Chapter Two

Computer Networks Basics

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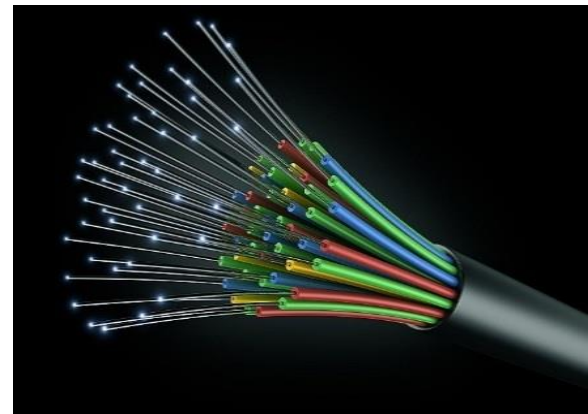- **Network and internetworking device**
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Definition of Computer Networks

- **Computer Network is a collection of autonomous computers interconnected by a single technology.**

- **Two computers are said to be interconnected if they are able to exchange information.**
  - **The connection can be via a copper wire; fiber optics, microwaves, infrared, and communication satellites.**
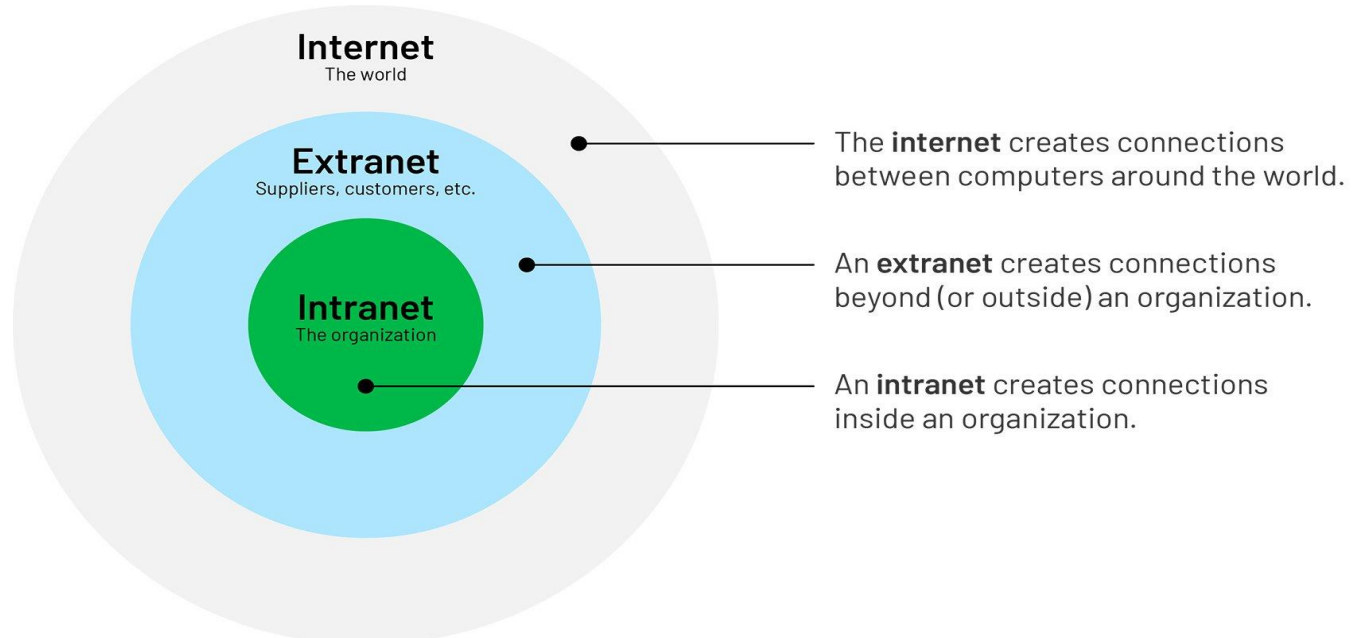
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- The objective of NW is to enable seamless exchange of data between end users.

- Computer Network is all about sharing Information & Resources amongst Users & Devices within network.

Internetwork

- is defined as two or more computer network LANs or WAN, connected using devices, and they are configured by a local addressing scheme.

- interconnection between public, private, commercial, industrial, or government computer networks

What are benefits of network?

- Strength business connections. Networking is about sharing, not taking.

- Interconnected business contacts.

- Get career advice and support.

- Sharing a resource like a file, a folder, a printer, a disk drive or just about anything else that exists on a computer

- Sharing of expensive software's and database.

- Connectivity: world ,country

- Reliability, Scalability, backup.

- E-commerce: amazon.com, ሶዪፌ

- Increased Storage Capacity.

✓ The nodes of a computer network may include personal computers, servers, networking HW, or other specialized hosts.

✓ A Compute network should ensure:

- reliability of the data communication process

- security of the data

- performance by achieving higher throughput and smaller delay.

