Computer Networks
CSE 252

UNIT - 1

Syllabus

Unit-1

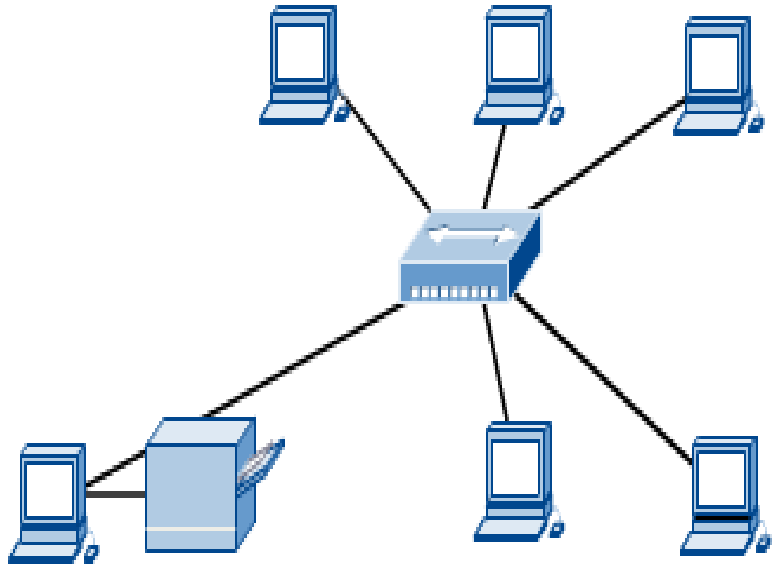
Introduction: Introduction to computer networks, applications and uses, classification of Networks based on topologies, geographical distribution and communication techniques

Reference models: OSI model, TCP/IP model , Overview of Connecting devices (Hub, Repeaters, Switches, Bridges, Routers, Gateways)

Transmission Media: wired , wireless, Multiplexing techniques-FDM, TDM

Computer Networks

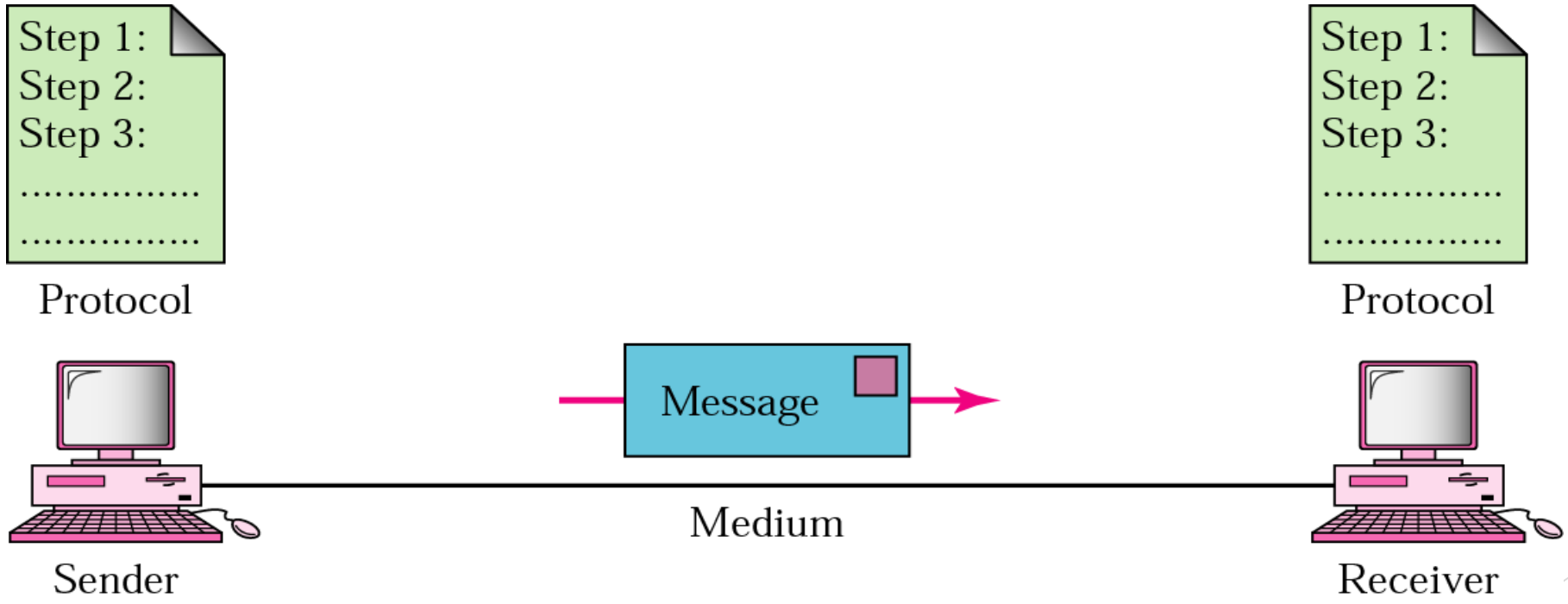
- **Computer network connects two or more autonomous computers.**
- **The computers can be geographically located anywhere.**



Applications of Networks

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

Five components of data communication

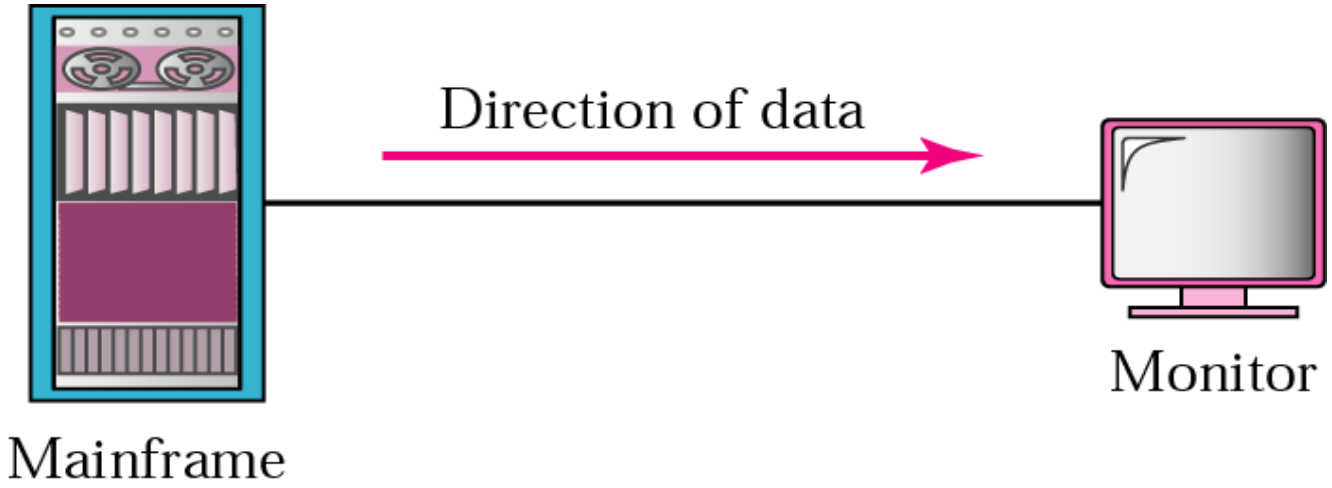


Types of Data Flow

1. **Simplex**
2. **Half-duplex**
3. **Full-duplex**

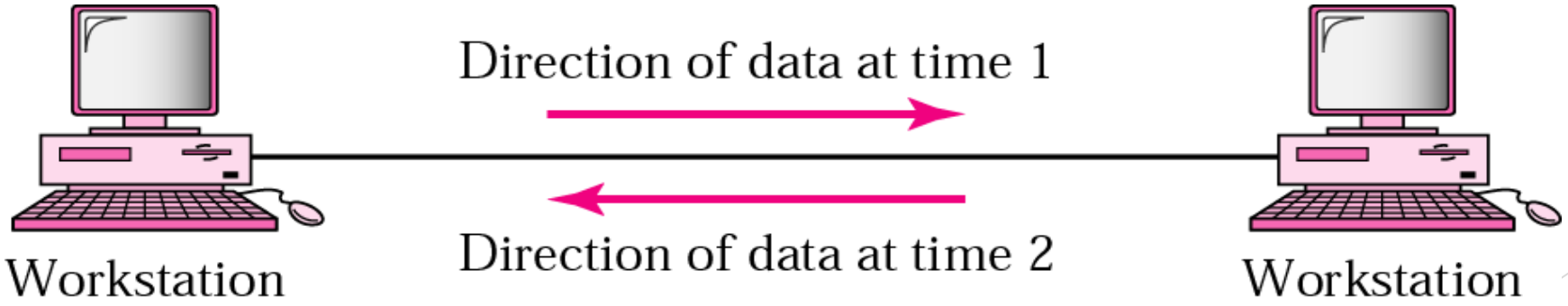
Simplex

In Simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit, the other can only receive. **Example:** Keyboard and traditional monitors. The keyboard can only introduce input, the monitor can only give the output.



