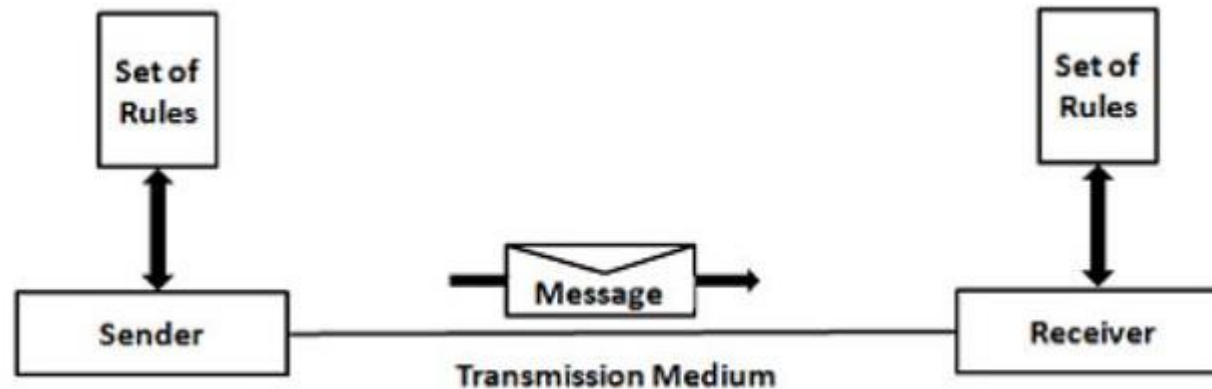# Unit - 1
Basic Concepts

Components of Data Communication

- **Data communication** is nothing but the exchange of data between any two devices via transmission media.

- There are five main components :

Components of Data Communication

- **Message**
- This is the most valuable asset of a system for data communication.
- The message actually refers to data that is to be shared or a piece of information.
- A message is in any form, like a text file, an audio file, a video file, and so on.

- **Sender**
- Someone who can play the role of a source must be there to pass messages from source to destination.
- The sender plays a part of the data communication device root.
- The node can be a computer, mobile device, telephone, laptop, video camera, workstation, etc.

Components of Data Communication

- **Receiver**
- It is the destination where messages sent by the source have finally arrived.
- It is a message-receiving system.
- The receiver is in the form of a computer, cell phone, workstation, etc., identical to the sender.

- **Transmission Medium**
- There must be something in the entire data communication process that could act as a bridge between sender and receiver.
- The transmission medium is the physical path from the sender to the recipient where the information or message passes.
- The examples of transmission medium are twisted pair cable, fibre optic cable, radio waves, microwaves, etc. The transmission medium could be guided (with wires) or unguided (without wires).

Components of Data Communication

- **Protocol**
- Different sets of rules have already been designed by the designers of communication systems to control data communication, reflecting a sort of agreement between communicating devices.
- These are characterized as protocols.
- The protocol is also called as a set of rules regulating data communication.
- If two separate devices are connected, but there is no protocol between them, there will be no contact between the two devices of any sort.

Standards and Organizations

- Are essential in creating and maintaining an open and competitive market for equipment manufacturers and in guaranteeing national and international interoperability of data and telecommunications technology and processes.

- Standards provide guidelines to manufacturers, vendors, government agencies and other service providers to ensure the kind of interconnectivity necessary in today's marketplace and in international communications.

- Data communication standards fall into two categories :
  - de facto (by fact or by convention)and
  - de jure (by law or by regulations)

Standards and Organizations

- De facto :
  - Standards that have not been approved by an organized body but have been adopted as standards through widespread use are de facto standards.
  - De facto standards are often established originally by manufacturers who seek to define the functionality of a new product or technology.

- De jure :
  - Those standards that have been legislated by an officially recognized body are de jure standards.

Standards and Organizations

- **Standards Organizations :**
- Standards are developed through the cooperation of –
    - standards creation committees
    - forums and
    - government regulatory agencies

Standards and Organizations

- **Standard Creation Committees**

- Many organizations are dedicated to the establishment of standards. Some of them are:

- **International Organization for Standardization (ISO) :**

- The ISO is a multinational body whose membership is drawn mainly from the standards creation committees of various governments throughout the world.

- The ISO is active in developing cooperation in the scientific, technological and economic activity.

Standards and Organizations

- **Standard Creation Committees**

- **International Telecommunication Union- Telecommunication Standards Sector (ITU-T) :**

- Consultative Committee for International Telegraphy and Telephony(CCITT) was devoted to the research and establishment of standards for telecommunications in general and for phone and data systems in particular.

- On March 1, 1993, the name of this committee was changed to the **International Telecommunication Union- Telecommunication Standards Sector (ITU-T)**

Standards and Organizations

- **Standard Creation Committees**

- **American National Standards Institute (ANSI) :**

- It is completely private, non-profit corporation.

- All activities are undertaken with the welfare of the United States and its citizens occupying primary importance.

Standards and Organizations

- **Standard Creation Committees**

- **Institute of Electrical and Electronics Engineers(IEEE) :**

- The Institute of Electrical and Electronics Engineers is the largest professional engineering society in the world.

- It aims to advance theory, creativity, and product quality in the fields of electrical engineering, electronics, and radio as well as in all related branches of engineering.

Standards and Organizations

- **Standard Creation Committees**

- **Electronic Industries Association (EIA) :**

- Electronic Industries Association is a non-profit organization devoted to the promotion of electronics manufacturing concerns.

- Its activities include public awareness education and lobbying efforts in addition to standards development.

Standards and Organizations

- **Forums**

- To accommodate the need for working models and agreements and to facilitate the standardization process, many special-interest groups have developed **forums** made up of representatives from interested corporations.

- The forums work with universities and users to test, evaluate, and standardize new technologies.

- By concentrating their efforts on a particular technology, the forums are able to speed acceptance and use of those technologies in the telecommunication community.

- The forum presents their conclusions to the standards bodies.

Standards and Organizations

- **Regulatory Agencies**

- The purpose of these agencies is to protect the public interest by regulating radio, television, and wire/cable communications.
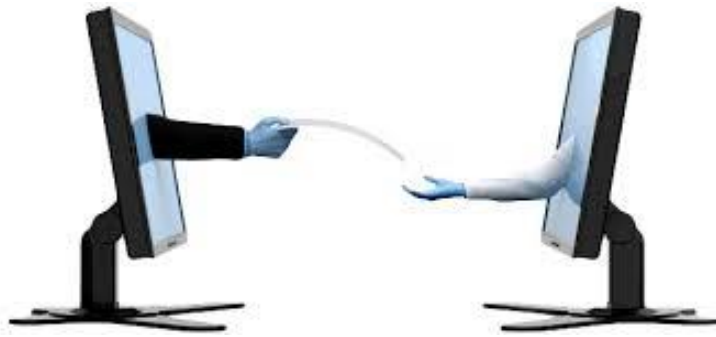
What is Computer Network?

