

Unit : 4

Network Devices

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COURSE OUTCOME (CO4)

- After completion of this Unit, students will be able to

Illustrate use of various network devices used in computer network.

LEARNING OUTCOME (LO)

- After completion of this session, students will be able to *explain use of various network devices*

→ Introduction

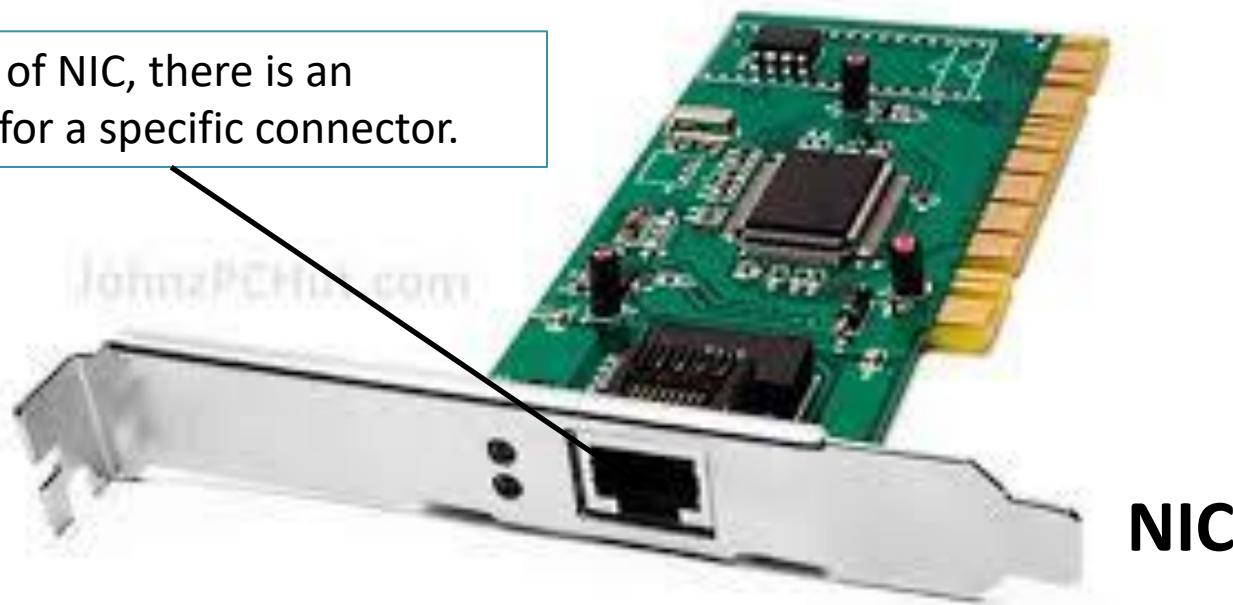
- Two or more devices connected with each other for sharing their data and resources are called a network.
- When two networks are connected, then called internetwork.
- Examples of networking and internetworking devices are:
 - Repeater, Hub, Switch, Bridge, router, gateway etc..

Network Adapter (NIC)

- It is ad-on card available on motherboard.
- It is a small printed circuit board that is installed on a mother board of CPU.
- This is additional hardware card required to install physically on the slot of motherboard.

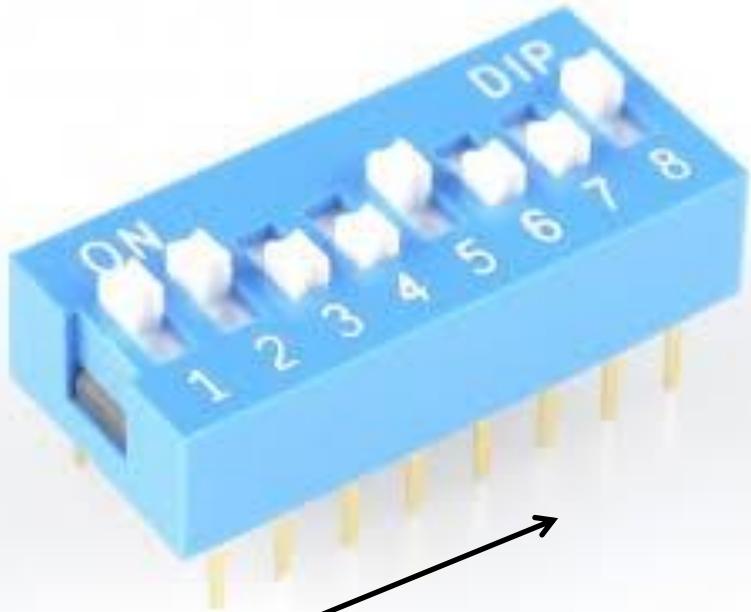
- This card provides the connectivity between computer internal resources and external resources connected to the network.
- Each NIC has a unique address called MAC address / physical address that is different from other NIC.
- Types of NICs are
 1. ARCNET Card
 2. Ethernet Card

Back side of NIC, there is an interface for a specific connector.

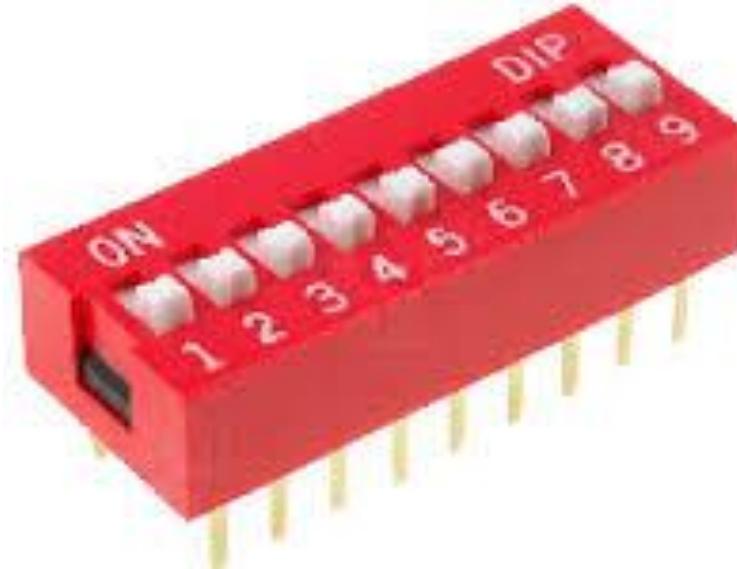


1. ARCNET Card

- The full form of ARCNET is **Attached Resource Computer Network**.
- It consists of 8 dual inline packages (DIP) switches. Which are used for defining address of nodes.
- If all switches are OFF then the address is 00h and if all ON then address is FFh.
- So we can connect 256 nodes with it.
- It supports MCA (micro Channel Architecture) bus.
- The cable used for this card is co-axial (RG-62).
- It has 8/16 bit port.
- Its transmission rate is 2.5 mbps.
- It consists of a boot ROM.
- Has BNC connector
- ARCNET uses token ring bus access method.
- This type of NIC supports BUS topology and STAR topology.



DIP switches



ARCNET



2. ETHERNET Card

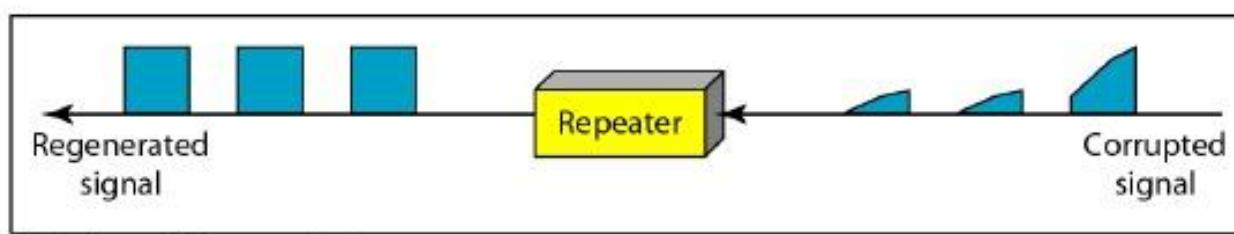
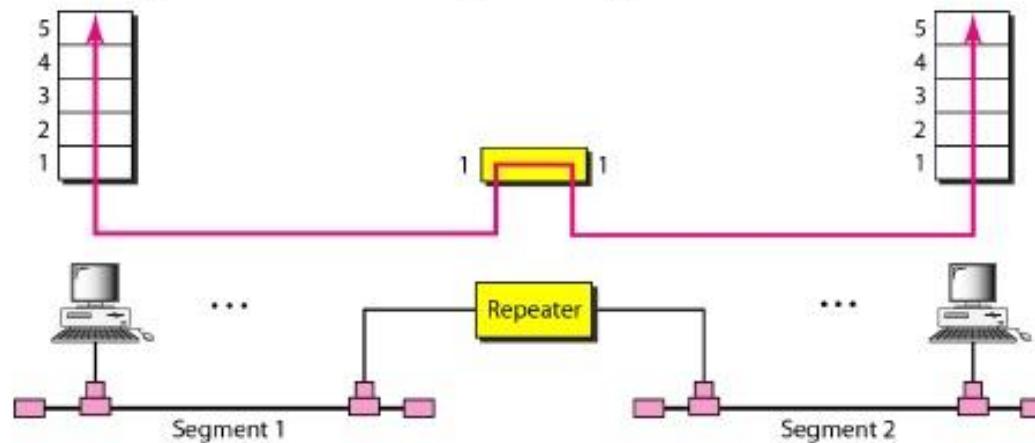
- It consists of PCI (peripheral component interface) bus.
- The slots available for this card are 8,16,32 bits.
- Node address is between 1 to 1023 (total 1024).
- DIP switches are not available.
- Cable used: RG-58 (previously) UTP (Now a days)
- Data transfer rate is 10 mbps.
- It uses BNC(previously) and RJ-45 (Now a days) connector.
- No switches for port address settings available.