Computer Network Architecture

- **Based on the type of computer in a network (configuration or architecture), it divided into two broad categories.**
  - **Peer-to-peer**
  - **Client/Server**
- **Peer-to-peer**
  - **There are no dedicated servers, and there is no hierarchy among the computers.**
  - **Each node considered as equal in terms of resource sharing and responsibilities**
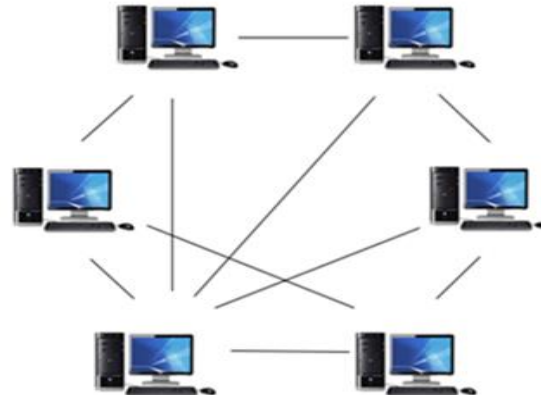
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pros
- Easy to set up
- Less expensive
- Demands moderate level of skill to administer
- User is able to control their own resources

Cons
- Only < 10 nodes
- Low performance
- low level security
- Files and folders cannot be centrally backed up
- Files and resources are not centrally organized into a specific shared area

- **Peer-to-peer networks are good choices for environments where:**
  - There are 10 users or fewer
  - Users share resources, such as printers, but no specialised servers exist
  - Security is not an issue
  - The organization and the network will experience only limited growth within the foreseeable future

- **Client Server Model**
  - **Consists of a group clients connected to a server.**
  - **Server with more RAM, larger hard disk, more processing power**…
  - A server performs all the major operations such as security and network management.
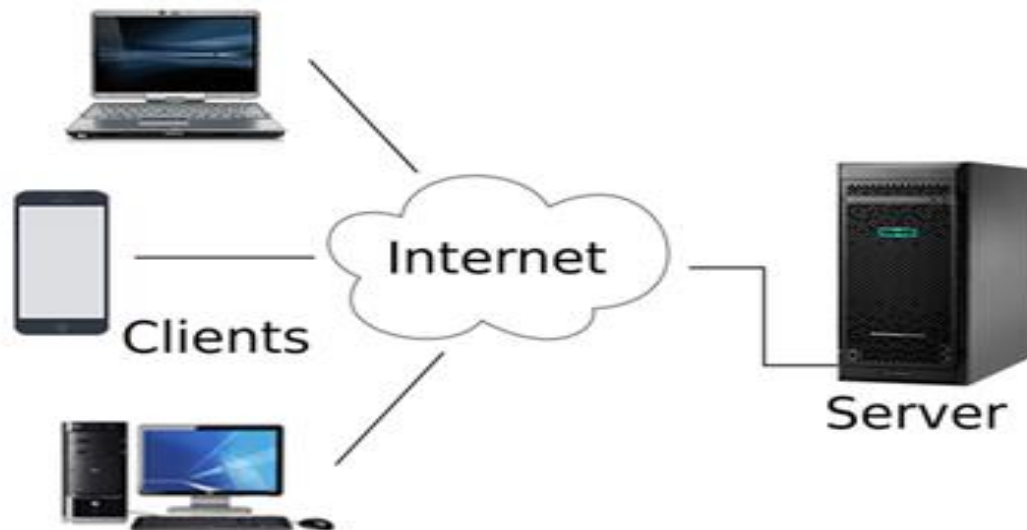
Advantages of client/server architecture

- Sharing Resources
- Back up the data easily.
- High Performance
- Security
- speed

Disadvantage of client/server architecture

- More complex to install, configure, and manage
- Expensive (large memory, NOS)
- Require skill – administrator

Types of Network

- **Networks may be classified according to a wide variety of characteristics**.

    – **such as Size, Architecture, Topology, etc.**

- **Based on** *size,* **there are Four types of network**: -
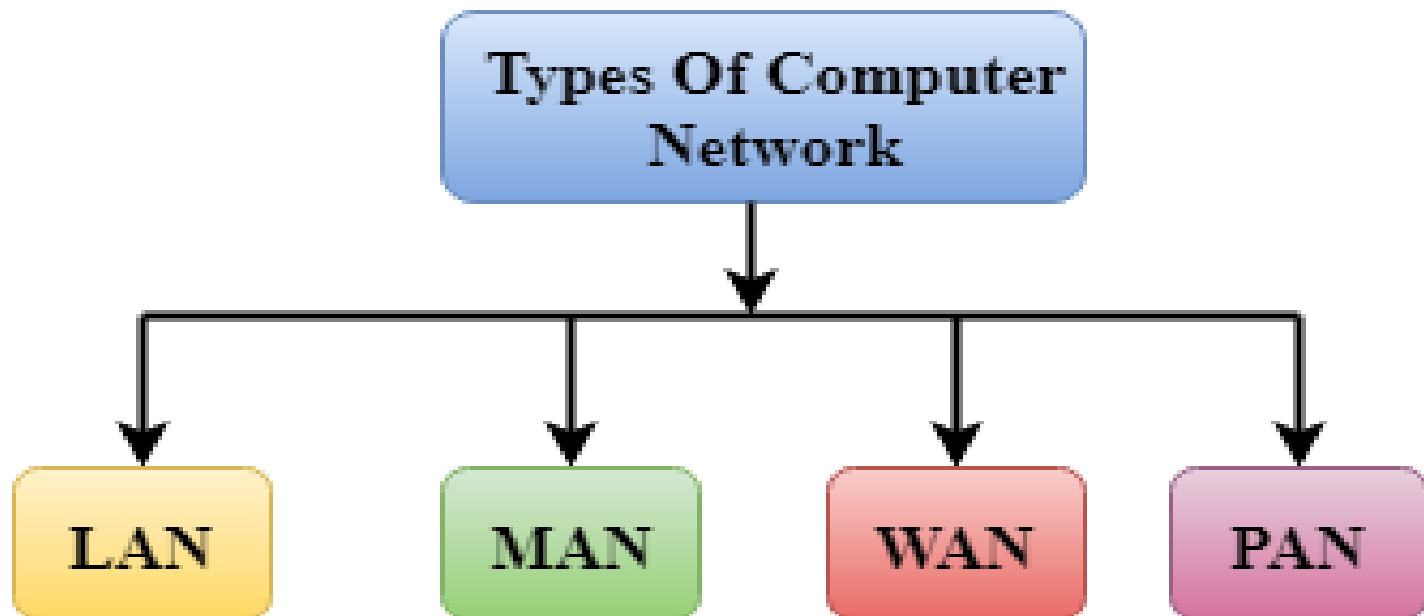
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Personal Area Network (PAN): used for communicating among computers and computer devices (including telephones) in close proximity of around a few meters within a room