- Computer Network is a system in which multiple computers are connected to each other to share information and resources.
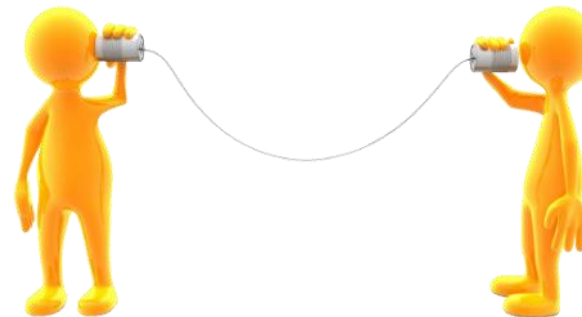
Advantages of Computer Network

File Sharing

Flexible Access

Entertainment

Better Communication
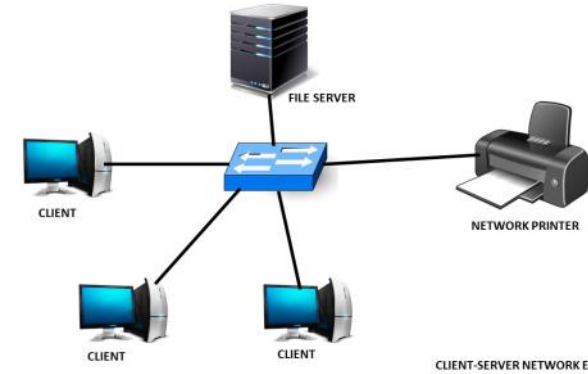
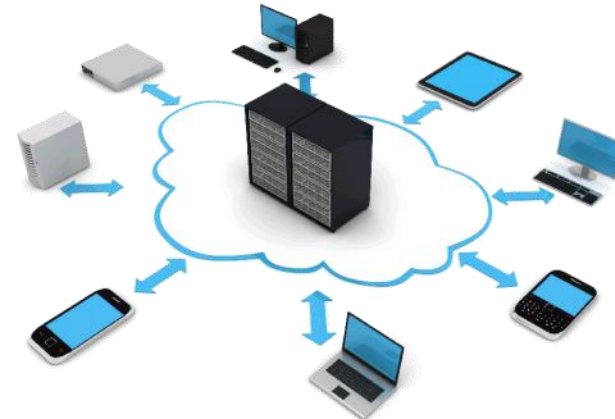# Advantages of Computer Network

Internet Access

Inexpensive System

FILE SERVER

CLIENT

NETWORK PRINTER

CLIENT

CLIENT

CLIENT-SERVER NETWORK E?

Instant and Multiple Access

Resource Sharing

Applications of Computer Network

Email Services

Teleconferencing

Business & Finance

File & Directory Services

& Many More….

Network Classification

- **Computer Network Types**

- A computer network is a group of computers linked to each other that enables the computer to communicate with another computer and share their resources, data, and applications.

- A computer network can be categorized by their size. A **computer network** is mainly of **four types**:
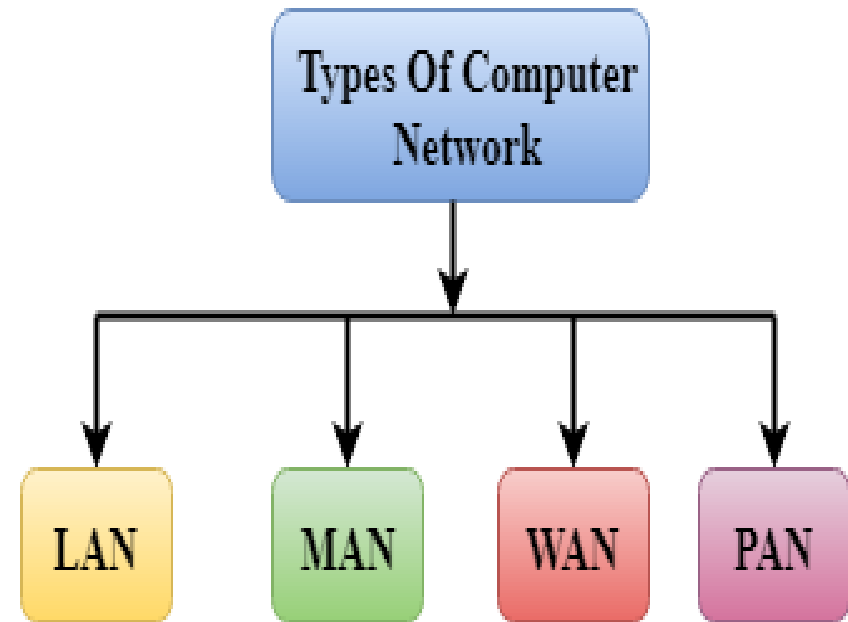
Network Classification

- **Computer Network Types**

  1. LAN(Local Area Network)

  2. PAN(Personal Area Network)

  3. MAN(Metropolitan Area Network)

  4. WAN(Wide Area Network)

Network Classification

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

- Is a group of computers connected to each other in a small area such as building, office.

- Is used for connecting two or more personal computers through a communication medium such as twisted pair, coaxial cable, etc.

- Is less costly as it is built with inexpensive hardware such as hubs, network adapters, and ethernet cables.

- The data is transferred at an extremely faster rate in Local Area Network.

- Provides higher security.

Network Classification

- **LAN(Local Area Network) :**
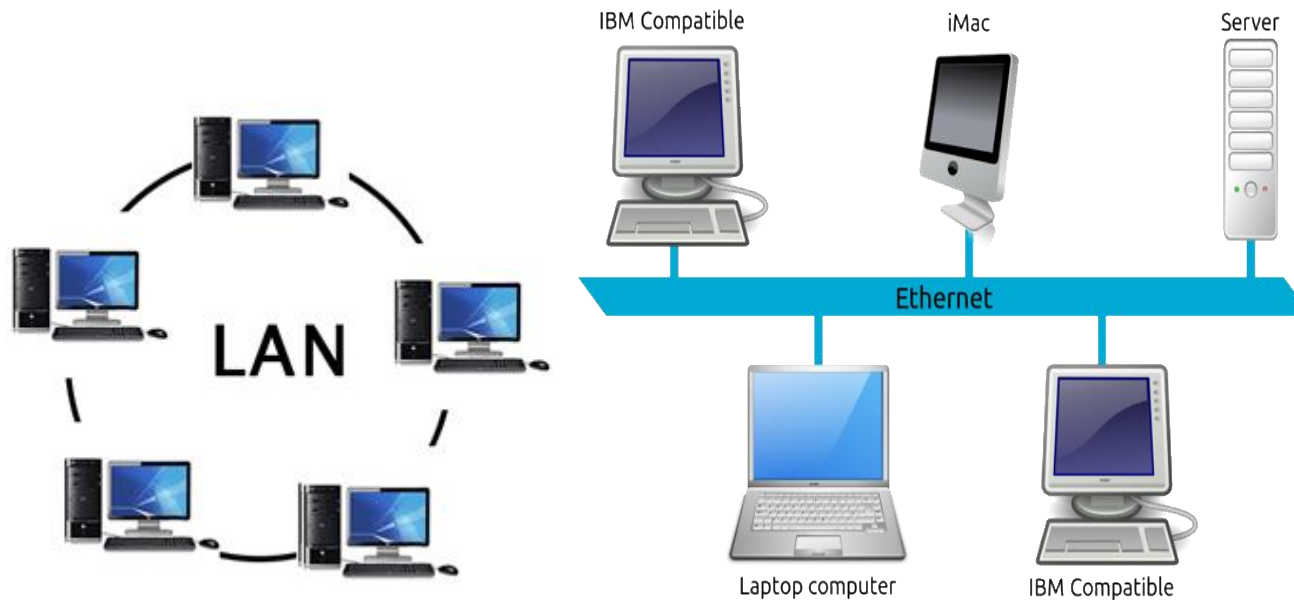
Network Classification