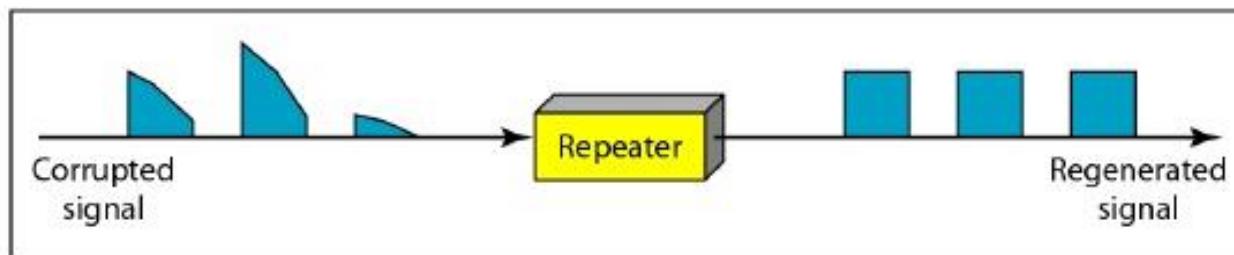
Repeaters

- Repeater is an electronic device which operates only in physical layer.
- Signal that carry information within a network can travel a fixed distance before noise can affect its integrity.
- Repeaters, installed on a link receives the signals before it becomes too weak or corrupted, it regenerates the original bit pattern and puts the new refreshed copy of signal back on the link.
- Repeaters allows us to extend only the physical length of a network.
- it does not change the functionality of the network.
- We can see the functions of the repeater in below figure.

Repeater connecting two segments of a LAN



a. Right-to-left transmission.

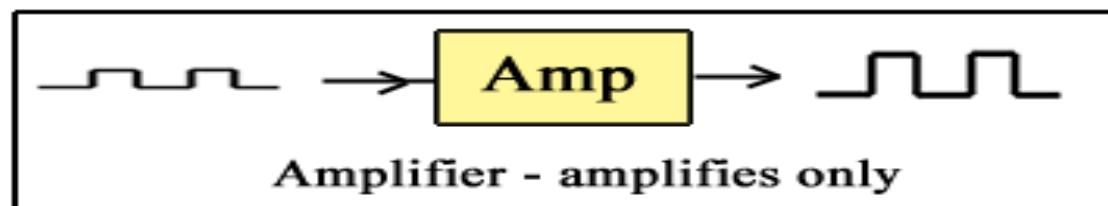


b. Left-to-right transmission.

Function of a repeater

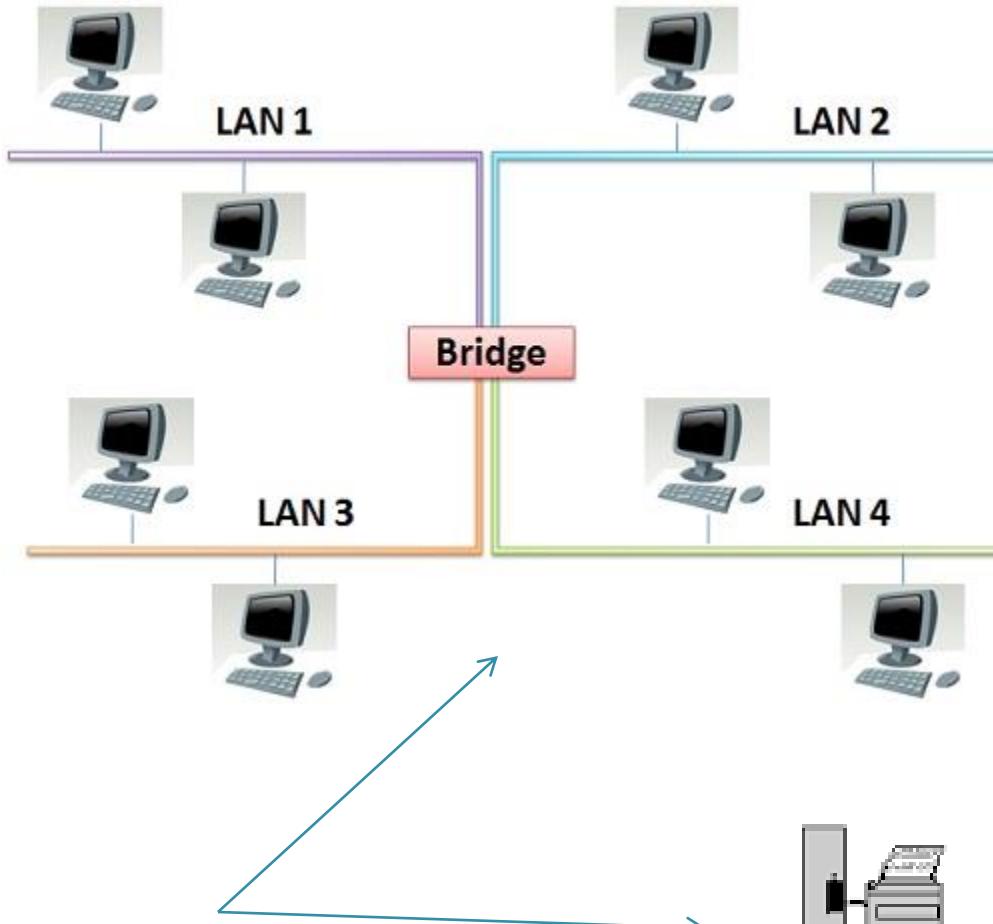
→ Repeater is not an amplifier

- An amplifier can not differentiate the intended signal and noise signal, hence it amplifies equally everything fed into it.
- While repeater does not amplify the signal instead it regenerates it.
- Repeaters placed so that a signal reaches it before the noise changes the meaning of any of its bits. So repeater is placed on the link before it becomes the weak or corrupted.



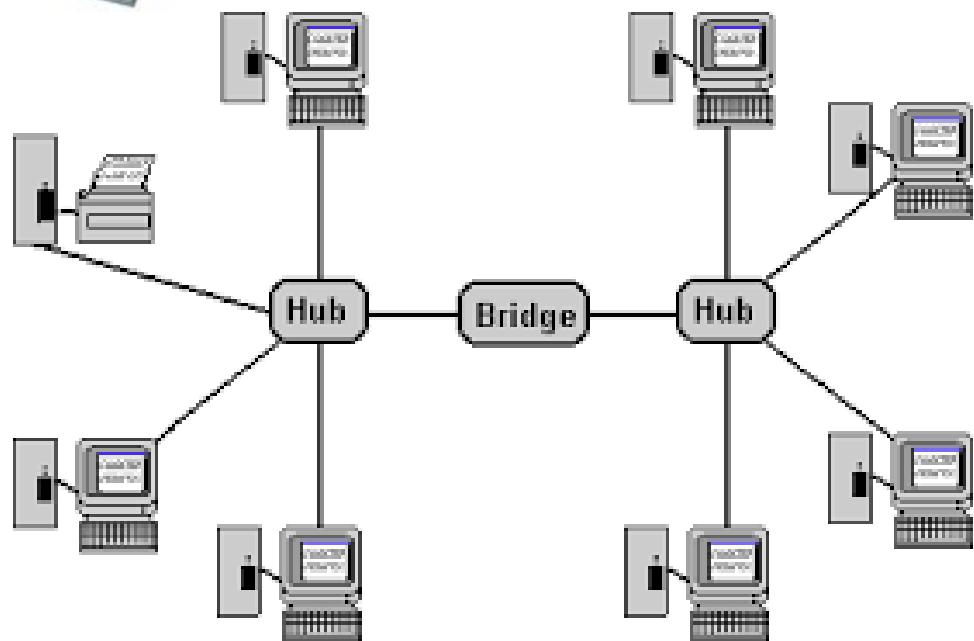
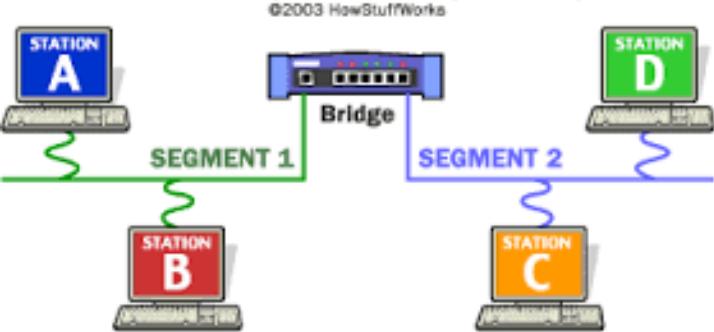
Bridge

- It operates on both physical and data link layer of OSI model.
- It connects two or more LANs.
- Bridge can divide the large network in to smaller segments.
- Bridge has a software which keeps the separate traffic for each segment.
- Repeater transmits frames to entire connected devices while bridge transmits the frames only to separate segments.
- Like this way, it **filters the traffic**.
- Bridges work on data link layer hence gives the access to physical address of the stations.
- Bridge contains the **look up table** that contains the physical addresses of every stations connected to it.
- Bridge is also worked for collision resolution.