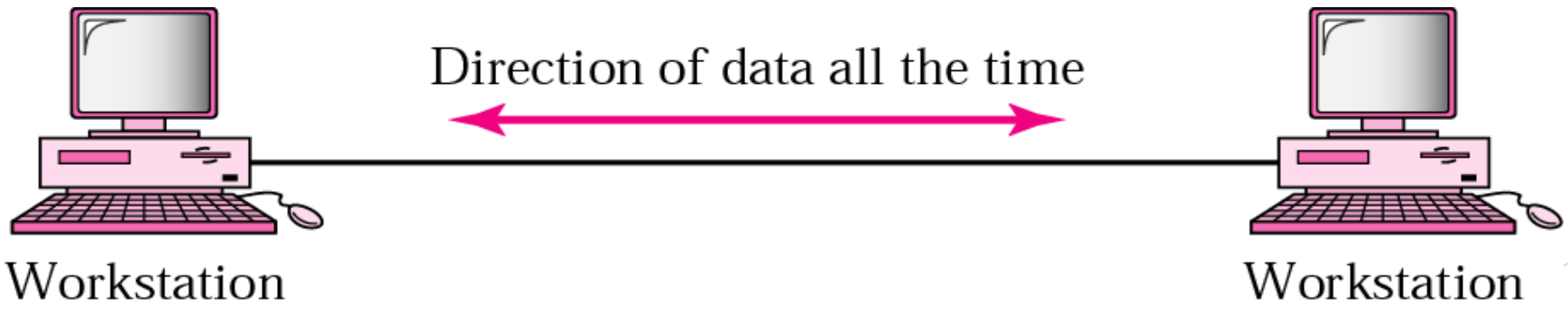
Half-duplex

In half-duplex mode, each station can both transmit and receive, but not at the same time. When one device is sending, the other can only receive, and vice versa. **Example:** Walkie- talkie in which message is sent one at a time and messages are sent in both the directions.



Full-duplex

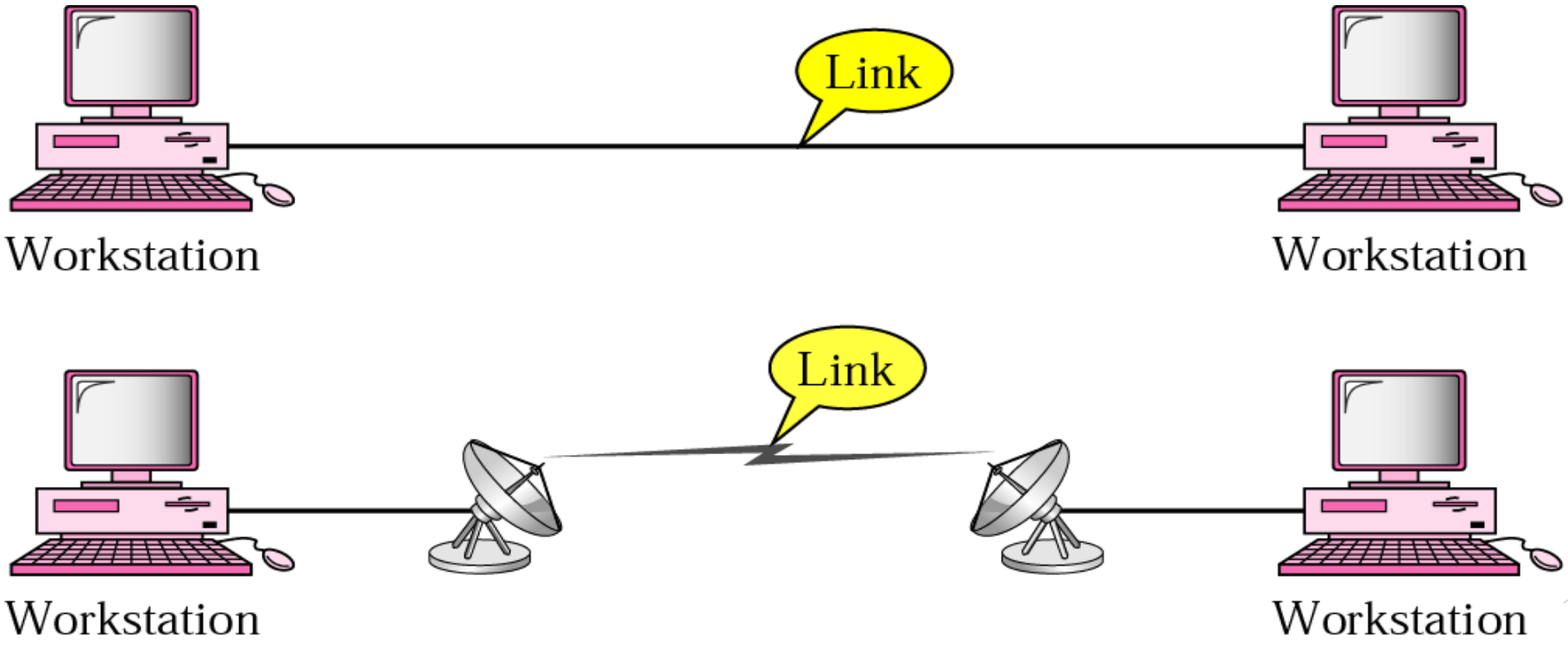
In full-duplex mode, both stations can transmit and receive simultaneously. **Example:** Telephone Network in which there is communication between two persons by a telephone line, through which both can talk and listen at the same time.