- **PAN(Personal Area Network) :**

- Is a network arranged within an individual person, typically within a range of 10 meters.
- Is used for connecting the computer devices of personal use.
- **Thomas Zimmerman** was the first research scientist to bring the idea of the Personal Area Network.
- Personal Area Network covers an area of **30 feet**.
- Personal computer devices that are used to develop the personal area network are the laptop, mobile phones, media player and play stations.
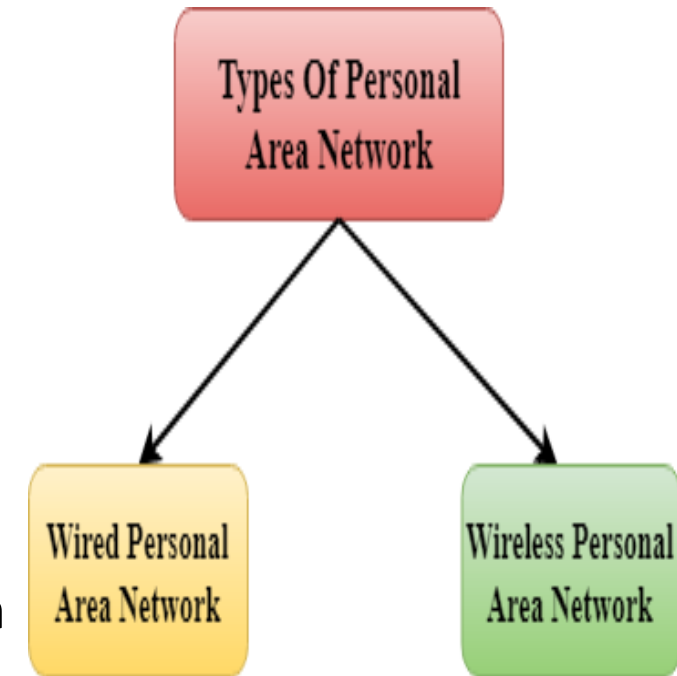
Network Classification

- **PAN(Personal Area Network) :**

Network Classification

- **PAN(Personal Area Network) :**

- There are two types of Personal Area Network:
- Examples of PAN :
- **Body Area Network:** Body Area Network is a network that moves with a person. - mobile network
- **Offline Network:** An offline network can be created inside the home, so it is also known as a **home network**. A home network is designed to integrate the devices such as printers, computer, television
- **Small Home Office:** It is used to connect a variety of devices to the internet and to a corporate network using a VPN

Types Of Personal Area Network

Wired Personal Area Network

Wireless Personal Area Network
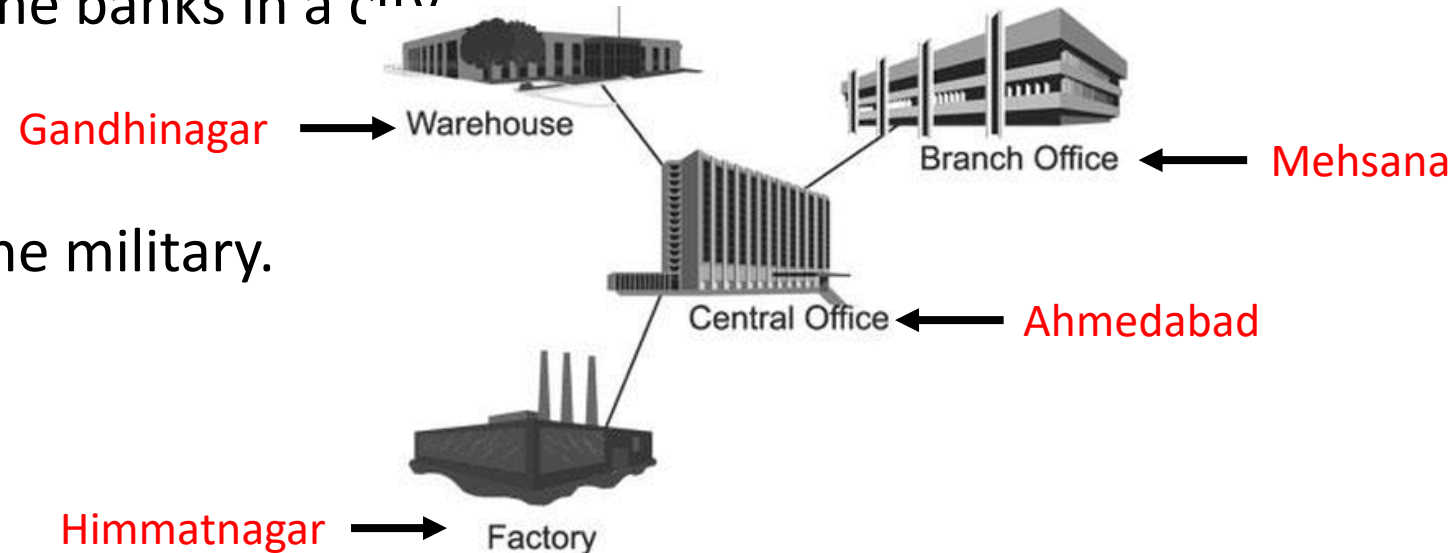
Network Classification

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

- Is a network that covers a larger geographic area by interconnecting a different LAN to form a larger network.

- Government agencies use MAN to connect to the citizens and private industries.

- In MAN, various LANs are connected to each other through a telephone exchange line.

- The most widely used protocols in MAN are RS-232, Frame Relay, ATM, ISDN, OC-3, ADSL, etc.

- It has a higher range than Local Area Network(LAN).

Network Classification

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

- Uses Of Metropolitan Area Network:
  - In communication between the banks in a city
  - In an Airline Reservation.
  - In a college within a city.
 - Used for communication in the military.

Network Classification

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

- Is a network that extends over a large geographical area such as states or countries.

- Is quite bigger network than the LAN.

- Is not limited to a single location, but it spans over a large geographical area through a telephone line, fibre optic cable or satellite links.

- The internet is one of the biggest WAN in the world.

- A Wide Area Network is widely used in the field of Business, government, and education.