Bridge placed in a network between different segments

An Ethernet Bridge Connecting Two Segments



- In the working of a bridge → when a frame enters to the bridge, it regenerates the signal and it checks the address of the destination and forwards the new copy only to the segment to which the address belongs.
- As a bridge found the frame, it reads the address contained in the frame and compares the address with a table of all the stations on both the segments.
- When bridge finds the correct match, it finds to which segment the station belongs and send the frame to only that segment.

→ **Types of Bridges**

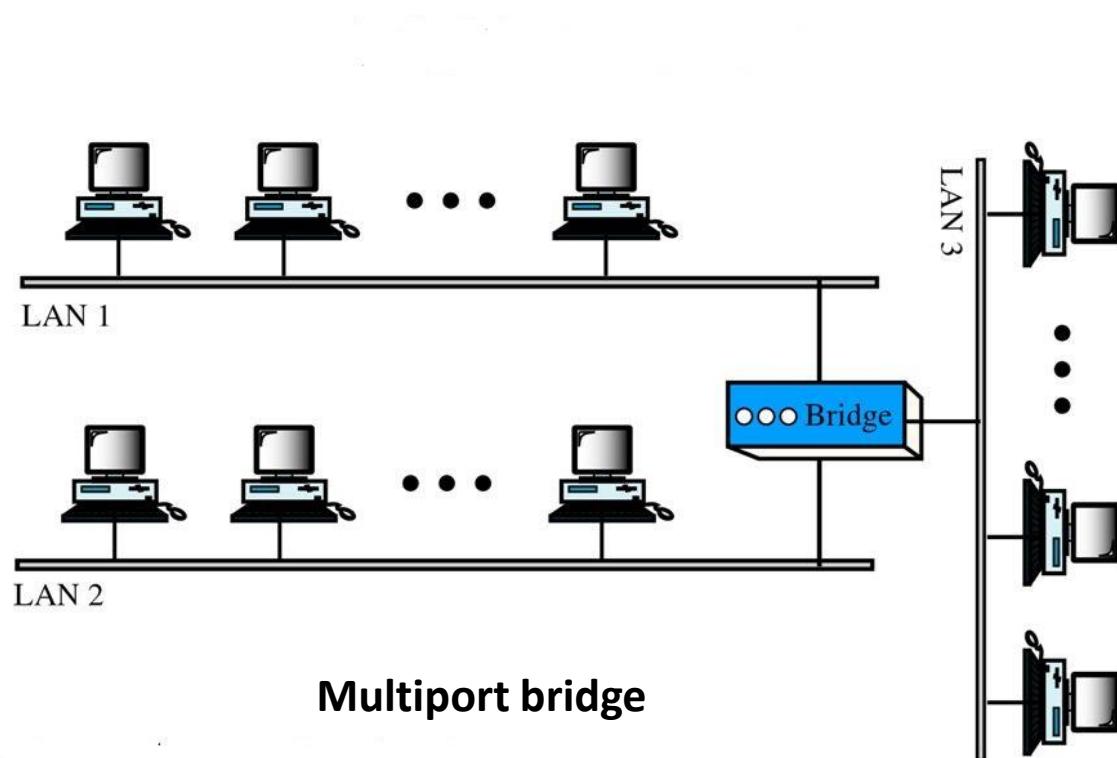
1. **Simple bridge**
2. **Multiport bridge**
3. **Transparent bridge**

1. Simple bridge

- It is the most primitive (ਮੂਲ, ਪ੍ਰਾਚੀਨ ਫ਼ਰਜ਼) and least expensive types of a bridge.
- It links two segments.
- It contains a table that lists the physical address of all the stations connected with it. Physical address must **entered manually**.
- In this bridge, **updating of device is time consuming** when new device is added / removed, the table must be modified at this time.
- So installation and maintenance for this bridge is time consuming and tedious.

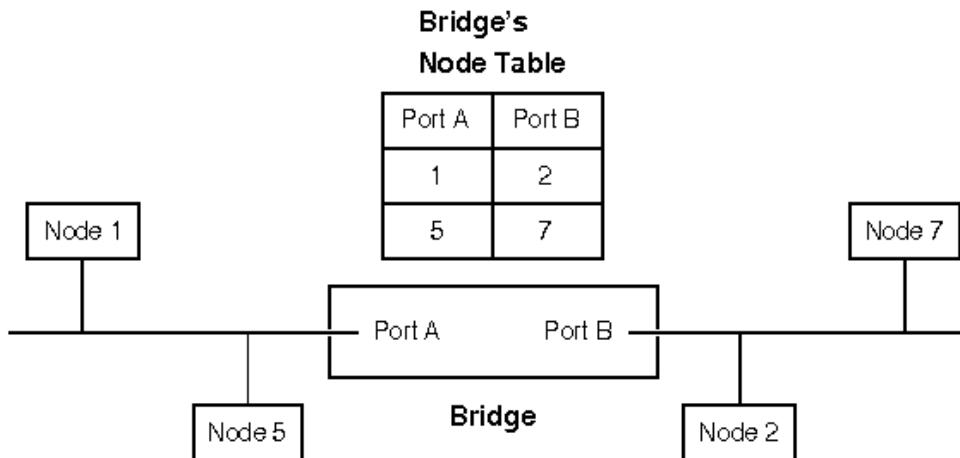
2. Multiport bridge

- It is used to connect more than two LANs.
- In this bridge, different tables are created each one holding the physical address of stations reachable through the corresponding port.



3. Transparent bridge

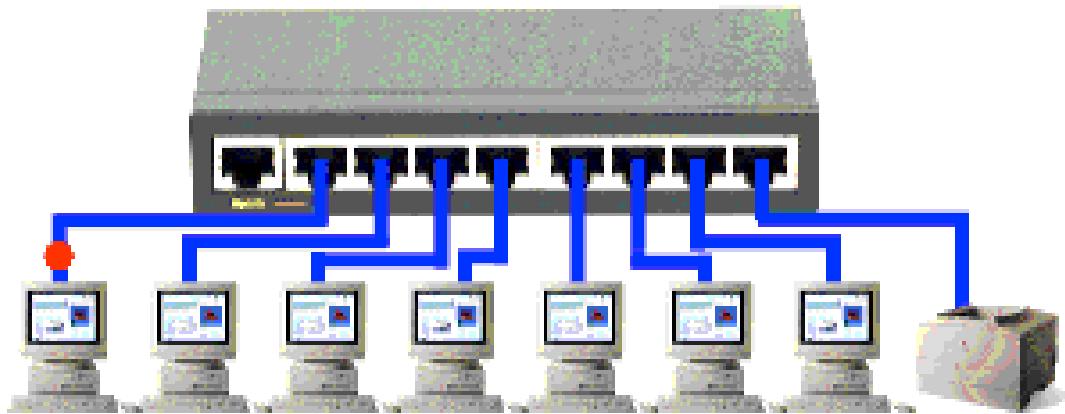
- It builds the table of physical address on its own as it performs its bridge function.
- Table is automatically built as frames are moved in the networks.
- Initially when bridge is installed, it is **empty**.
- As transmission is done the table is updated accordingly.
- The first packet transmitted by each station, the bridge makes entries inside the table with corresponding segment. So at last the table is completed with all details.
- So we can say, this bridge has '**self updating features**'.



Hub

- Hub is used to create connections between stations in physical star topology.
- Large number of computers can be connected in single or multiple LANs.
- Hub is a central network device that connects network nodes. So is also referred as concentrator.
- Hub enables central network management.
- It provides connection for several different media types like: coaxial, fiber optic, twisted pair.
- Hubs are available in 8/16/24 ports.
- It provides high speed communication.