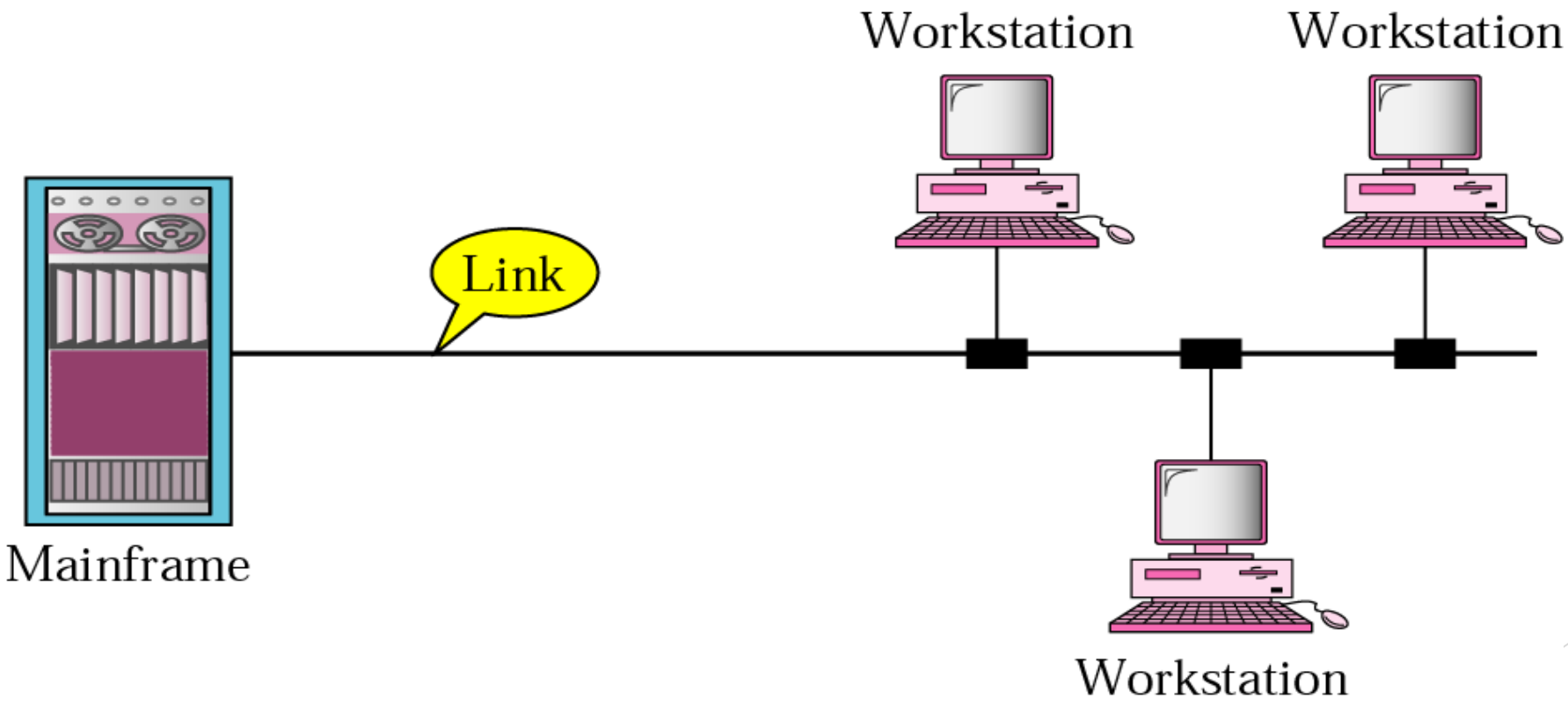
Types of Connection

1. **Point-to-point**
2. **Multi point**

Point-to-point connection



Multi Point Connection



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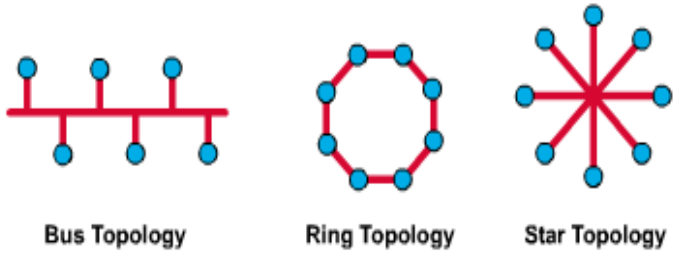
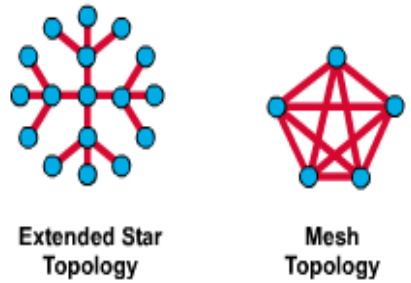
BASIS FOR COMPARISON	POINT-TO-POINT	MULTIPOINT
Link	There is dedicated link between two devices.	The link is shared between more than two devices.
Channel Capacity	The channel's entire capacity is reserved for the two connected devices.	The channel's capacity is shared temporarily among the devices connected to the link.
Transmitter and Receiver	There is a single transmitter and a single receiver.	There is a single transmitter and multiple receivers.
Example	Frame relay, T-carrier, X.25, etc.	Frame relay, token ring, Ethernet, ATM, etc.

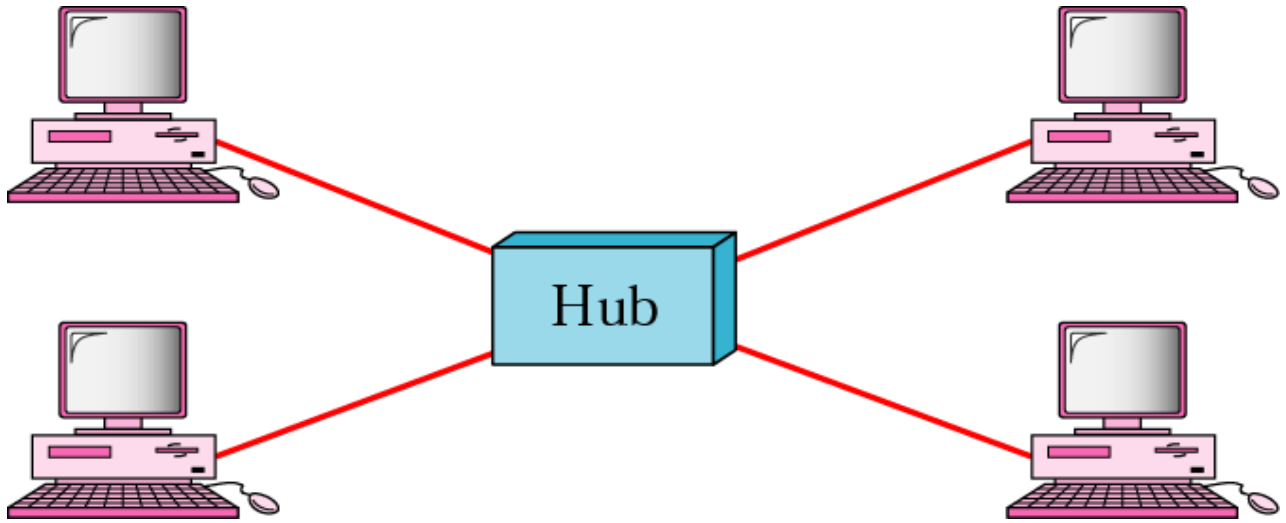
Network Topology

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





Star Topology



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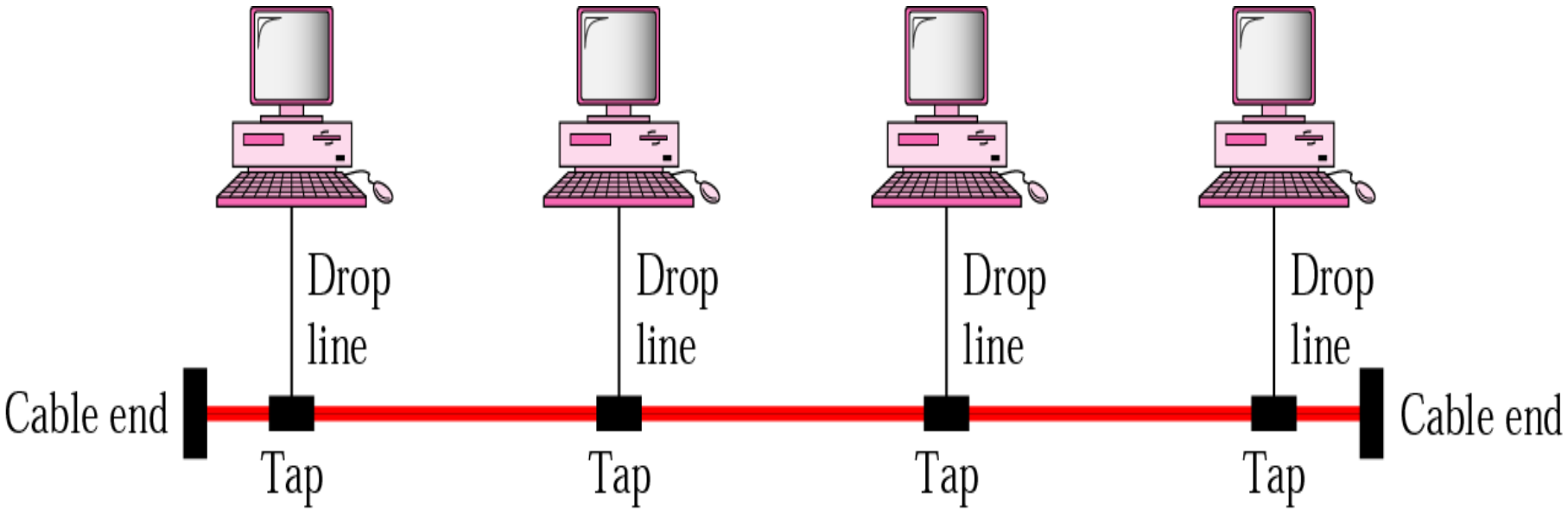
- In star topology a number of workstations are directly linked to a central node.
- Any communication between stations on a star LAN must pass through the central node.
- The central node controls all the activities of the nodes.