Network Classification

- **WAN(Wide Area Network) :**
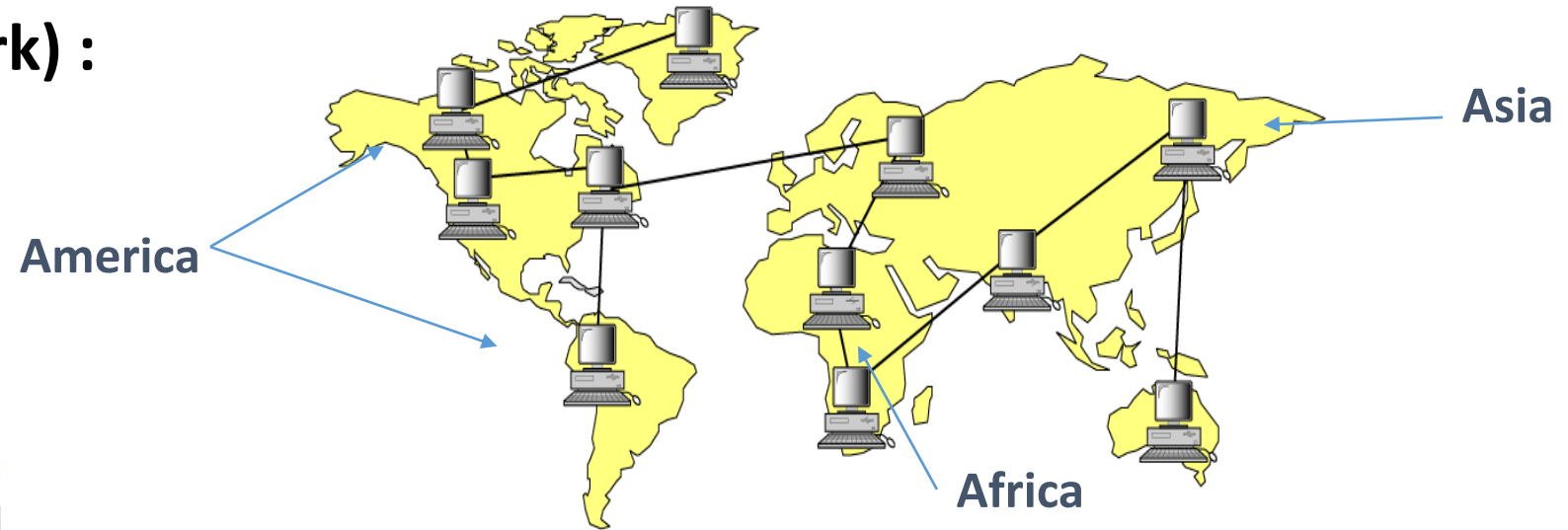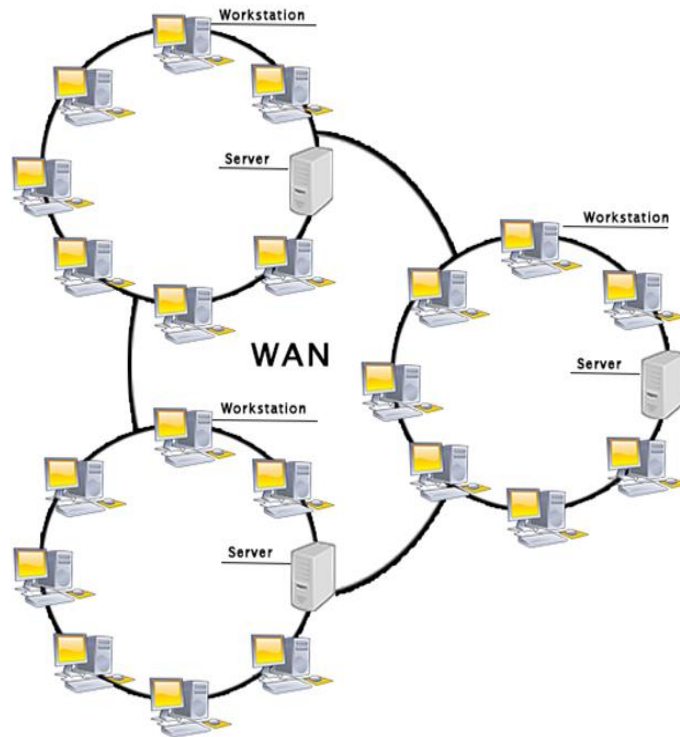
Types of Computer Networks - Summary

Comparison	LAN	MAN	WAN
Full Name	Local Area Network	Metropolitan Area Network	Wide Area Network
Meaning	A network that connects a group of computers in a small geographical area	It covers relatively large region such as cities, towns	It spans large locality & connects countries together. e.g. Internet
Ownership of Network	Private	Private or Public	Private or Public (VPN)
Design and Maintenance	Easy	Difficult	Difficult
Propagation Delay	Short	Moderate	Long
Speed	High	Moderate	Low
Equipment Used	NIC, Switch, Hub	Modem, Router	Microwave, Radio Transmitter & Receiver
Range(Approximately)	1 to 10 km	10 to 100 km	Beyond 100 km
Used for	College, School, Hospital	Small towns, City	State, Country, Continent

What is Internet?

- The internet is a type of world-wide computer network.
- The internet is the collection of infinite numbers of connected computers that are spread across the world.
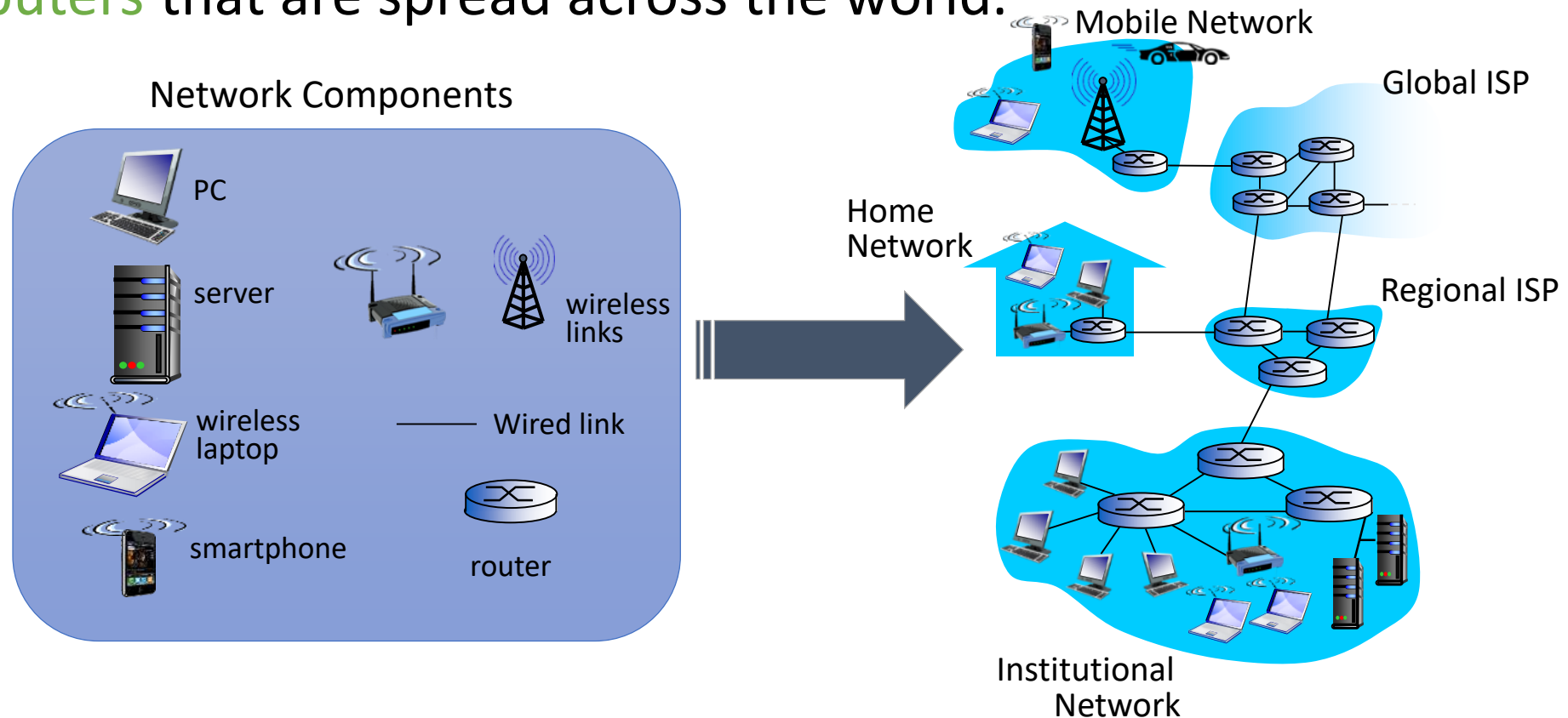
Network Topologies

- **What is Network Topology?**

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

- There are two types of topology: physical and logical topology.

- **Types of Network Topology**

- Physical topology is the geometric representation of all the nodes in a network.