- o e.g. a wireless network connecting a computer and printer
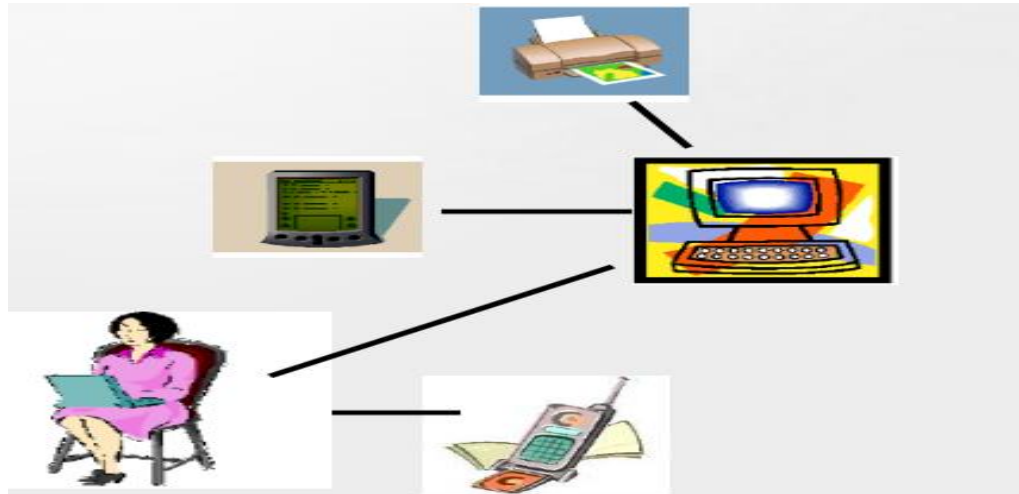
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- **Local Area Network (LAN):**

- Its smaller in size usually privately owned and links devices in a single office, building or campus.

- LAN works under its own local domain and controlled centrally.

- Data speed of 10 Mb/s to 10 GB/s.

- Easy to maintenance.

- It has low BW and high DR.
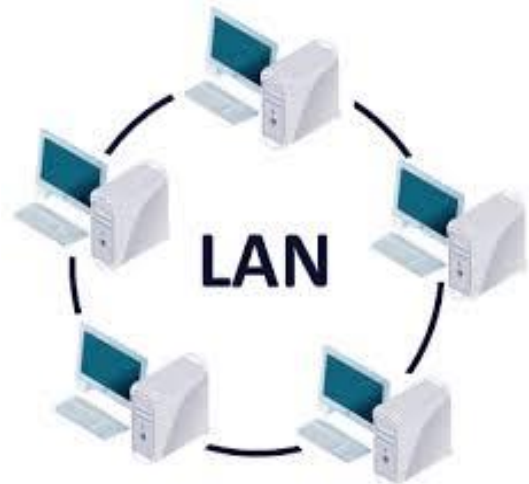
- Metropolitan Area Network (MAN): designed to extend over an entire city; it may be a single network or interconnected LANs. covers large geographic area like city.

- 5 to 50 KM in range

- small village or collage and it is speed range from 155 Mb/s to 10 GB/s.
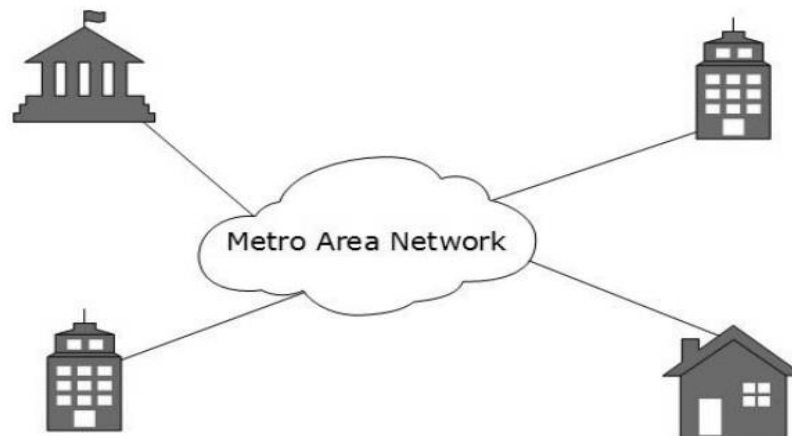
Metro Area Network