Hub



→ Types of Hub

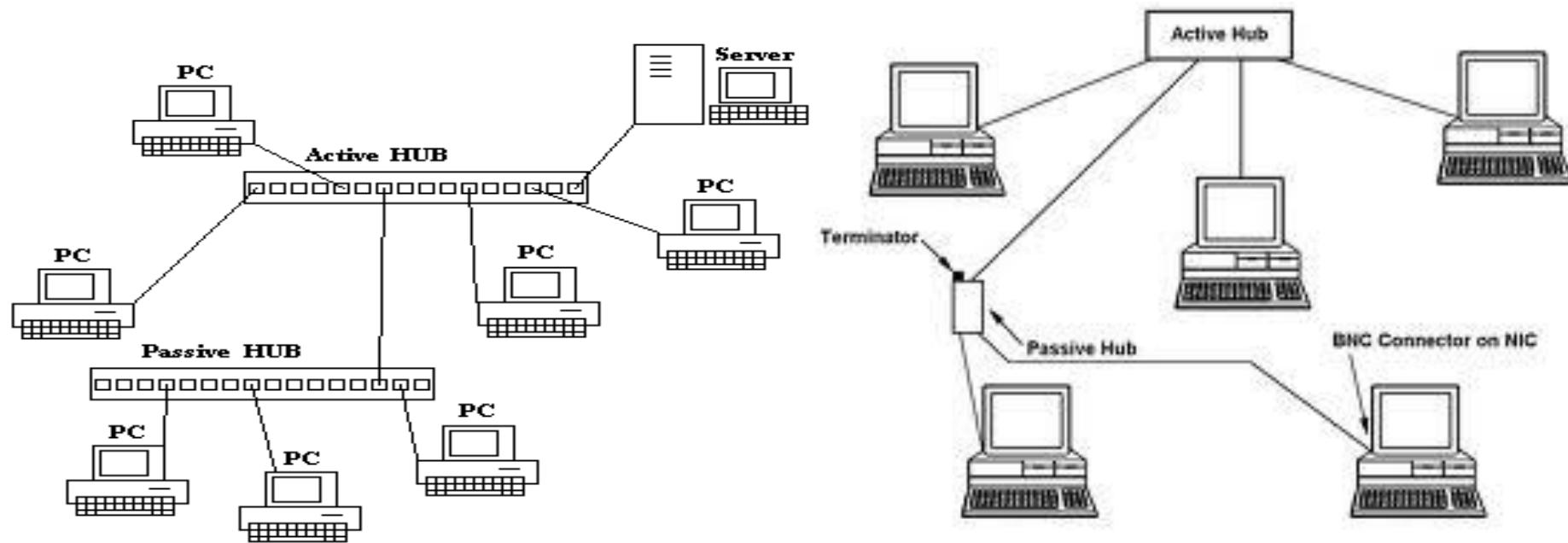
1. Active hub

2. Passive hub

3. Intelligent hub

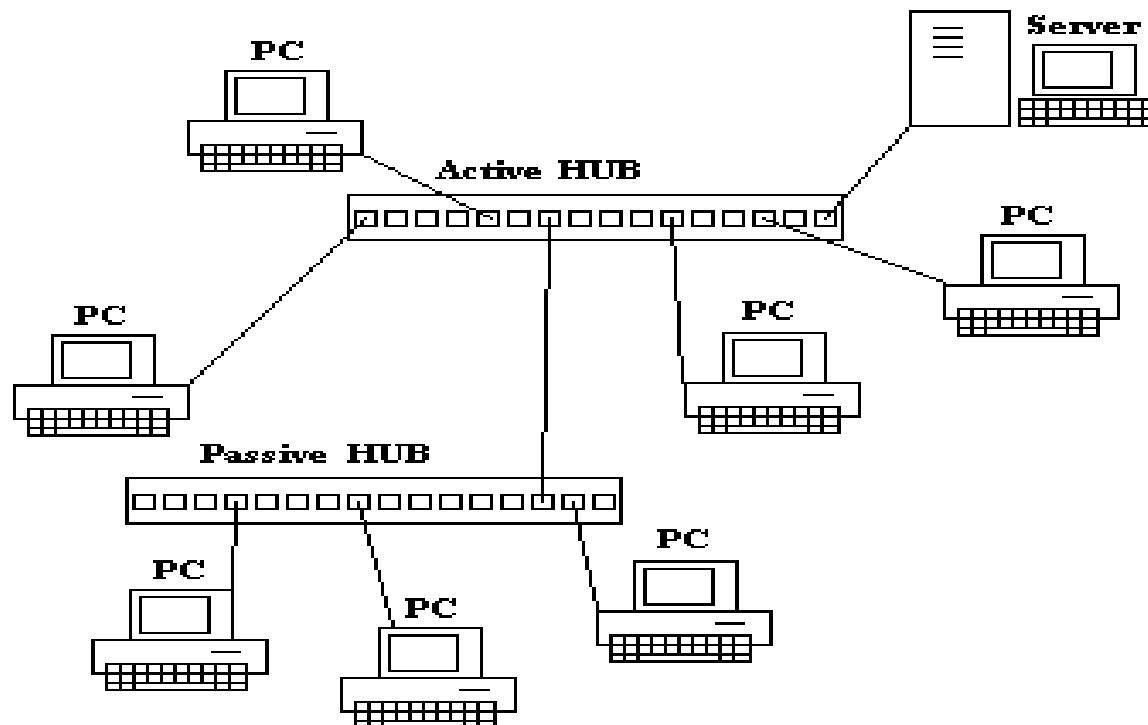
❖ Active hub

- It acts like repeaters, it regenerates and retransmits the signals.
- Because of multiple ports are available in it, it also called multiport repeaters.
- it needs electric power to run.



❖ Passive hub

- It provides the physical connections between the attached devices.
- It do not amplify or regenerates the signals passes through hub.
- It do not require electricity to run.



❖ Intelligent hub

- It is the third and last type of hub which can perform task of both active and passive hub.
- It can accommodate several types of cables.
- It can perform some other tasks like Bridging and routing.
- It increases the speed and effectiveness of total network thus makes the performance of whole network fast and efficient.
- It is intelligent because capable of doing hub management and switching functionality.

➤ Applications of hub

- Hubs are used to create small Home Networks.
- Hubs are used for monitoring the networks.
- It Makes one device or peripheral available throughout the whole network.
- Hubs are used in Organizations and Computer Labs for connectivity.

Switch

- Switch provides the bridging functionality with greater efficiency.
- It acts as a multiport bridge to connect different devices or segments in a LAN.
- It operates in data link layer of OSI model (also called layer 2 switch).
- Switch has **buffer** for each link connected with it.
- When it receives the frame, it stores the frame in the buffer of receiving link and checks address to find outgoing link.
- If outgoing link is free the switch sends the frame to that particular link.
- two different characteristics of switch:
 - **Store and forward switch** → it stores the frame in input buffer until the whole frame is arrived.
 - **Cut through switch** → it forwards the frame to the output buffer as soon as the destination address is received.

LEARNING OUTCOME (LO)

- After completion of this session, students will be able to *Differentiate Layer 2 and Layer 3 Switches.*

Difference between layer 2 and layer 3 switch

Layer2 switch



Layer3 switch



❖ Layer2 switch

- It operates using **MAC address** for sending the frames from one node to next node.
- It performs at the **physical and data link layer** of OSI model.
- L2 switch is like a multiport transparent bridge, which allows better and faster performance.
- L2, as a bridge does the filtering decision based on the MAC address of the frame it received.
- It has **buffer to hold the frames** for processing.
- It has the switching factor that can forwards the frame faster.
- Generally it is used in **small private network**.
- L2 provides the following benefits:

- Hardware based bridging	- High speed
- Low latency	

❖ Layer3 switch

- It is used at the network layer of OSI model. (layer-3, hence called layer-3 switch).
- L3 switch is like a router, but it is more faster and sophisticated.
- Switching in L3 switch allows faster table lookup and forwarding.
- It operates utilizing IP address to make forwarding decision.
- L3 is best for large network and working good in case of heavy traffic.
- L3 switch provides following benefits:

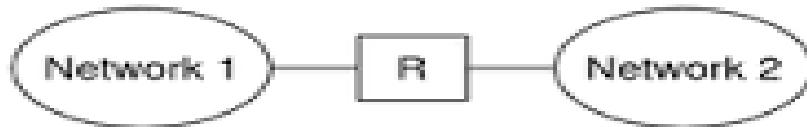
- High speed scalability	- High performance packet switching
- Low latency	-Security
- Quality-of-Service (QoS)	- Flow accounting

LEARNING OUTCOME (LO)

- After completion of this session, students will be able to *explain use of various internetworking devices*