- Logical topology is the representation of how data is transmitted and received between devices on a network, regardless of the physical layout of the network

- There are six types of network topology
  - Bus Topology, Ring Topology, Tree Topology, Star Topology, Mesh Topology, and Hybrid Topology.

Network Topologies

- Network topology is the arrangement of the various components (links, nodes, etc.) of a computer network.

- Types of network topologies :
  1. Bus
  2. Ring
  3. Star
  4. Mesh
  5. Tree
  6. Hybrid
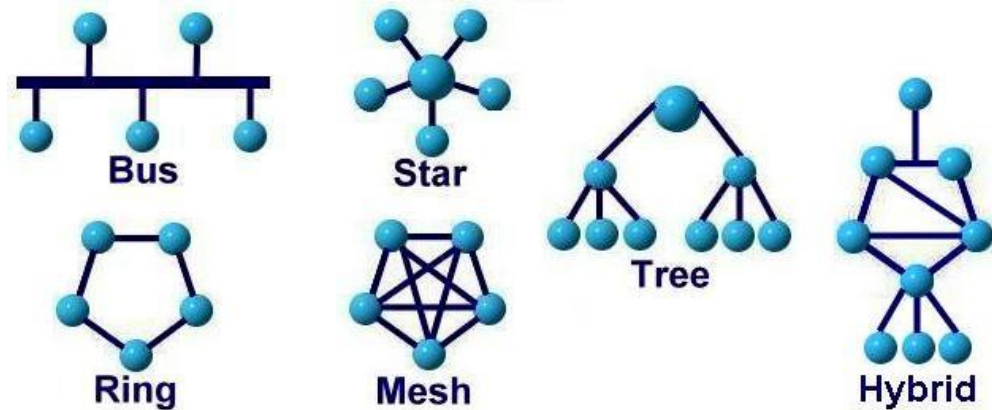
Bus Topology

- Every computer and network device is connected to single cable.

- It transmits data only in one direction.

- When a node wants to send a message over the network, it puts a message over the network.

- All the stations available in the network will receive the message whether it has been addressed or not.

- Used in small networks.

- Easy to expand joining two cables together.

- It is used in early LAN connection.
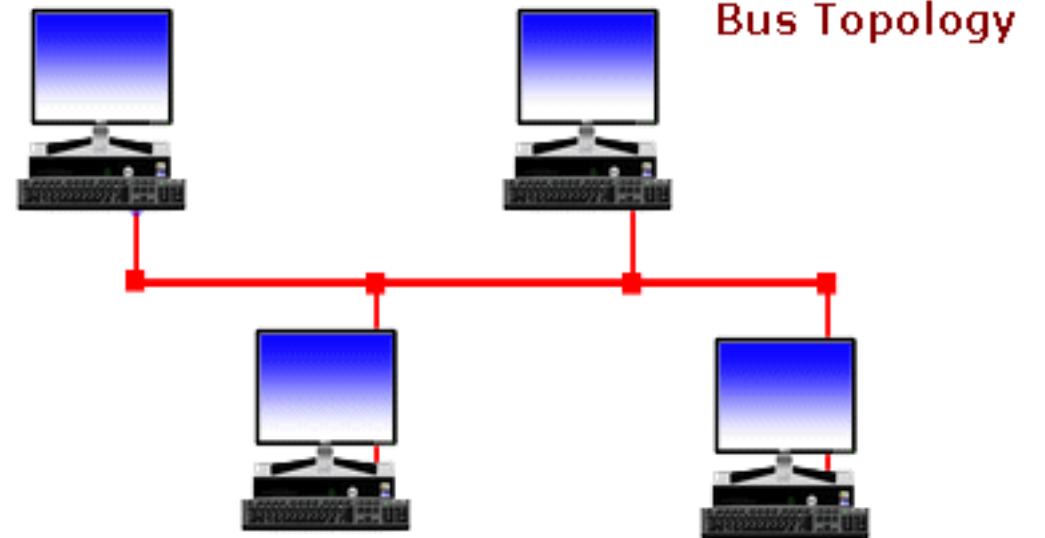
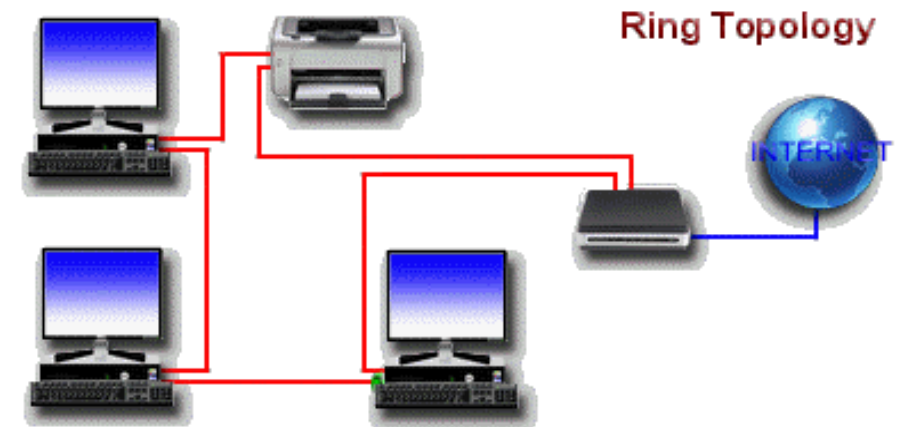Bus Topology

Bus Topology – Advantages

- **Low-cost cable:**
  - In this, nodes are directly connected to the cable without passing through a hub. Therefore, the initial cost of installation is low.
- **Moderate data speeds:**
  - Coaxial or twisted pair cables are mainly used in bus-based networks that support upto 10 Mbps.
- **Familiar technology:**
  - Bus topology is a familiar technology as the installation and troubleshooting techniques are well known, and hardware components are easily available.
- **Limited failure:**
  - A failure in one node will not have any effect on other nodes.

Bus Topology – Disadvantages

- **Extensive cabling:**
  - A bus topology is quite simpler, but still it requires a lot of cabling.
- **Difficult troubleshooting:**
  - It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Signal interference:**
  - If two nodes send the messages simultaneously, then the signals of both the nodes collide with each other.
- **Reconfiguration difficult:**
  - Adding new devices to the network would slow down the network.
- **Attenuation:**
  - Attenuation is a loss of signal leads to communication issues. Repeaters are used to regenerate the signal.

Ring Topology

- It forms a ring as each computer is connected to another computer, with the last one connected to the first.

- Transmission is unidirectional & sequential way that is bit by bit.

- The data flows in a single loop continuously known as an endless loop.

- The data in a ring topology flow in a clockwise direction.

- Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.

- Cheap to install and expand.

Ring Topology

Ring Topology – Advantages

- **Network Management:**
  - Faulty devices can be removed from the network without bringing the network down.
- **Product availability:**
  - Many hardware and software tools for network operation and monitoring are available.
- **Cost:**
  - Twisted pair cabling is inexpensive and easily available. Therefore, the installation cost is very low.
- **Reliable:**
  - It is a more reliable network because the communication system is not dependent on the single host computer.

Ring Topology – Disadvantages

- **Difficult troubleshooting:**
  - It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Failure:**
  - The breakdown in one station leads to the failure of the overall network.
- **Reconfiguration difficult:**
  - Adding new devices to the network would slow down the network.
- **Delay:**
  - Communication delay is directly proportional to the number of nodes. Adding new devices increases the communication delay.

Star Topology

- Computers are connected to a single central hub through a cable.

- Fast performance with few nodes and low network traffic.

- Easy to troubleshoot & Easy to setup and modify.