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

  o Spans huge geographic area which may span across larger area and even a whole country, continent

  o Connecting computers and covers a wide geographical area and it is contain a few smaller networks such as LANs, MANs. Ex, Internet

  o Ownership of WAN is either private or public
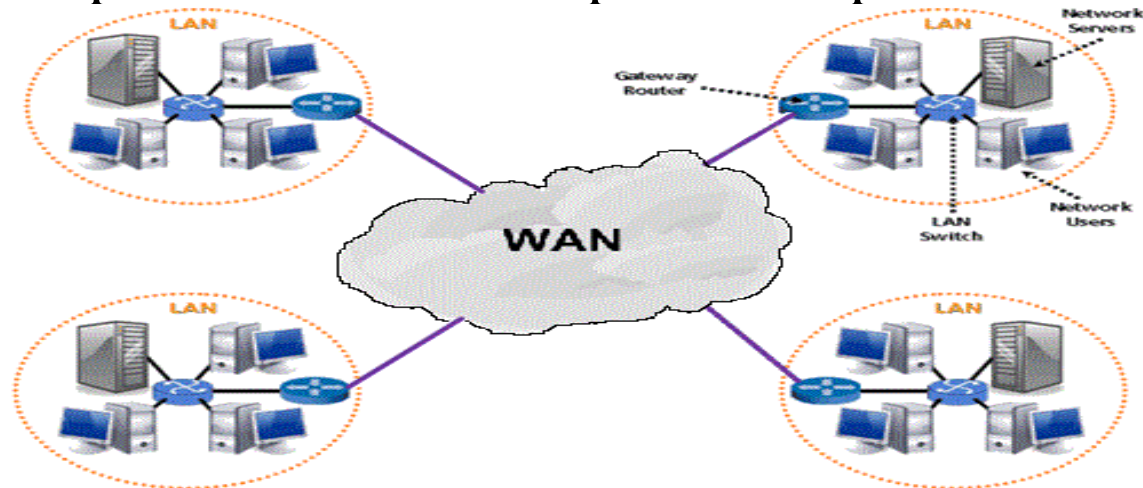
WAN - Wide Area Network
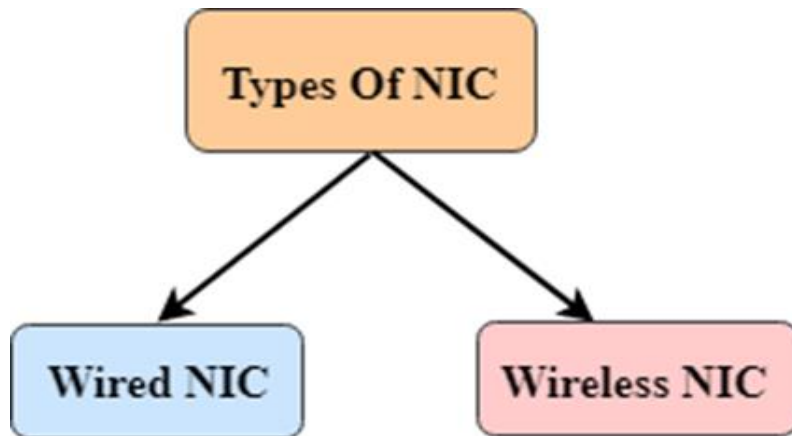
Computer network components

- **Comprise both physical parts as well as the software required for installing computer networks**

- **The HW components are the server, client, peer, transmission medium, and connecting devices.**

- **SW components are NOS and protocols.**

Cont…

HW Components:

- **NIC**
  - used to connect a computer with a NW.
  - NIC provides the physical interface between computer and cabling support a transfer rate of 100 to 1000 Mb/s.

Types Of NIC

Wired NIC   Wireless NIC

Cont…

- **Software Components**
  - NOS− is typically installed in the server and facilitate workstations in a network to share files, DB, applications, printers etc.
  - Protocol − is a rule or guideline followed by each computer for data communication.

Network and internetworking device

- **Used for interconnect public, private, commercial, industrial, or government computer networks .**

A. Repeater

- operates at the physical layer.

- Its job is to regenerate the signal over the same network

- It is a 2 port device.

- Extending the geographical LAN range

B. Hub

✓ multiport repeater

✓ It cannot filter data, so data packets are sent to all connected devices

✓ It broadcast the request to the entire network.

  – Acts on the physical layer

 – Operate on bits rather than frames
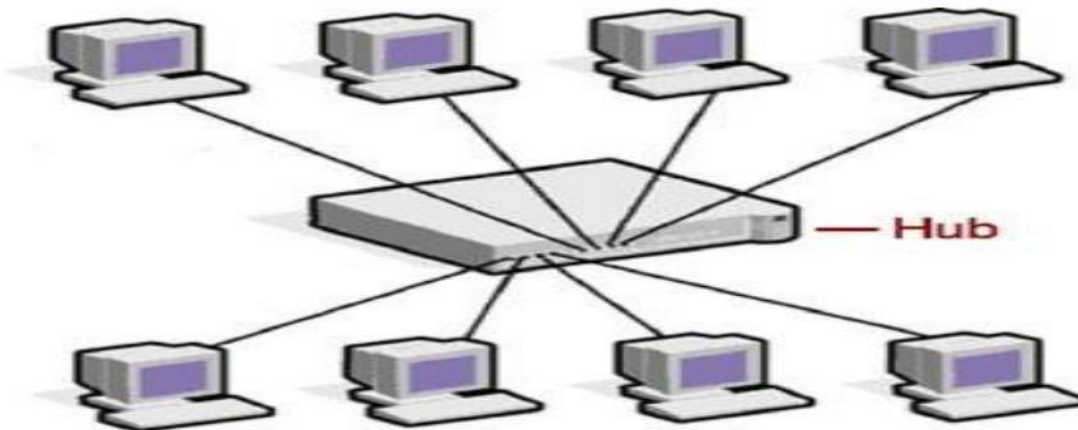
Type of Hub