The advantages of the star topology are:

- It offers flexibility of adding or deleting of workstations from the network.
- Breakdown of one station does not affect the entire system

The major disadvantage of star topology is that failure of the central node disables communication throughout the whole network

Bus Topology



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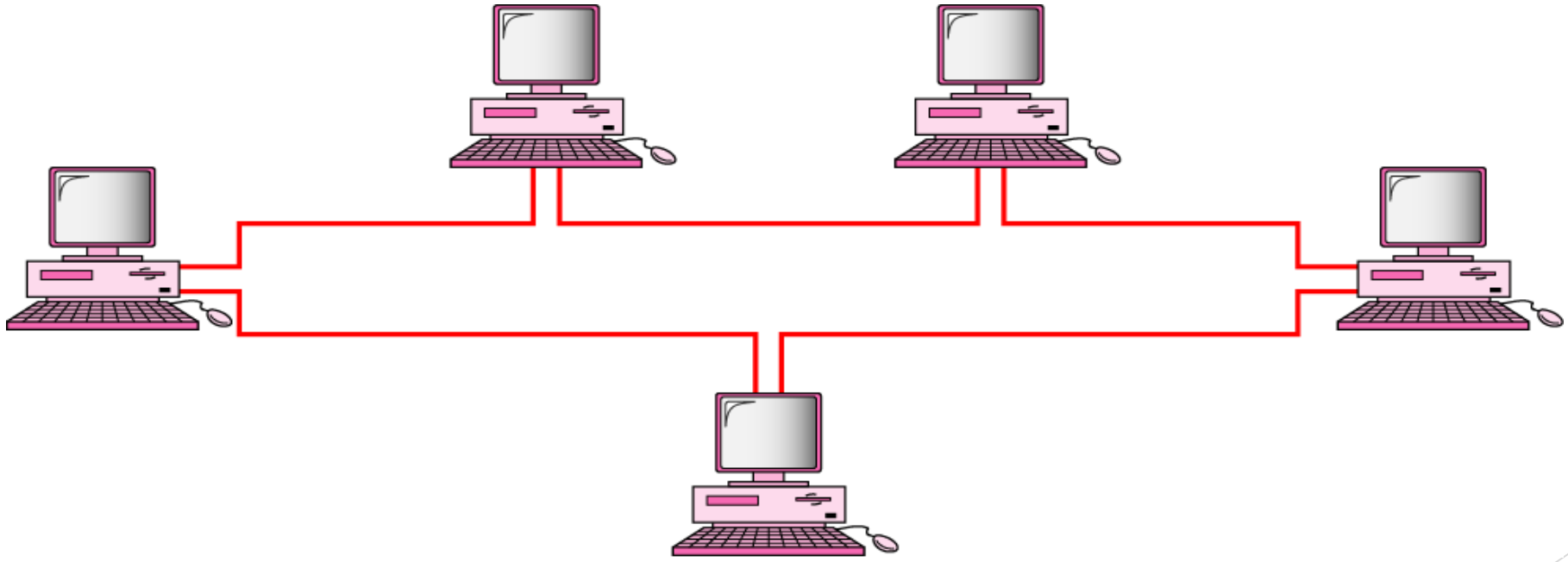
- In bus topology all workstations are connected to a single communication line called *bus*.
- There is no central node as in star topology.
- Transmission from any station travels the length of the bus in both directions and can be received by all workstations.

The advantage of the bus topology is that

- It is quite easy to set up.
- If one station of the topology fails it does not affect the entire system.

The disadvantage of bus topology is that any break in the bus is difficult to identify.

Ring Topology



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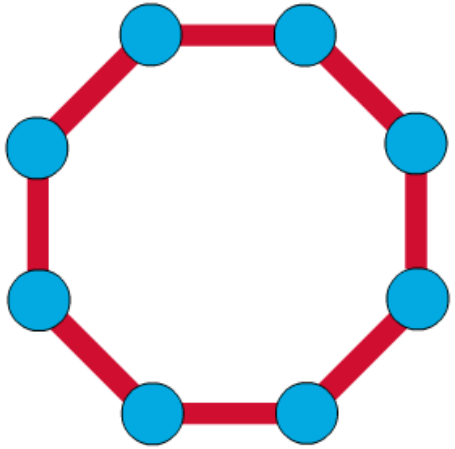
- In ring topology each station is attached to the nearby stations on a point to point basis so that the entire system is in the form of a ring.
- In this topology data is transmitted in one direction only.
- Thus the data packets circulate along the ring in either clockwise or anti-clockwise direction.

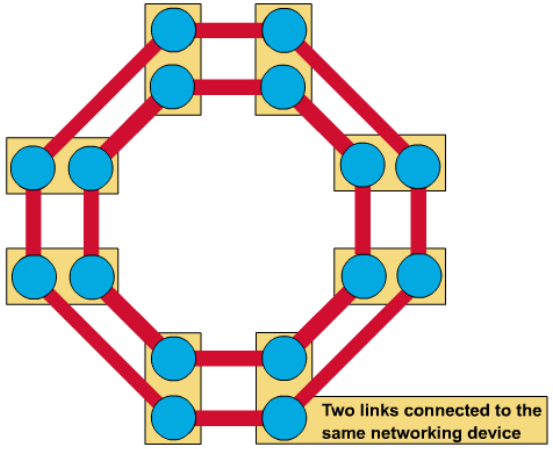
The advantage of this topology is that any signal transmitted on the network passes through all the LAN stations.

The disadvantage of ring network is that the breakdown of any one station on the ring can disable the entire system.

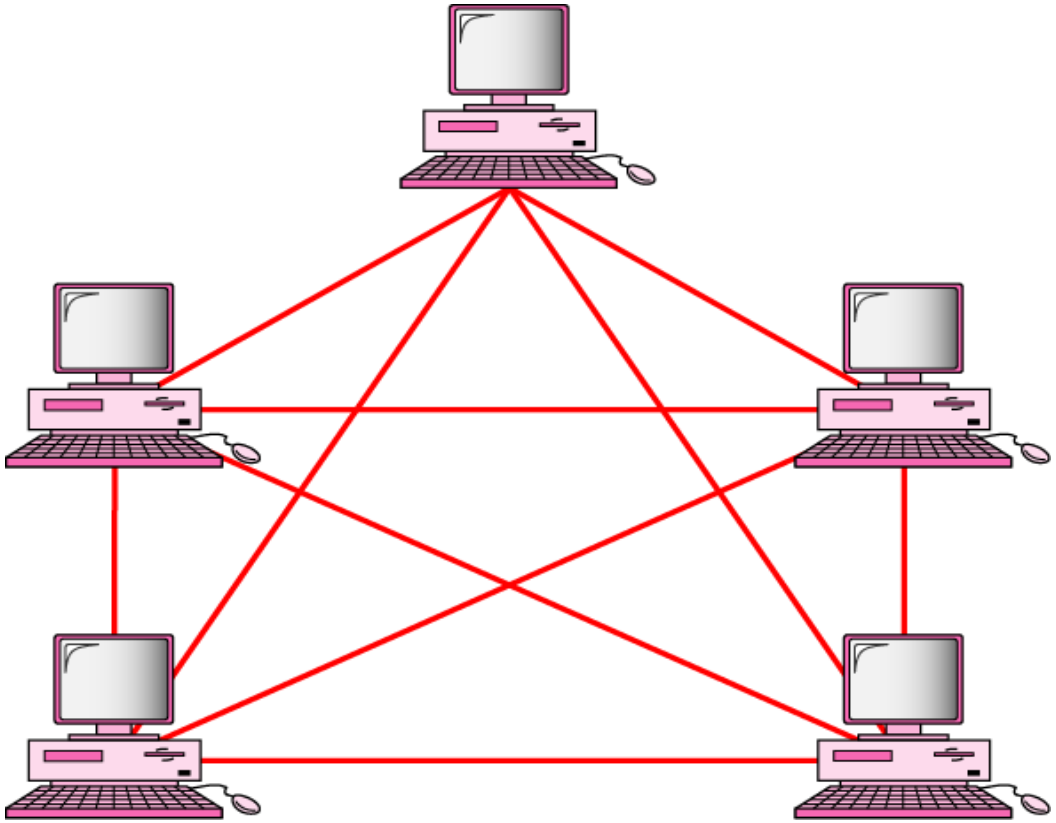
Continued..