- Only that node is affected which has failed rest of the nodes can work smoothly.

- Hub can be upgraded easily.

Star Topology
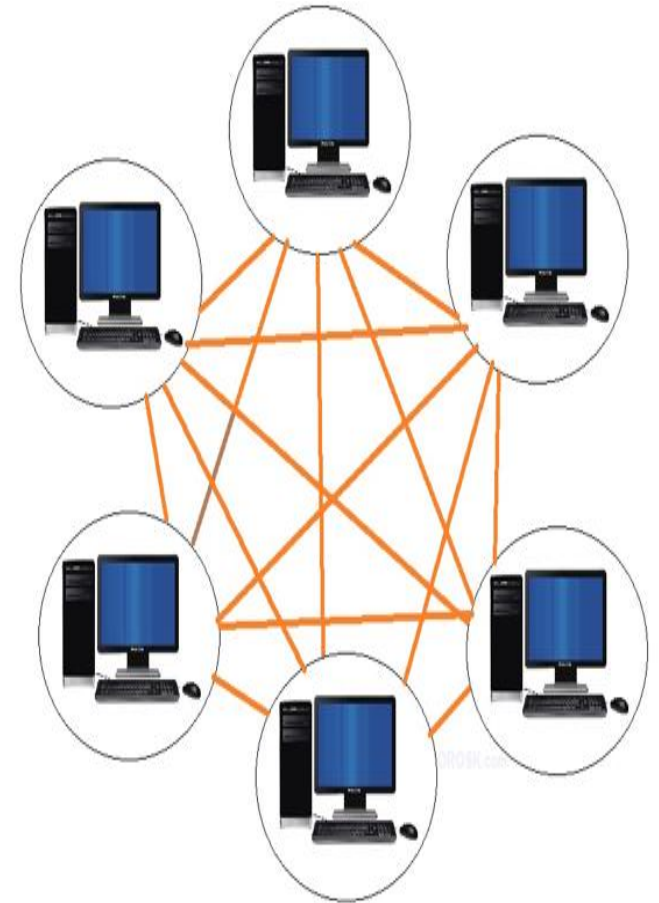
Star Topology - Advantages

- **Efficient troubleshooting:**
    - All the stations are connected to the centralized network. Therefore, the network administrator has to go to the single station to troubleshoot the problem.

- **Network control:**
    - Complex network control features can be easily implemented in the star topology. Any changes made in the star topology are automatically accommodated.

- **Limited failure:**
    - As each station is connected to the central hub with its own cable, therefore failure in one cable will not affect the entire network.

- **Easily expandable:**
    - It is easily expandable as new stations can be added to the open ports on the hub.

- **Cost effective:**
    - Star topology networks are cost-effective as it uses inexpensive coaxial cable.

- **High data speeds:**
    - It supports a bandwidth of approx 100Mbps. Ethernet 100BaseT is one of the most popular Star topology networks.

Star Topology - Disadvantages

- **A Central point of failure:**
  - If the central hub or switch goes down, then all the connected nodes will not be able to communicate with each other.
- **Cable:**
  - Sometimes cable routing becomes difficult when a significant amount of routing is required.

Mesh Topology

- Point-to-point connection to other devices or fully connected.

- Traffic is carried only between two connected devices.

- Robust, costly but not flexible.

- Fault is diagnosed easily.

- More cable resource used in setup.

Mesh Topology - Advantages

- **Reliable:**
  - The mesh topology networks are very reliable as if any link breakdown will not affect the communication between connected computers.
- **Fast Communication:**
  - Communication is very fast between the nodes.
- **Easier Reconfiguration:**
  - Adding new devices would not disrupt the communication between other devices.

Mesh Topology - Disadvantages

- **Cost:**
    - A mesh topology contains a large number of connected devices such as a router and more transmission media than other topologies.
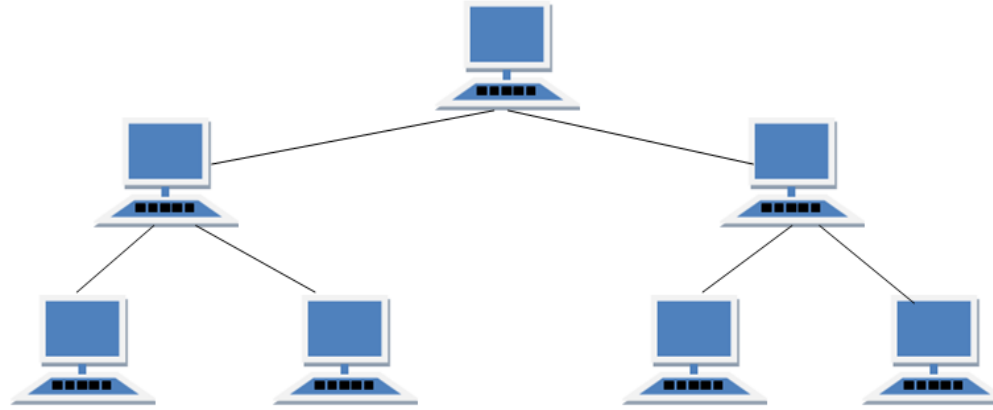
- **Management:**
    - Mesh topology networks are very large and very difficult to maintain and manage. If the network is not monitored carefully, then the communication link failure goes undetected.

- **Efficiency:**
    - In this, redundant connections are high that reduces the efficiency of the network.

Tree Topology

- It has a root node and all other nodes are connected to it forming a hierarchy.

- Also called hierarchical topology.

- Mostly used in Wide Area Network – WAN.

- Expansion of nodes is possible and easy.

- Easily managed and maintained.

Tree Topology - Advantages

- **Support for broadband transmission:**
  - Tree topology is mainly used to provide broadband transmission, i.e., signals are sent over long distances without being attenuated.
- **Easily expandable:**
  - We can add the new device to the existing network. Therefore, we can say that tree topology is easily expandable.
- **Easily manageable:**
  - In tree topology, the whole network is divided into segments known as star networks which can be easily managed and maintained.
- **Error detection:**
  - Error detection and error correction are very easy in a tree topology.
- **Limited failure:**
  - The breakdown in one station does not affect the entire network.
- **Point-to-point wiring:**
  - It has point-to-point wiring for individual segments.

Tree Topology - Disadvantages

- **Difficult troubleshooting:**
  - If any fault occurs in the node, then it becomes difficult to troubleshoot the problem.
- **High cost:**
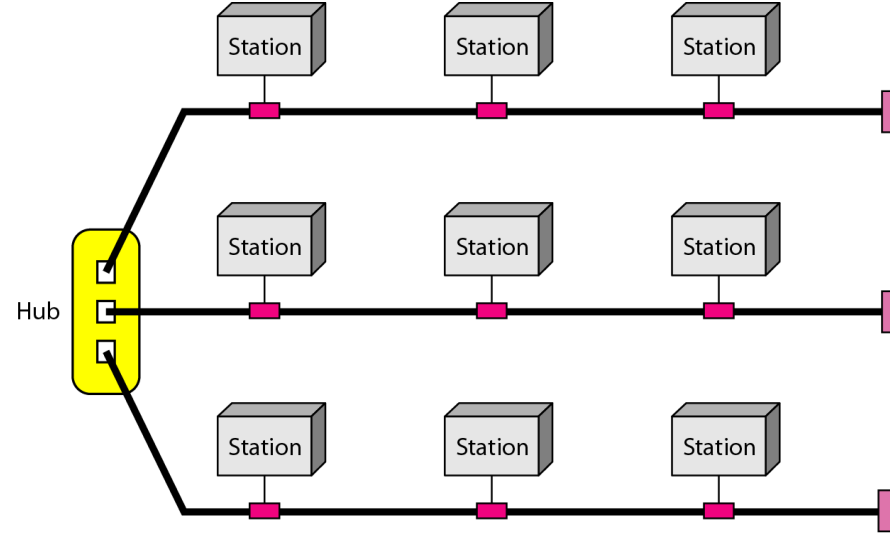 - Devices required for broadband transmission are very costly.
- **Failure:**
  - A tree topology mainly relies on main bus cable and failure in main bus cable will damage the overall network.
- **Reconfiguration difficult:**
  - If new devices are added, then it becomes difficult to reconfigure.