- **Active Hub-** have their own power supply and can clean, boost, and relay the signal along with the network.
  - It serves both as a repeater as well as a wiring center.
- **Passive Hub**-collect wiring from nodes and power supply from the active hub.
  - These hubs relay signals onto the network without cleaning and boosting them and can't be used to extend the distance between nodes.
- **Intelligent Hub**-includes remote management capabilities. They also provide flexible data rates to network devices.
  - It also enables an administrator to monitor the traffic passing through the hub and to configure each port in the hub.

Bridge

- – connects two similar network segments together.
- – It operates at the data link layer
- – filtering content by reading the MAC addresses of source and destination.
- – It has a single input and single output port
- – **can't connect dissimilar network types or perform intelligent path selection**
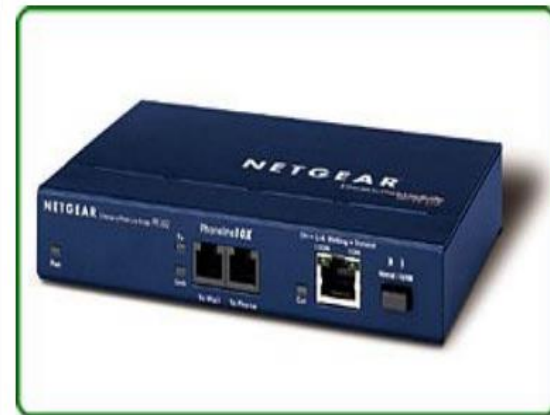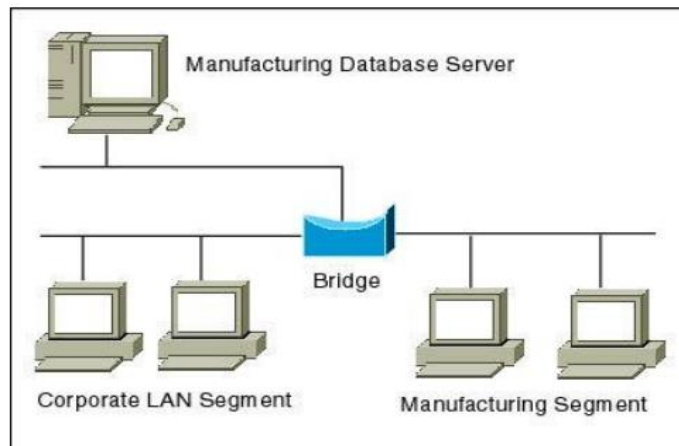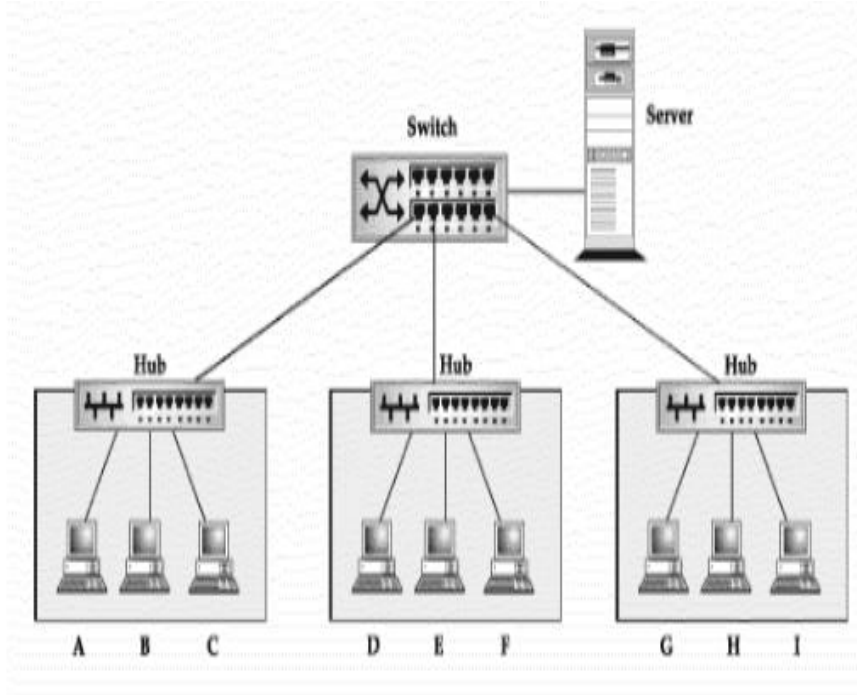
Switch

- It is a multiport bridge with a buffer and a design that can boost its efficiency (a large number of ports imply less traffic) and performance

- data link layer device

- can perform error checking before forwarding data

- delivers the message to the **correct destination** based on MAC address

- does not broadcast the message to the entire network

Cont…

- Therefore, switch provides a direct connection between the source and destination.