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





Mesh Topology



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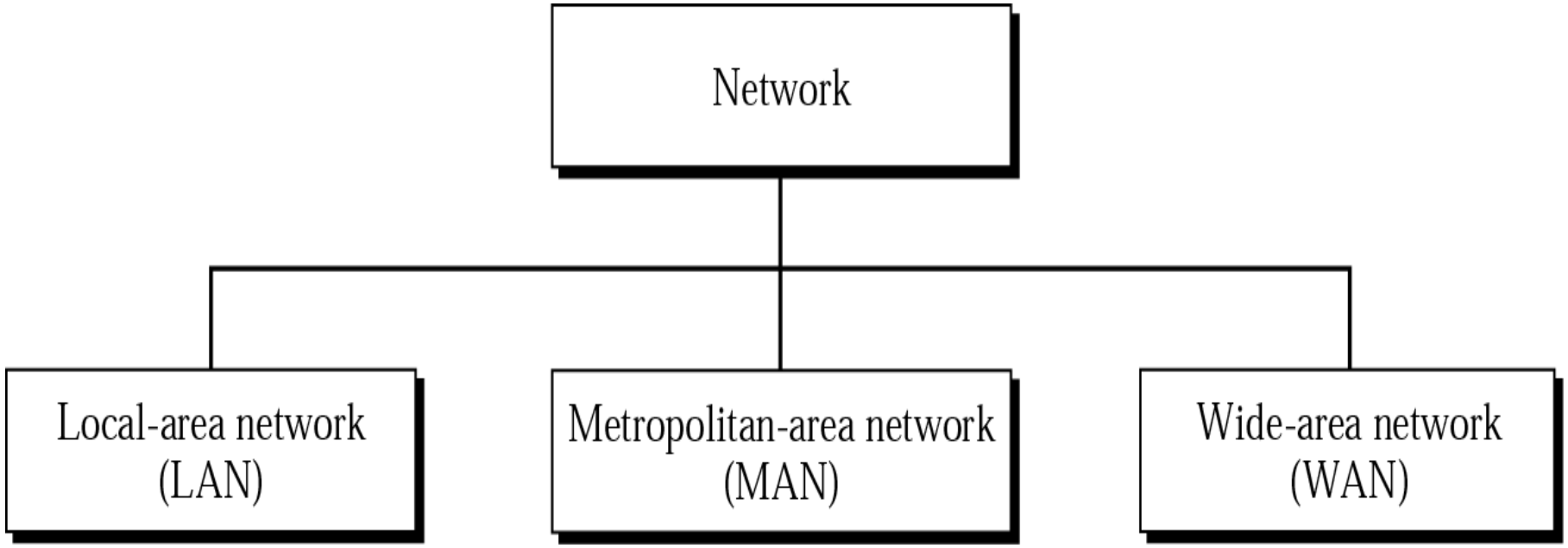
- The mesh topology connects all devices (nodes) to each other for redundancy and fault tolerance.
- It is used in WANs to interconnect LANs and for mission critical networks like those used by banks and financial institutions.
- Implementing the mesh topology is expensive and difficult.

Categories of Networks



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

LAN

- Networks used to interconnect computers in a single room, rooms within a building or buildings on one site are called Local Area Network (LAN).
- LAN transmits data with a speed of several megabits per second
- The transmission medium is normally coaxial cables.
- LAN links computers, in the same area for the purpose of sharing information.
- People working in LAN get more capabilities in data processing, work processing and other information exchange compared to stand-alone computers.

Use of LAN

1) File transfers and Access
2) Word and text processing
3) Electronic message handling
4) Remote database access
5) Personal computing
6) Digital voice transmission and storage

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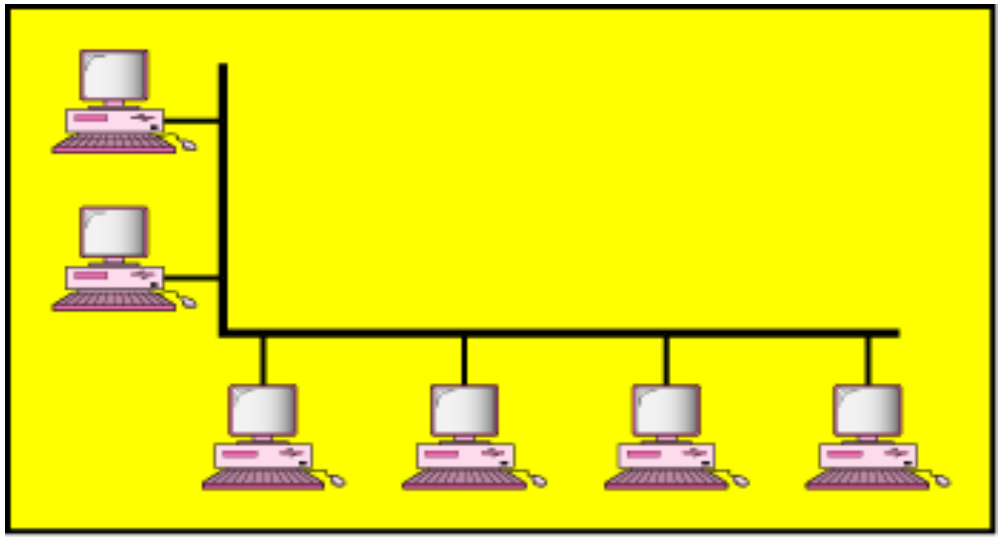