Hybrid Topology

- A network structure whose design contains more than one topology is said to be hybrid topology.

- It is a combination of two or more topologies.

- Flexible & reliable as error detection and easy to troubleshoot.

- Scalable as size can be increased easily.

Comparison of Topologies

|	Bus	Ring	Star	Mesh	Tree
Means	every computer and network device is connected to single cable.	Each computer is connected to another, with the last one connected to the first.	All the computers are connected to a single hub through a cable.	All the network nodes are connected to each other.	It has a root node and all other nodes are connected to it forming a hierarchy.
Cost	Average	Cheap	High	High	High
Used in	Small Network	Expand Network	Small Network	Expand Network	Expand Network
Troubleshoot	Easy, But Cables fail then whole network fails.	Difficult; Failure of one computer disturbs the whole network.	Easy; If the hub fails then the whole network is down.	Difficult; Installation and configuration is difficult.	Easy; Central root hub fails, network fails.

The Network Edge

- Computers and other devices are connected at the edge (end) of the network.

- These computers are known as hosts or end systems. Router is known as edge router.
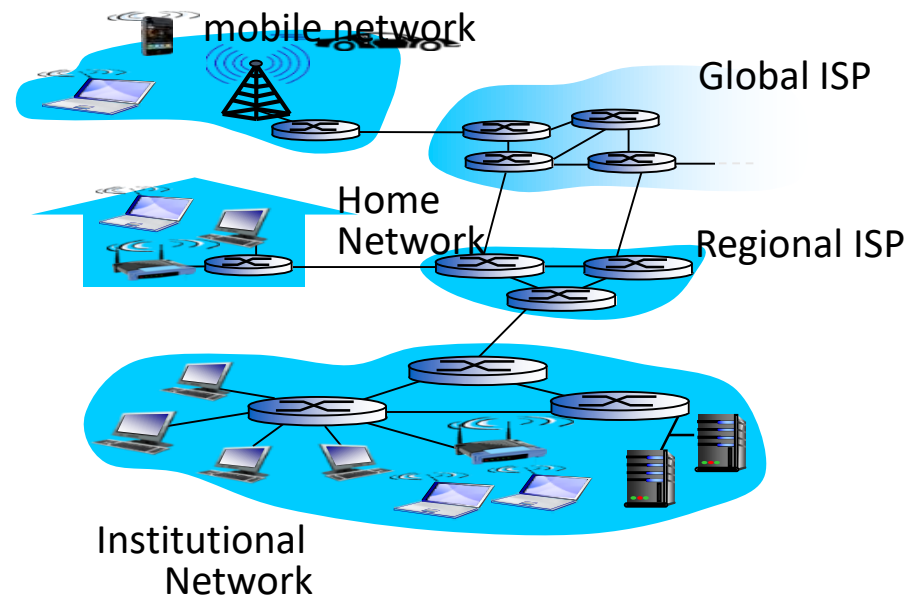
The Network Core

- Defines the connection of different network segments together and process to transmit data packets across the network.

- It is implemented through the use of switching techniques.

Switched
Networks

Circuit-Switched
Networks

Packet-Switched
Networks
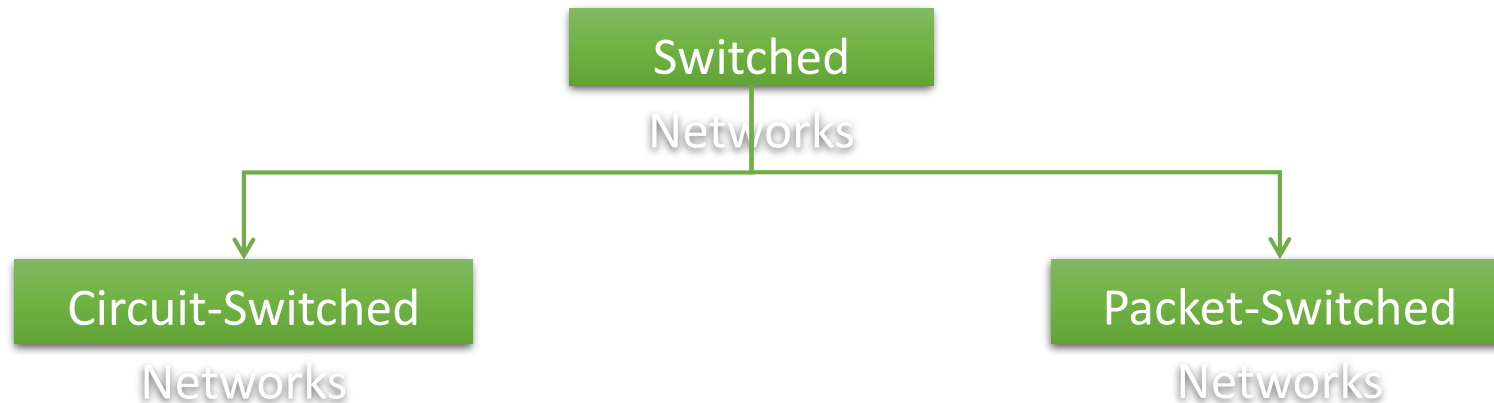
Circuit Switched Network

- A dedicated channel has to be established before the call is made between users.

- The channel is reserved between the users till the connection is active.

- For half duplex(one way) communication, one channel is allocated and for full duplex(two way) communication, two channels are allocated.

- It is mainly used for voice communication requiring real time services without delay.