Routers

Two Networks Connected by a Router



Three Networks Connected by Two Routers



Figure 1

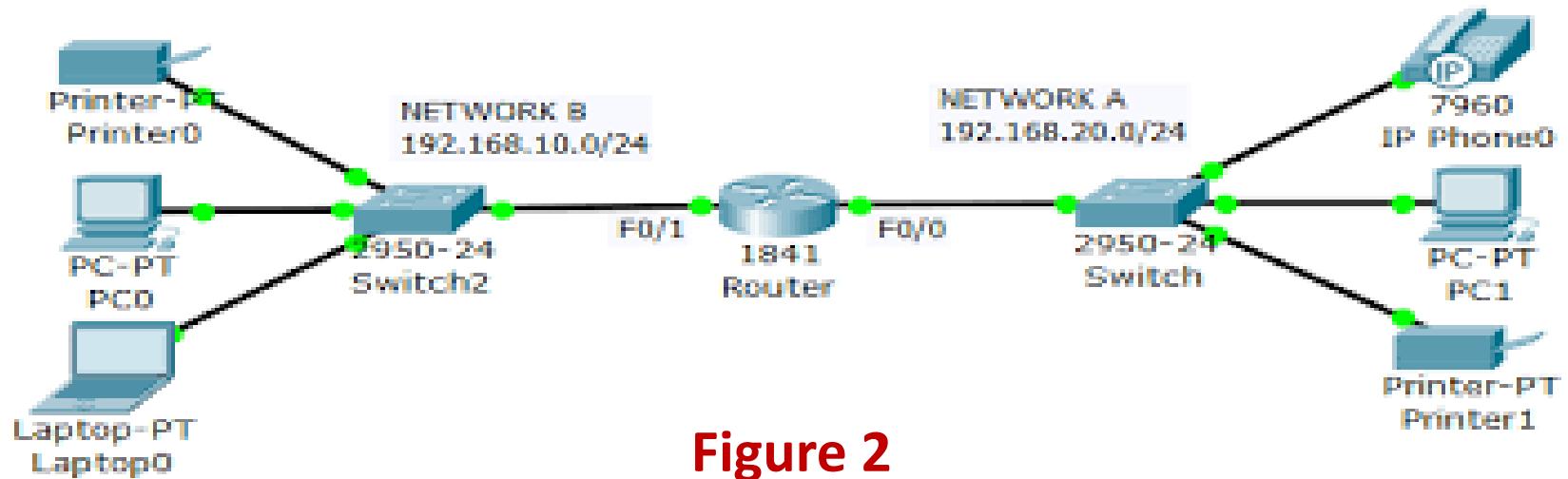


Figure 2

Routers

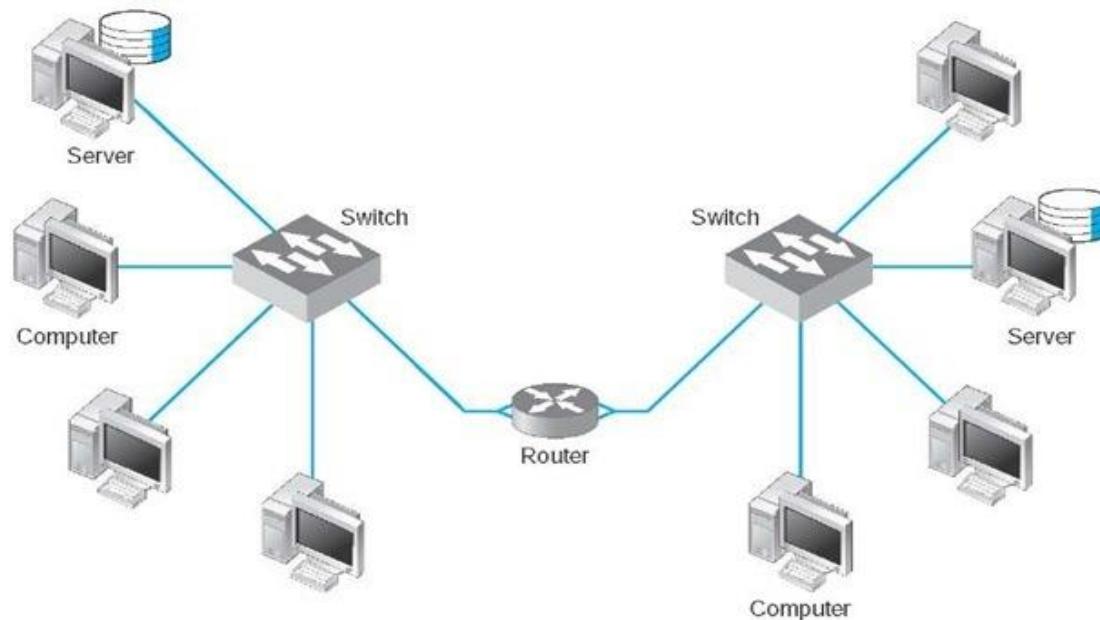


Figure 3

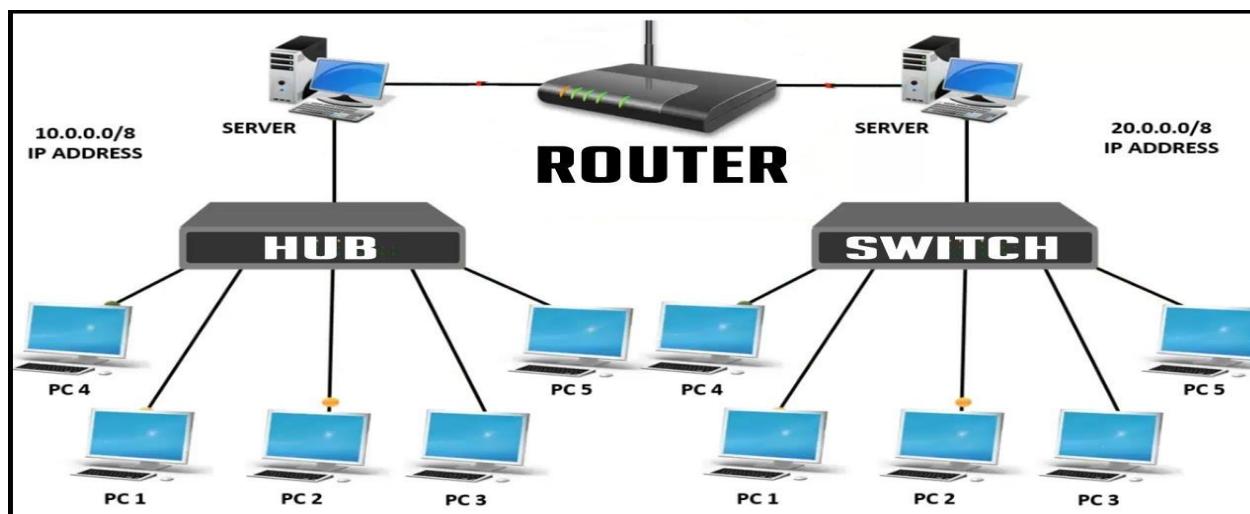
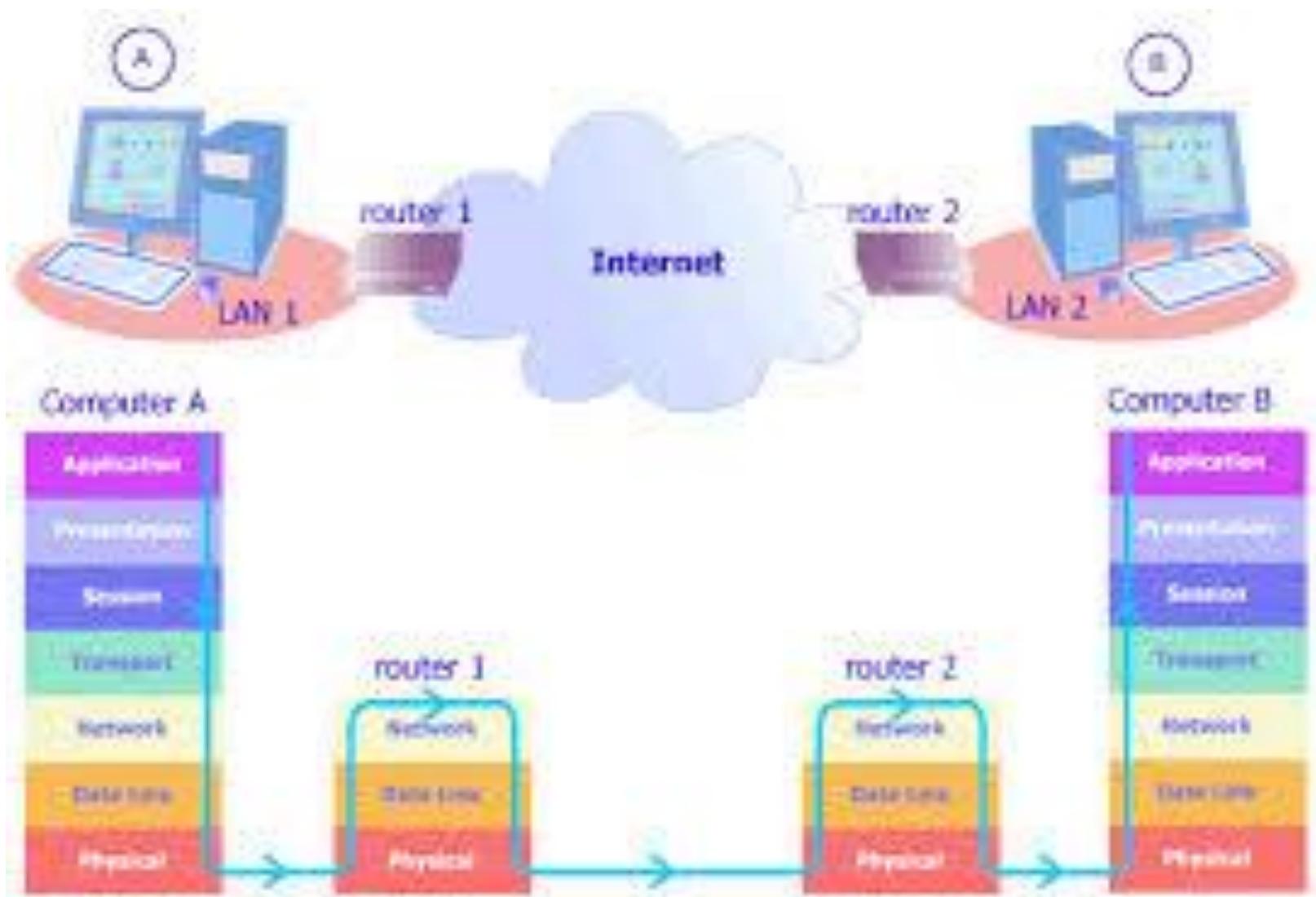


Figure 4

Router

- A router is hardware device designed to receive, analyze and move incoming **packets** to another network.
- It operates in **physical, data link and network** layer of the OSI model. But most **active in network layer**.
- Routers are able to access network layer address (IP address) of the device.
- Simple function of router is to receive the **packet** from one connected network and pass them to a second connected **network**.
- Routers also perform the **traffic directing functions** on the Internet.
- A packet sent from a station on one network to a device on a neighboring network **goes first to the jointly device – router** which forwards the packet to the destination network.
- Routers consult with **routing table** when packet is ready to be forwarded.