a. Single-building LAN

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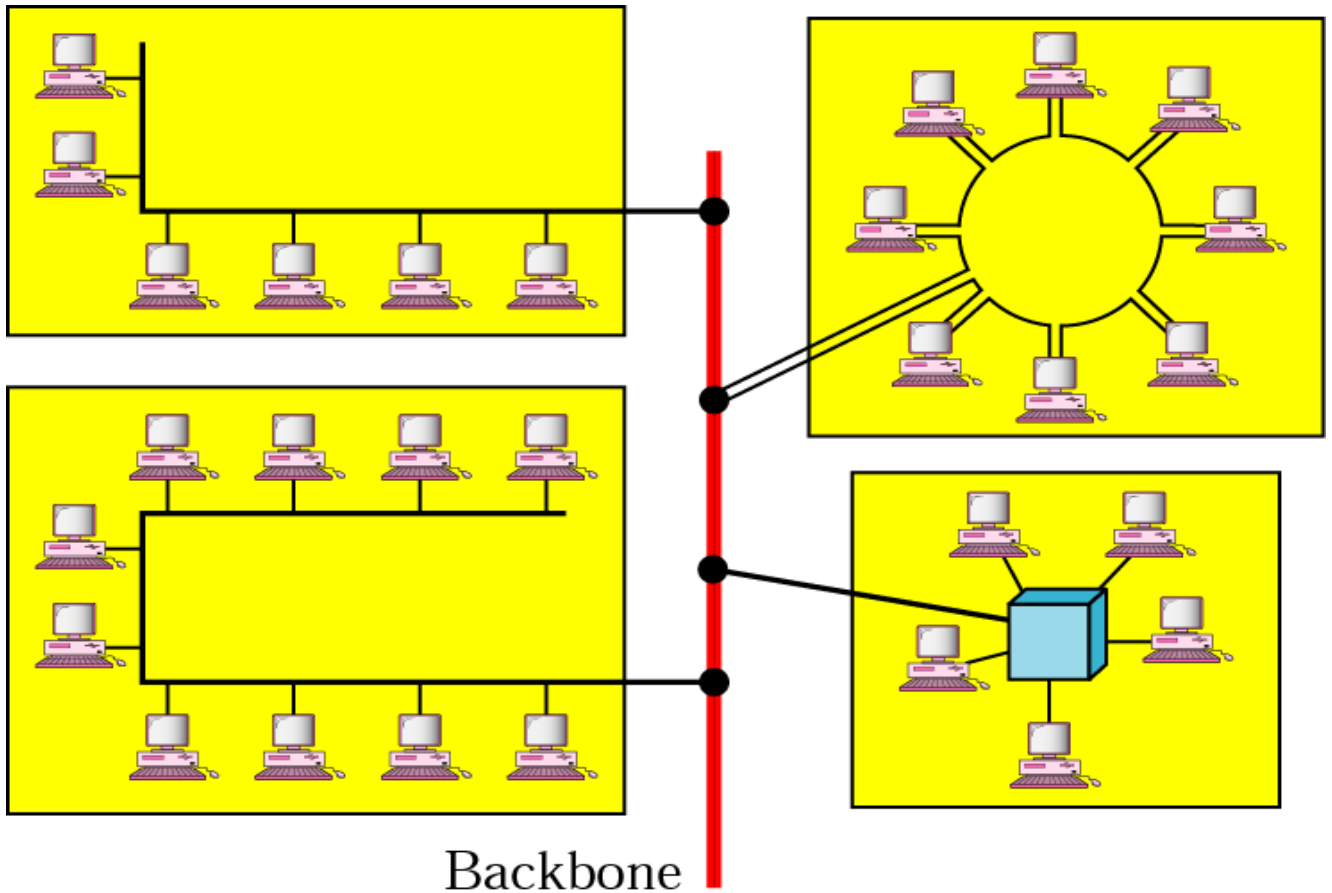

b. Multiple-building LAN

MAN

- A Metropolitan Area Network (MAN) is a larger network than LAN.
- It often covers multiple cities or towns.
- It is quiet expensive and a single organization may not have own it.

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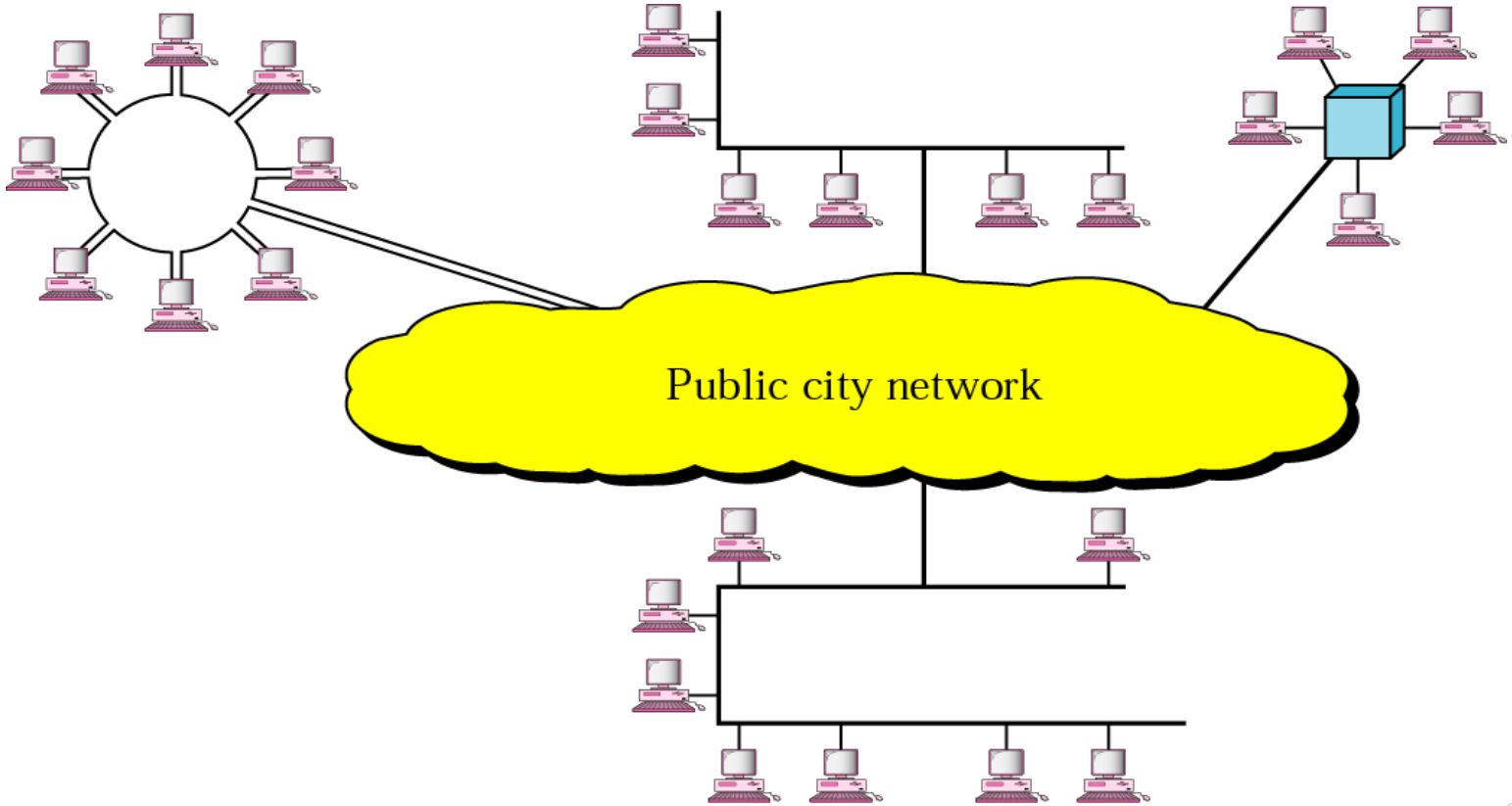

WAN

- The term Wide Area Network (WAN) is used to describe a computer network spanning a regional, national or global area.
- **Communication Facility**
- **Computer conferencing** is another use of WAN where users communicate with each other through their computer system.
- **Remote Data Entry** is possible in WAN. It means sitting at any location you can enter data, update data and query other information of any computer attached to the WAN
- **Centralized Information:** WAN permits collection of this data from different sites and save at a single site
- **Ethernet:** Ethernet developed by Xerox Corporation is a famous example of WAN