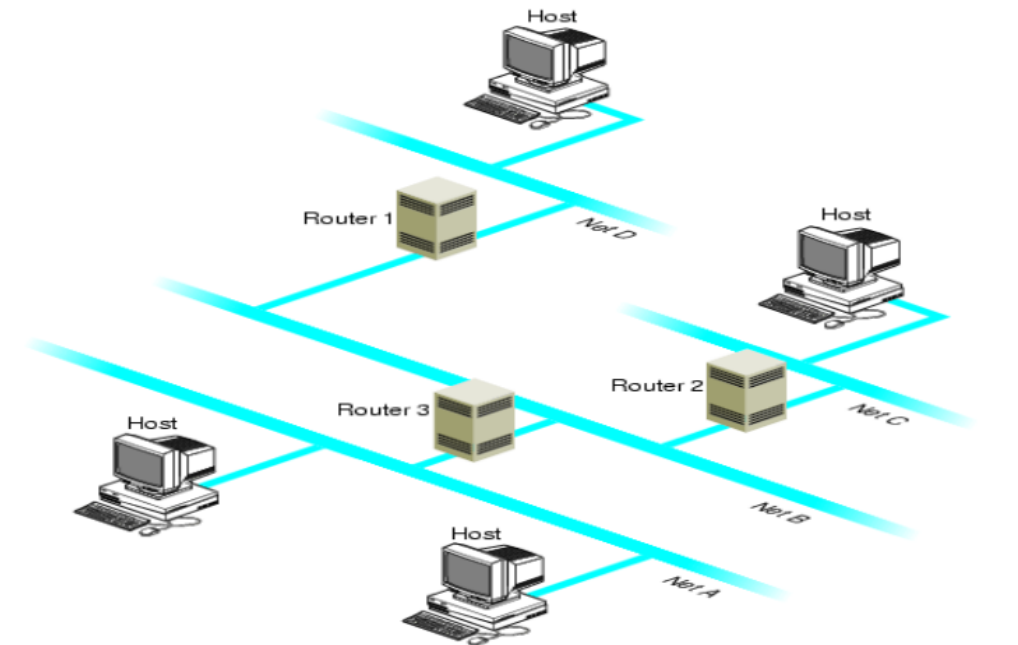- It increases the speed of the network.

Router

- **It is a Layer 3 device that has much more intelligence than a hub or switch**

- **It determines the best path from the available paths for the transmission of the packet.**

- **routes data packets based on their IP addresses**

- **connect LANs and WANs together**

Advantages of Router

- **Security**
- **Reliability**
- **Performance**

Gateway

- It is any hardware and software combination that connects dissimilar network environments.

- most complex of network devices because they perform translations at multiple layers of the OSI model.

- It acts as a "gate" between two networks. It may be a router, firewall, server, or other device that enables traffic to flow in and out of the network.

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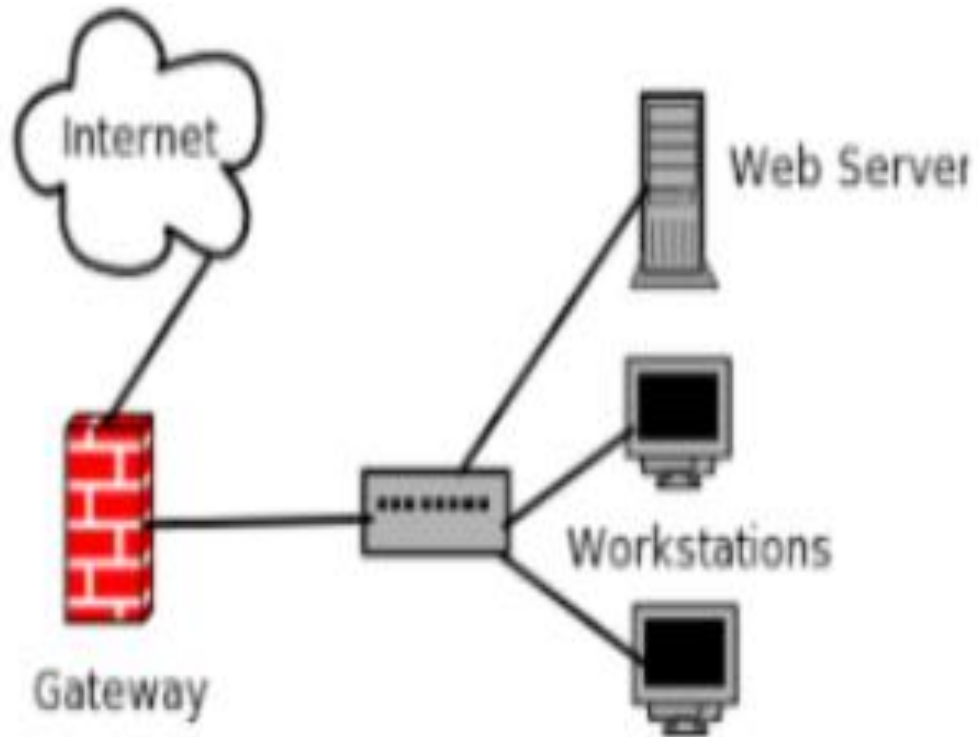
Network Topology

- **Topology** refers to the **way in which multiple devices are interconnected via communication links**.

