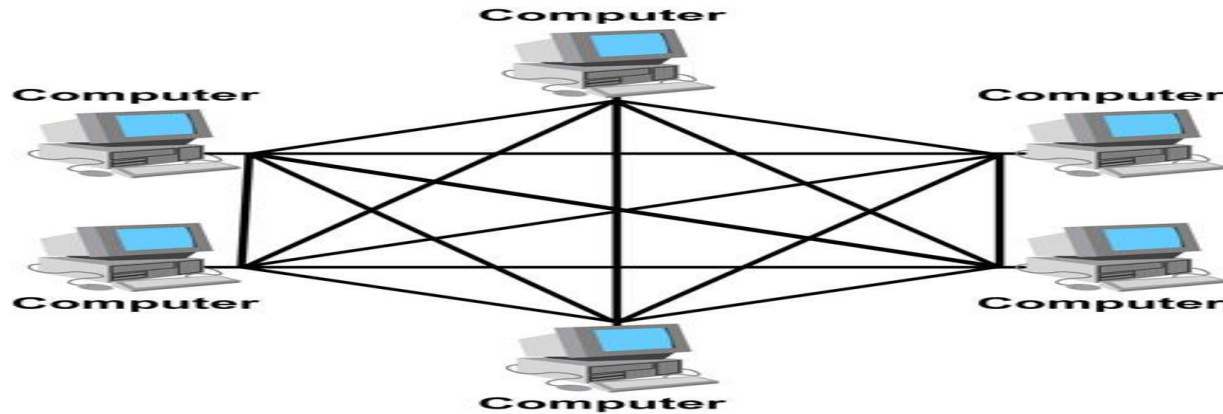
TREE TOPOLOGY

TREE TOPOLOGY

➢ Tree Topology integrates the characteristics of Star and Bus topology.

➢ The number of Star networks are connected using Bus.

➢ Main cable seems like a main stem of a tree, and other star networks as the branches.

➢ It is also called Expanded Star Topology.

➢ Ethernet protocol is commonly used in

ADVANTAGE OF TREE TOPOLOGY

➢ It is an extension of Star and bus Topologies, so in networks where these topologies can't be implemented individually for reasons related to scalability, tree topology is the best alternative.

➢ Expansion of Network is possible and easy.

➢ Divide the whole network into segments (star networks), which can be easily managed and maintained.

➢ Error detection and correction is easy.

➢ Each segment is provided with dedicated point-to-point wiring to the central hub.

➢ If one segment is damaged, other segments are not affected.

DISADVANTAGE OF TREE TOPOLOGY

➢ Because of its basic structure, tree topology, relies heavily on the main bus cable, if it breaks whole network is crippled.

➢ As more and more nodes and segments are added, the maintenance becomes difficult.

➢ Scalability of the network depends on the type of cable

SiTE - AAiT - AAU

COMPARISON BETWEEN TOPOLOGY

➤ Bus topology uses one main cable to which all nodes are directly connected. The main cable acts as a backbone for the network. One of the computers in the network typically acts as the computer server.

➤ Star topology each computer is connected to a central hub using a point-to-point connection. The central hub can be a computer server that manages the network, or it can be a much simpler device that only makes the connections between computers over the network possible.

➤ Star topology is very popular because the startup costs are low. It is also easy to add new nodes to the network.

COMPARISON BETWEEN TOPOLOGY

➢ Ring topology the computers in the network are connected in a circular fashion, and the data travels in one direction. Each computer is directly connected to the next computer, forming a single pathway for signals through the network. This type of network is easy to install and manage.

➢ mesh topology, every node has a direct point-to-point connection to every other node. Because all connections are direct, the network can handle very high-volume traffic. It is also robust because if one connection fails, the others remain intact. Security is also high since data travels along a dedicated connection.

➢ This type of topology requires a lot of cables and is, therefore, expensive.

COMPARISON BETWEEN TOPOLOGY

➢ Tree topology combines multiple star topologies onto a bus. Hub devices for each star topology are connected to the bus. Each hub is like the root of a tree of devices. This provides great flexibility for expanding and modifying the network.

THANK YOU!