Routers in OSI model



❖ Router characteristics

- **Least-cost routing:** Router finds the shortest path for the packet which is fastest, cheapest, reliable and secure.
- **Non Adaptive routing:** In which, once a pathway to a destination has been selected, the router sends all packets for that destination along that one route.
- **Adaptive routing:** In this, Router may select a **new route for each packet**. Routers send the packet depending on which route is most efficient at that moment.
- **Example:**
 - Packet transmission from **A to D**
 - Non adaptive:
 - Once path A-B-D is selected then all packets will follow the same path.
 - Adaptive:
 - First through network B, means A-B-D
 - Second through network C, means A-C-D
 - Third through network E, means A-E-D

- Routers finds the best path and routes the packets based on the information **stored in routing table**.
- Routing table also contains → **network address** of each connected device, **possible paths** and **cost of sending data**.

❖ **Types of router (Two types)**

→ **Static router**

- In it, routing table information are entered manually. Administrator enters the route for each destination into the table.
- In case of change in the connection, it can not update automatically.
- It is more secure. It always uses the same route.

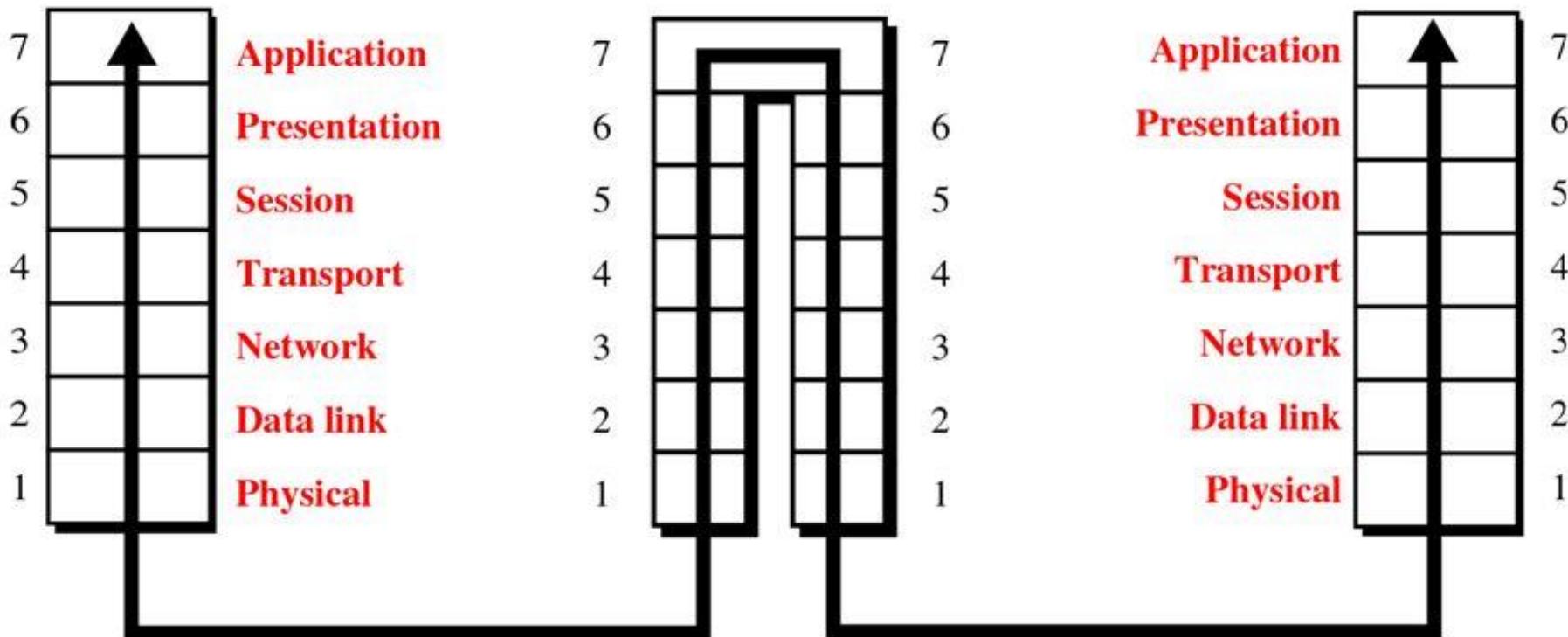
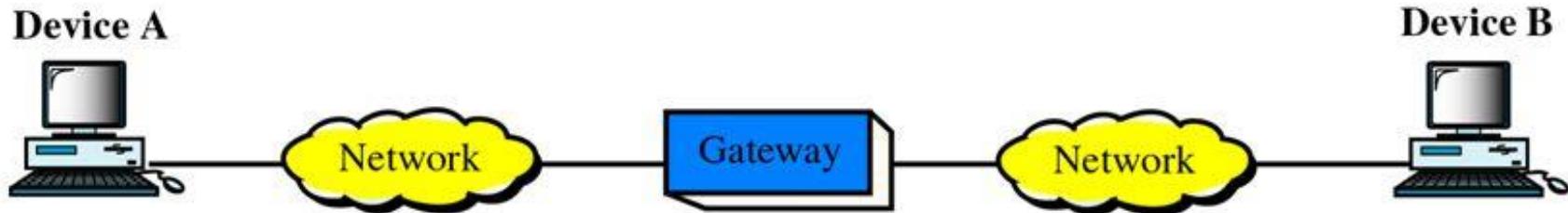
→ **Dynamic router**

- In it, routing table is created and updated automatically.
- When there is a change in the connection, routing table is updated using any of the routing protocols.