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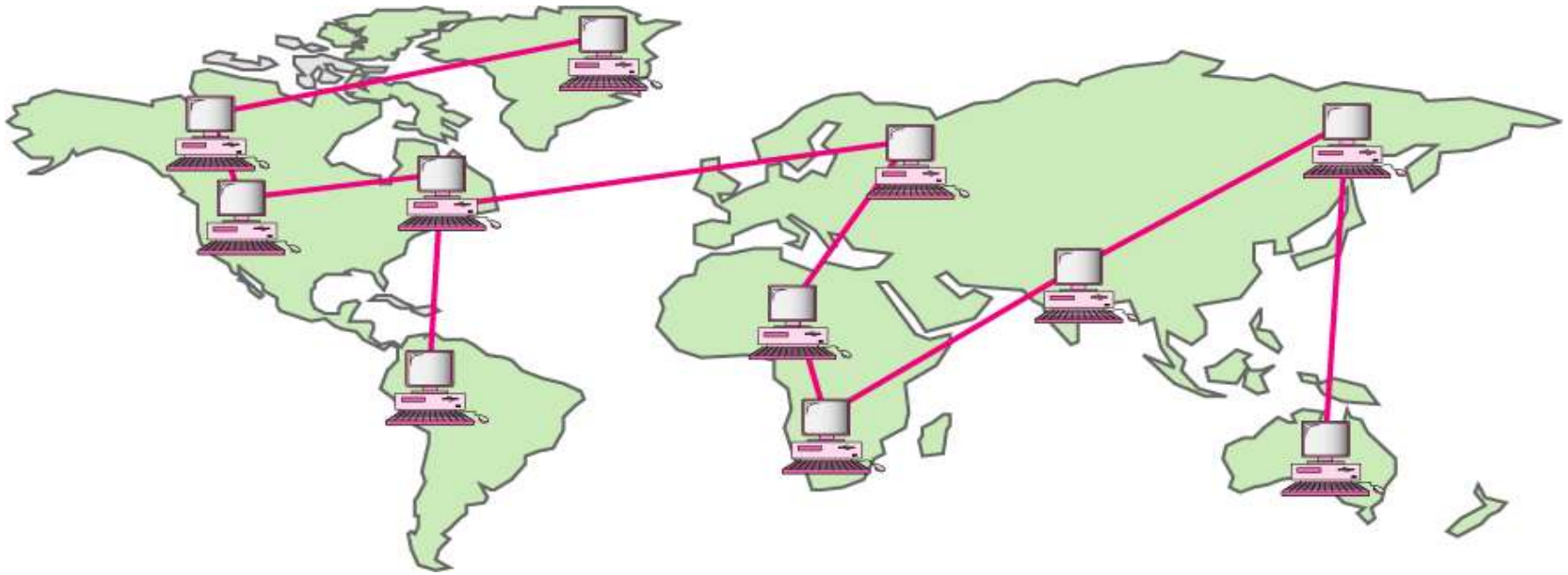
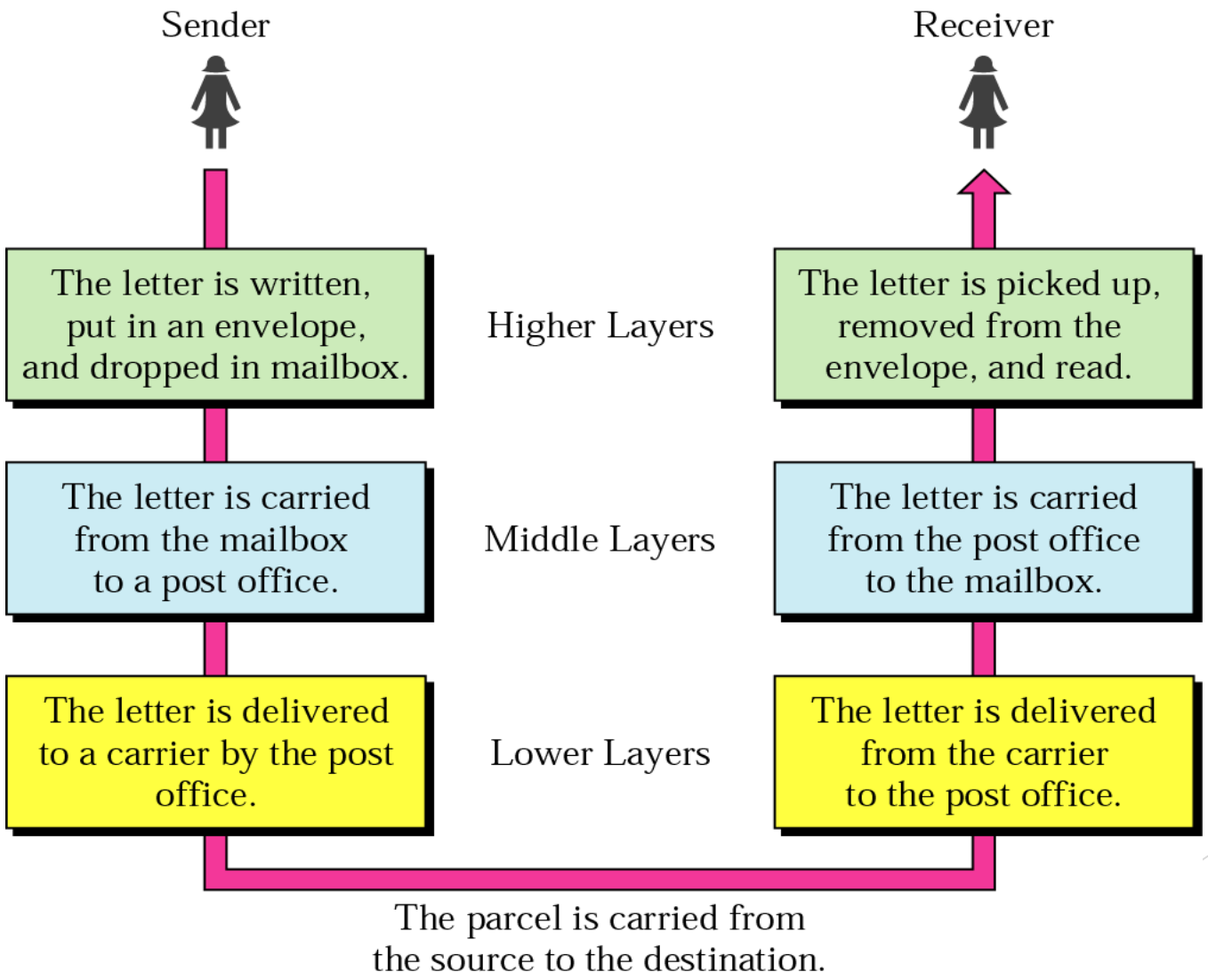
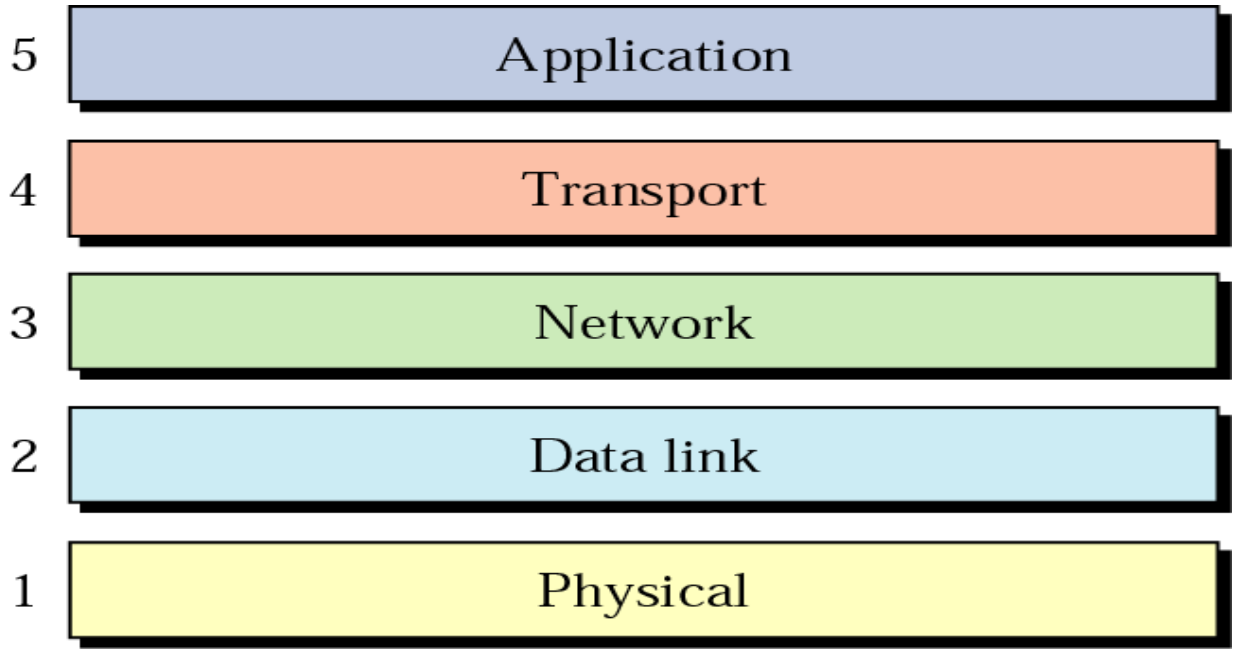