Cannot have two on going communications on one line

Switch board
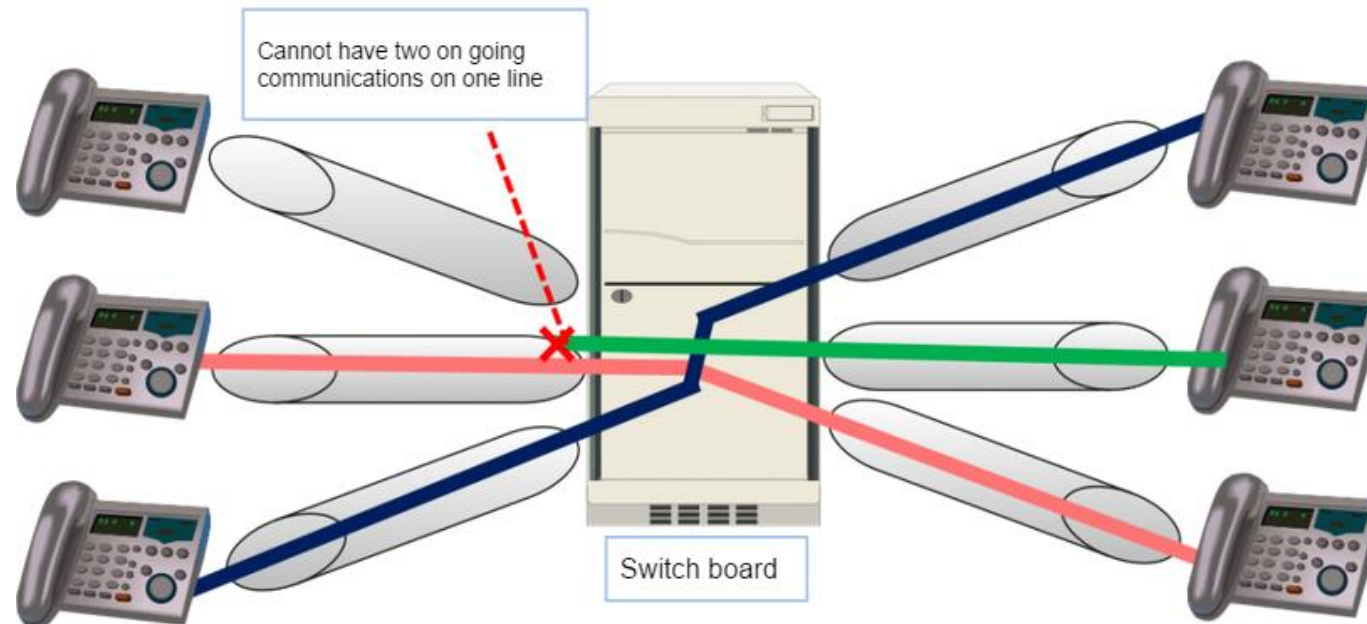
Circuit Switched Network – Cont…

- Communication via circuit switching involves three phases:
    1. Circuit Establishment
    2. Data Transfer
    3. Circuit Disconnect
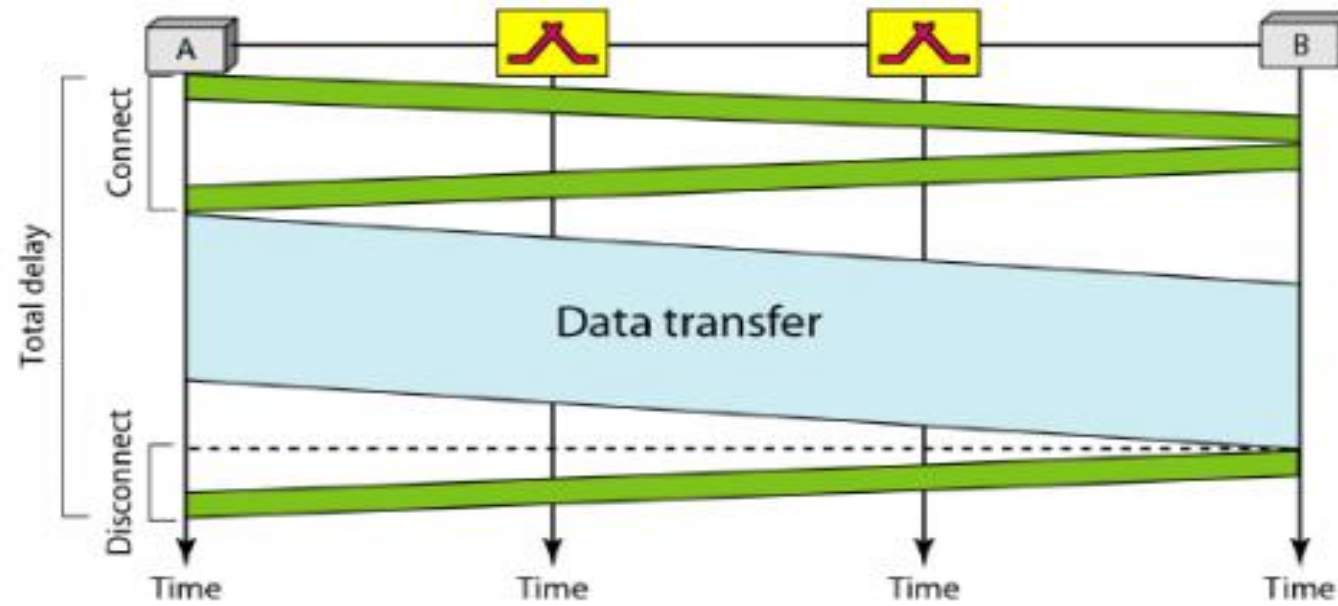
Packet Switched Network

- It is not required to establish the connection initially.
- The connection/channel is available to use by users. But when traffic or number of users increases then it will lead to congestion in the network.
- Packet switched networks are mainly used for data and voice applications requiring non-real time scenarios.
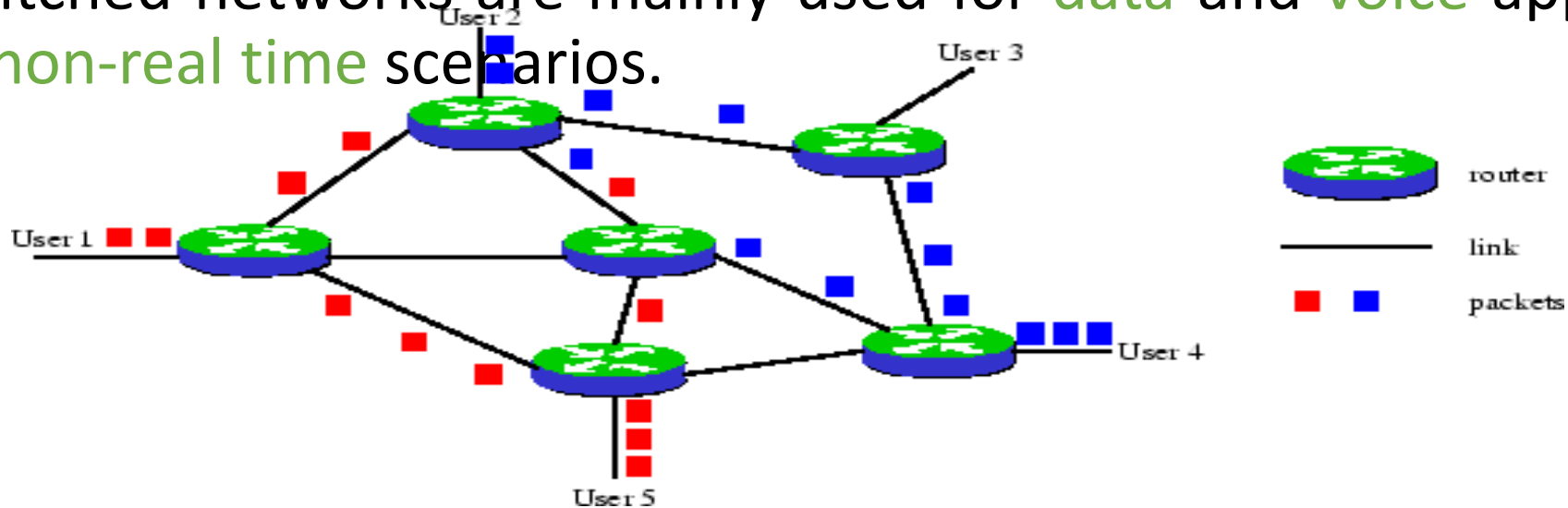
Differences

Circuit Switching	Packet Switching
▸ Dedicated path between source and destination	▸ No dedicated path
▸ All packets use same path	▸ Packets travel independently
▸ Reserve the entire bandwidth in advance	▸ Does not reserve bandwidth
▸ Bandwidth wastage	▸ No bandwidth wastage
▸ No store and forward transmission	▸ Supports store and forward transmission