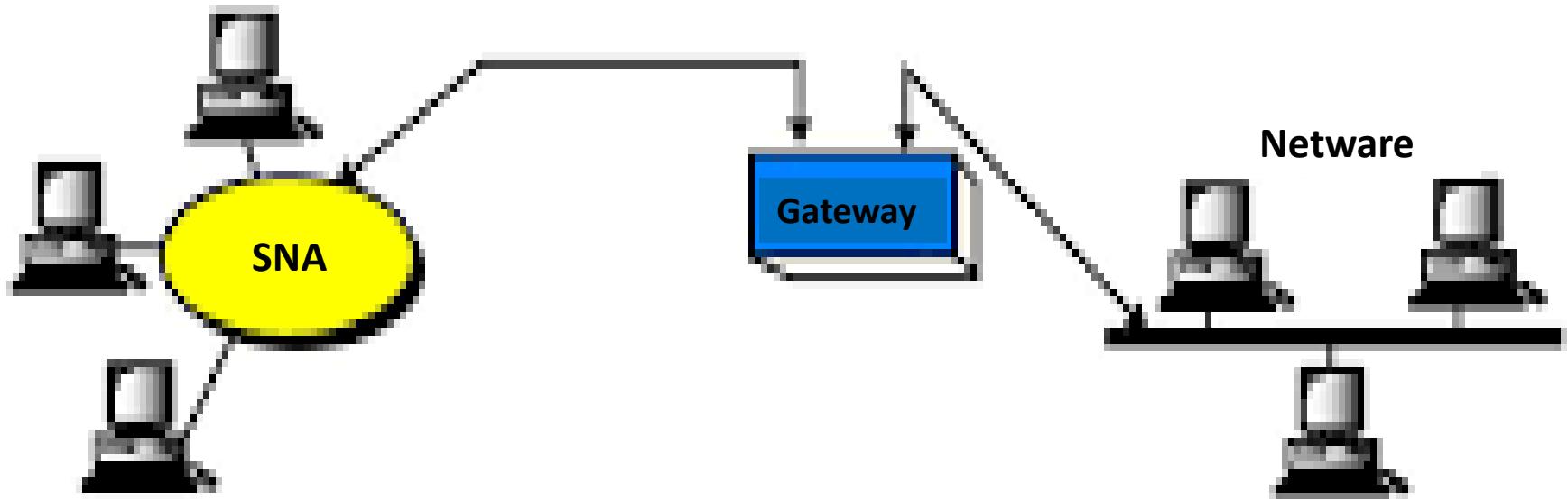
Gateways

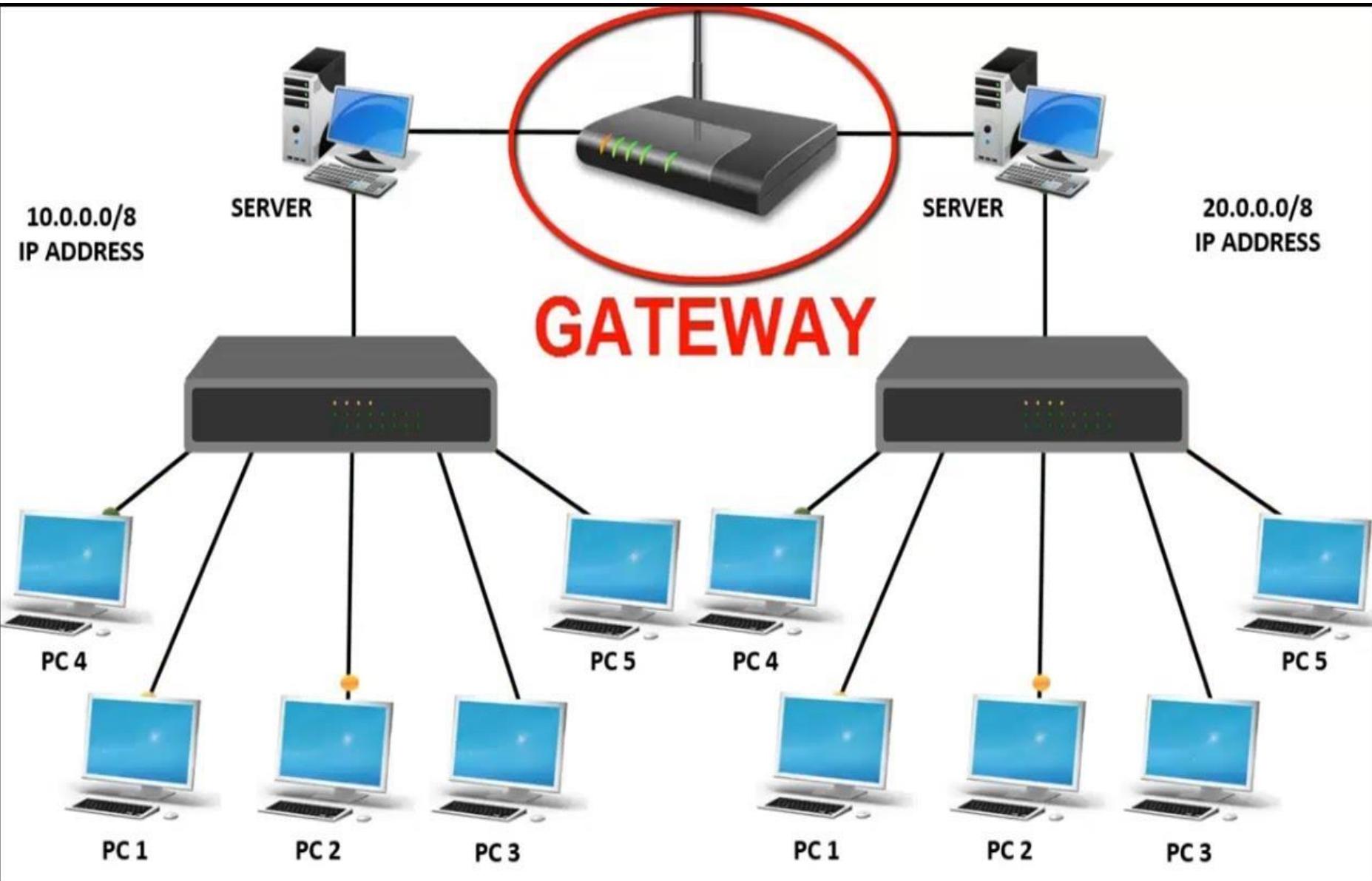
- Gateways operate in all seven layers of OSI model.
- A gateway is a hardware device that acts as a "gate" between two networks
- It is also called as **protocol convertor**.
- It is generally used to connect **two different network systems**.
- Routers transfers packets only across networks using **similar protocols** while a gateway can accept a packet formatted for one protocol and converts it to a packet formatted for another protocol before forwarding it.
- It may be a router, firewall, server, or other device that enables traffic to flow in and out of the network.

A Gateway in the OSI Model



Gateway as protocol convertor





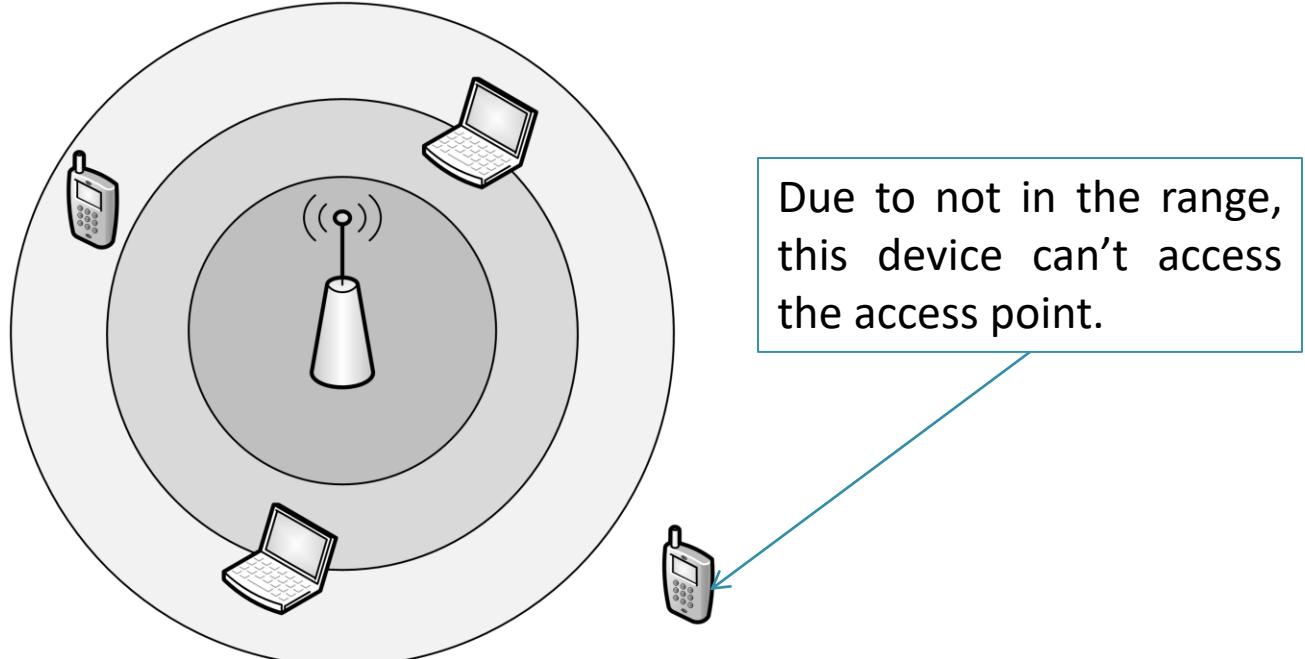
Access point

- **Definition:** An access point is a device that allows wireless devices to connect to a wired network using Wi-Fi.
- Most access points have built-in routers, while others must be connected to a router in order to provide network access.



- Access points can be found in many places, including houses, businesses, and public locations.

- Every access point has its own range. Any device placed within the range of access point can only use the services of that. (see below figure)



→ How do access point works?

- Wireless access point performs the technique called '**modulation**' to transfer the data receives in or out.
- It takes the modulated radio frequency voltages highs and lows transmitted from a nearby wireless network card, and turns them into 1s and 0s instead. These 1s and 0s assembled into packets and forwarded to the destination.

Workstation (client or node)

- A workstation (WS) is a computer dedicated to a user or group of users for particular work. It includes one or more high resolution displays and a **faster processor than a personal computer (PC)**.
- In networking term → workstation is an individual single user computer which is connected with the server.