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

  o **Physical Topology**

  ✓ **Refers to the arrangement or physical layout of computers, cables, and other components on the network**

  ✓ **Can be referred as Physical layout, Design, Diagram, Map**

  o **Logical topology**

  ✓ It is logical flow of information in the network.

- The choice of one topology over another will have an impact on the

  o Types of equipment that the network needs

  o Growth of the network – scalability

  o The Way the network managed

- There are five main network topologies;

  A. Bus Topology

  B. Ring Topology

  C. Mesh Topology

  D. Star Topology

  E. Hybrid Topology

A. Bus Topology

- all the stations are connected through a single cable known as a backbone cable.

- All <u>nodes</u> (file server, workstations, and peripherals) are connected to the backbone cable.

Terminator

File Server
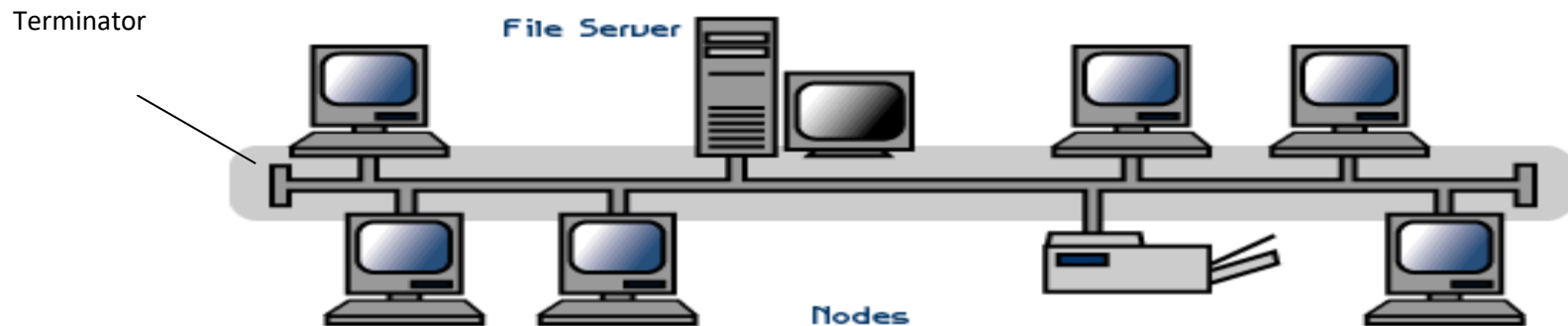
Nodes

Advantages of Bus Topology

- **Scalable: Easy to connect** a computer or peripheral to a linear bus.
- **Low cost**
- **Failure of a single node does not terminate the network**
- **If a cable that connect the nodes with the backbone fails, the network does not fail**

Disadvantage of bus topology

- **Entire network shuts down if there is a break in the main cable (backbone).**

- **Terminators are required at both ends of the backbone cable.**
  - **Absorbs signal reaching the end of the cable; thus avoiding reflection of the signal back in to the system and prevent collusion with regular traffic.**

- **Difficult to identify the problem if the entire network shuts down.**

- **Less secure**

B. Ring Topology

- All microcomputers and other communication devices are connected in a continuous loop.

- Electronic messages are passed around the ring in one direction, with each node serving as the repeater, until they reach the right destination.

- Since, all messages are flowing in only one direction; failure of a single node can compromise the entire network.

Cont…

- **The most common access method of the ring topology is token passing.**
  - **Token passing: It is a network access method in which token is passed from one node to another node.**
  - **Token: It is a frame that circulates around the network.**

Advantages of a Ring Topology

- Network Management-Faulty devices can be removed from the network without bringing the network down
- Low cost- installation cost is very low
- Reliable- communication system is not dependent on the single host computer

Disadvantages of a Ring Topology

- **Difficult to setup**
- **If any computer/cable in the ring fails, the whole network goes down.**
- **Reconfiguration difficult**
- Delay

C. Star Topology

- designed with each <u>node</u> connected directly to a central network <u>hub</u> or <u>switch or central computer</u>.

- Data passes through the central device before continuing to its destination.

- The hub or concentrator manages and controls all functions of the network.

- most popular topology in
  network implementation
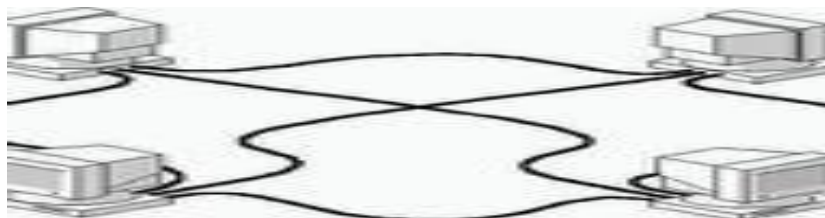
Advantages of star topology

- Easy to install and wire.
- No disruptions to the network when connecting or removing devices.
- Easy to detect faults and to remove parts.
- Easily scalable, i.e., you can add a node easily
- Failure of a single computer/cable does not affect the rest of the network

Disadvantages of star topology

- Requires more cable length than a bus topology.
- If the central device fails, all nodes attached are disabled.

D. Mesh Topology

- each of the network node, computer and other devices, are interconnected with one another.
- Every node not only sends its own signals but also relays data from other nodes.
- This type of topology is very expensive as there are many redundant connections, thus it is not mostly used in computer networks.
- mainly used for wireless networks

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- Number of cables $= (n*(n-1))/2$, Where n is the number of nodes that represents the network.
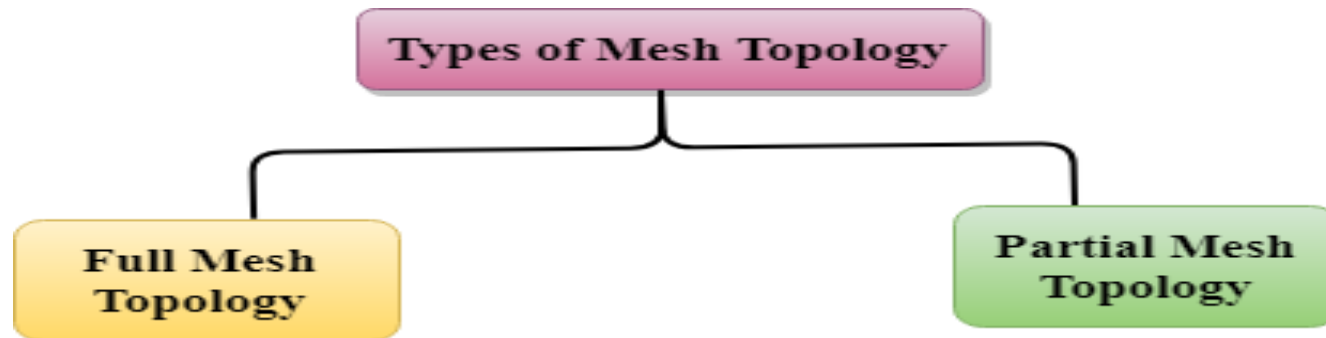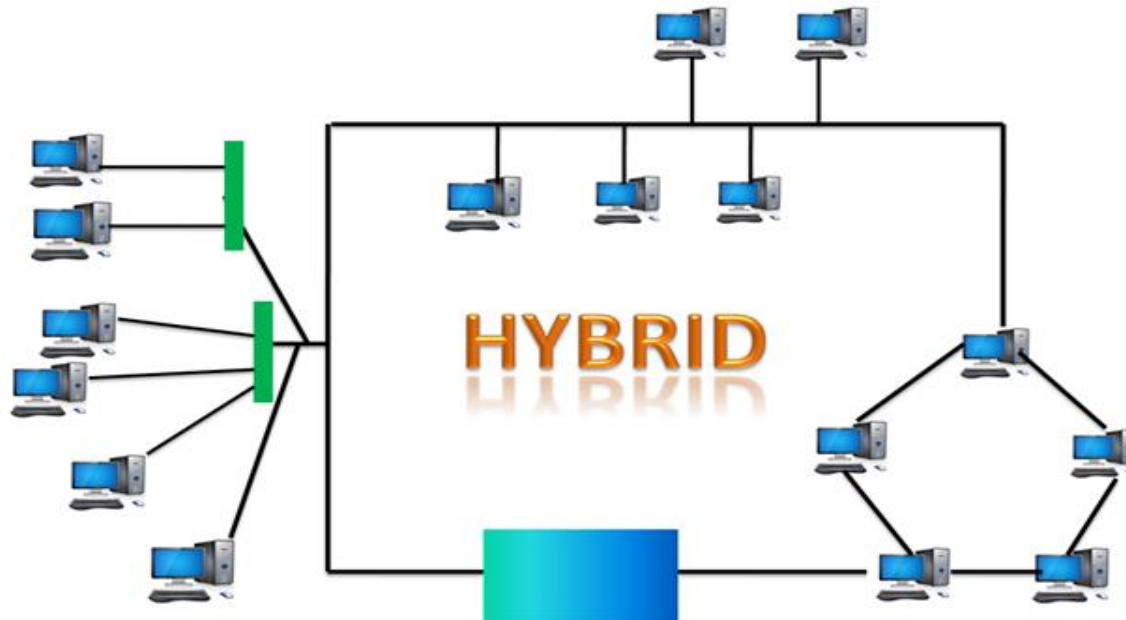
Advantages of Mesh topology

- Reliable.
- Fast Communication.
- Easier Reconfiguration

Disadvantages of Mesh topology

- high chances of redundancy
- High cost
- Set-up and maintenance of this topology is very difficult.

E. Hybrid Topology

- When two or more different topologies are combined together forms Hybrid topology.

Hybrid Topology

Advantage

- **Reliable**.
- **Scalable**
- **Flexible**
- **Effective**

Dis advantage

- **Complex design**
- **Costly infrastructure**

Group discussion

- **If school of computing asks you to configure network to all the offices and laboratory classes**
  - **which topology do you prefer and why?**

Network protocols

- A Protocol is one of the components of a data Communications **system**.

- Without protocol communication cannot occur.

- It is defined as a set of rules that governs data communications.

Elements of a Protocol

- **Syntax**: -It means the structure or format of the data.

- **Semantics**: - It tells the meaning of each section of bits and indicates the interpretation of each section.

- **Timing**: - It tells the sender about the readiness of the receiver to receive the data.

  Example: - FTP, HTTP, SSH, TCP, IP.

THANK YOU!

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