→ **There are two types of workstation:**

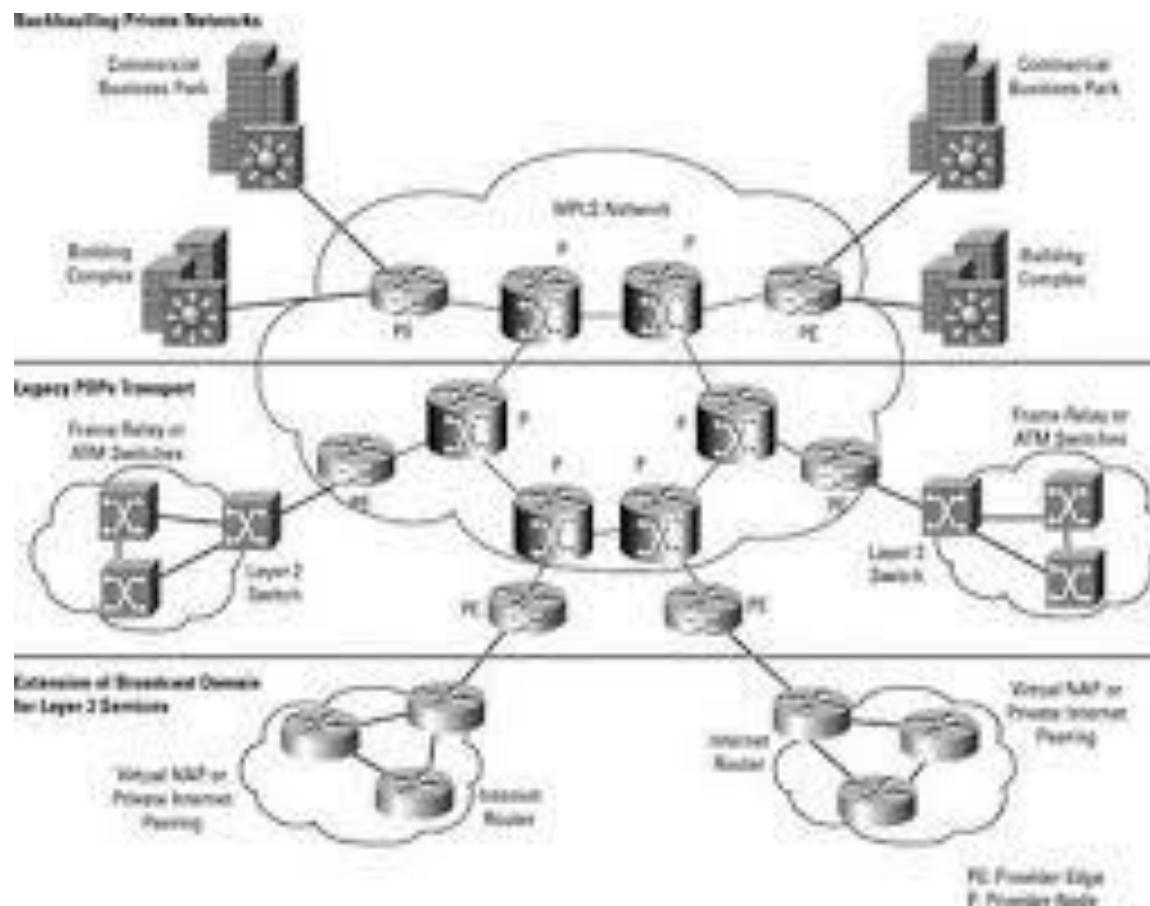
1. *Diskless WS* → - a node which has no floppy drive, no HDD is referred as diskless node.
 - it has add-on card added with CPU and also has one boot RAM for temporary data storage.
2. *WS with HDD* → - programs can be loaded in hard disk. It has memory for permanent data storage.

LEARNING OUTCOME (LO)

- After completion of this session, students will be able to *explain network management software.*

Network Management Software

- When network becomes more complex in terms of device population, topology and distances, there should be some way for controlling all the pieces of whole network.



- **Network management** can be defined as monitoring, testing, configuring, and troubleshooting network components to meet a set of requirements defined by an organization.
- Two standard protocols are there for network management and monitoring.

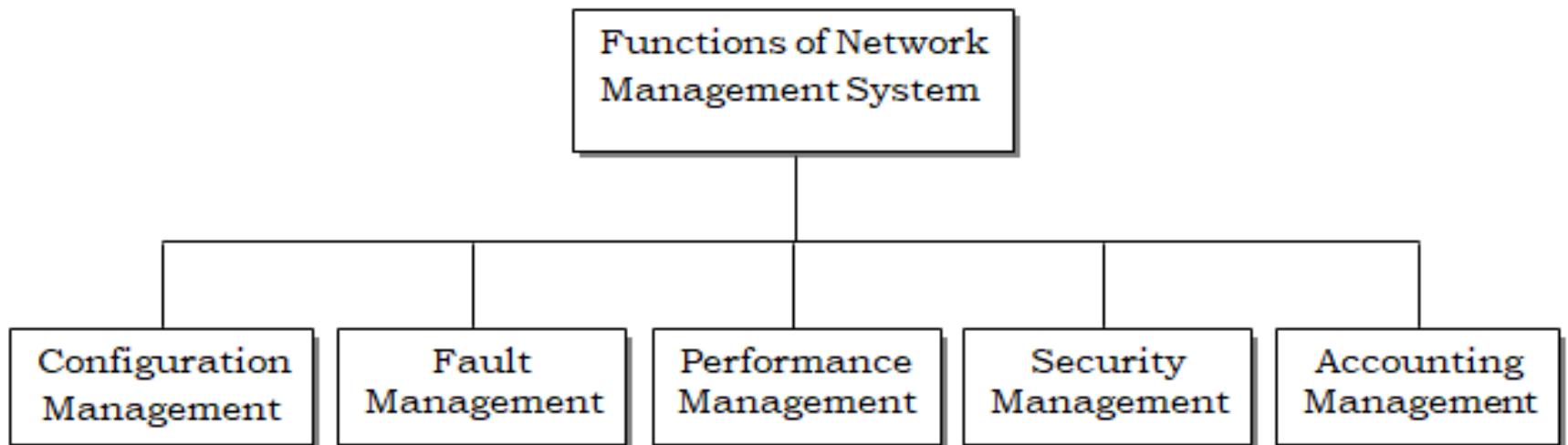
1. SNMP(Simple Network Management Protocol)

- It defines the set of instructions that can be used to view and change the settings of any SNMP compliant device.

2. RMON (Remote MONitoring protocol)

- It allows remote collection of network information.

❖ Basic features (functions) of network management software



→ Configuration management

- In which network operation is monitored and controlled.
- Addition of new programs and equipments, modification of existing systems are coordinated. And all these are updated regularly.

→ **Fault management**

- In it, network problems are found and corrected.
- Future problems are identified and prevented from re occurring.
- Network downtime is minimized and keep network in operational mode most time.

→ **Performance management**

- In it, the capacity, traffic, throughput, or response time of the network is measured and improve the performance of the network.

→ **Security management**

- In it, network is protected against hackers and unauthorized users for physical/ electronic damage.
- User confidentiality is maintained.

→ **Accounting management**

- In which, distributing resources optimally and fairly among network subscribers.
- Making most effective use of available systems.
- Minimizing cost of operations.

Concept of wireless network

- Wireless network Is Collection of NICs, APs (access points) and routers.

→ Advantages of wireless network

- Saves the cost of installation of LAN cabling.
- Easy to relocate the network.
- Easy to modify the structure of network.
- Easy to expand.

→ Disadvantages of wireless network

- Troubleshooting is difficult.
- More expensive.

→ Types of wireless network

- LAN
- Mobile computing

Types of communication

1. Unicasting

- Unicast is communication between a single sender and a single receiver over a network.
- In other term it can be said '*point-to-point*' communication.
- Examples of unicasting are: HTTP, TELNET, POP3, SSH

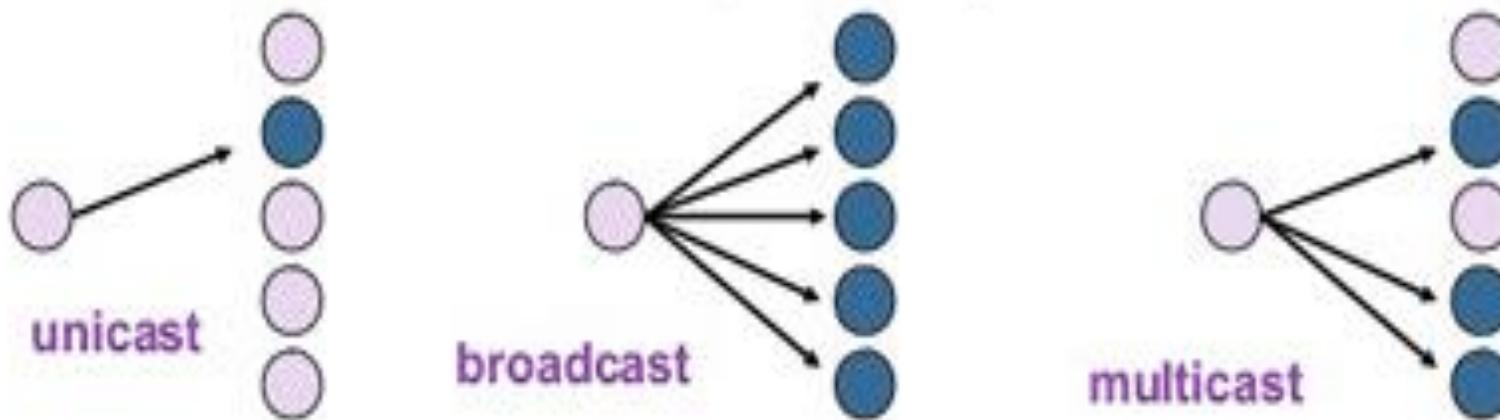
2. Multicasting

- Multicast is communication between a single sender and a group of users over a network.
- Examples of multicasting are: video conferencing, e-mail system, teleconferencing.

3. Broadcasting

- In broadcast, data is delivered from one point to several points.
- Communication between sender to all the nodes (including itself).
- Example → satellite television, education video broadcasting.

- one-to-one (unicast)
- one-to-all (broadcast)
- one-to-several (multicast)



Thank You...