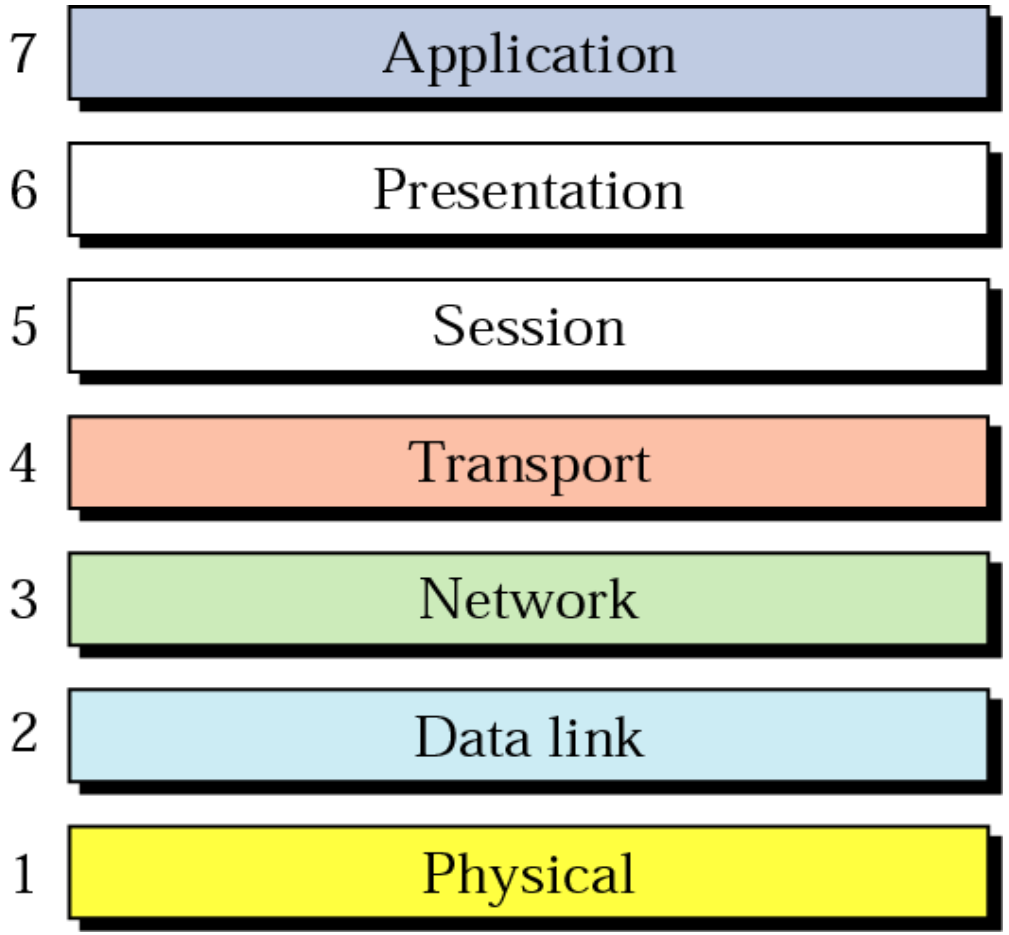
Network Models



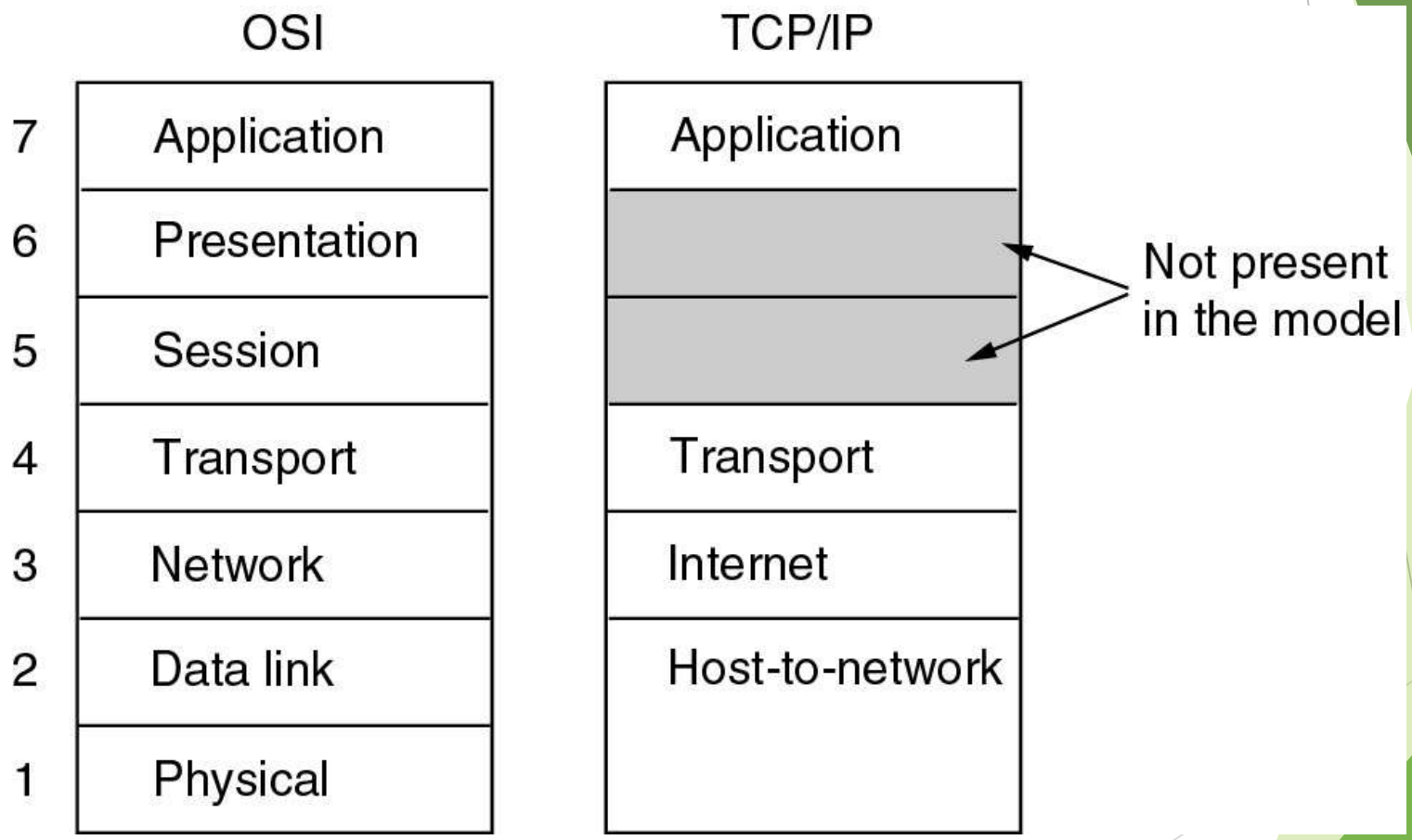
Internet Layers



OSI Model


7
Application
6
Presentation
5
Session
4
Transport
3
Network
2
Data link
1
Physical

Reference Models (2)



OSI Model

Physical layer	Deals with the mechanical and electrical specification of the interface and transmission media.
Data Link Layer	Transforms the physical layer, to a reliable link and is responsible for node-to-node delivery.
Network Layer	Responsible for the source-to-destination delivery of a packet across multiple links.

Continued..

Transport Layer	Responsible for the source-to-destination (end-to-end) delivery of the entire message.
Session Layer	It establishes, maintains and synchronizes the interaction between communicating systems.
Presentation Layer	It concerns with the syntax and semantics of the information between two systems.

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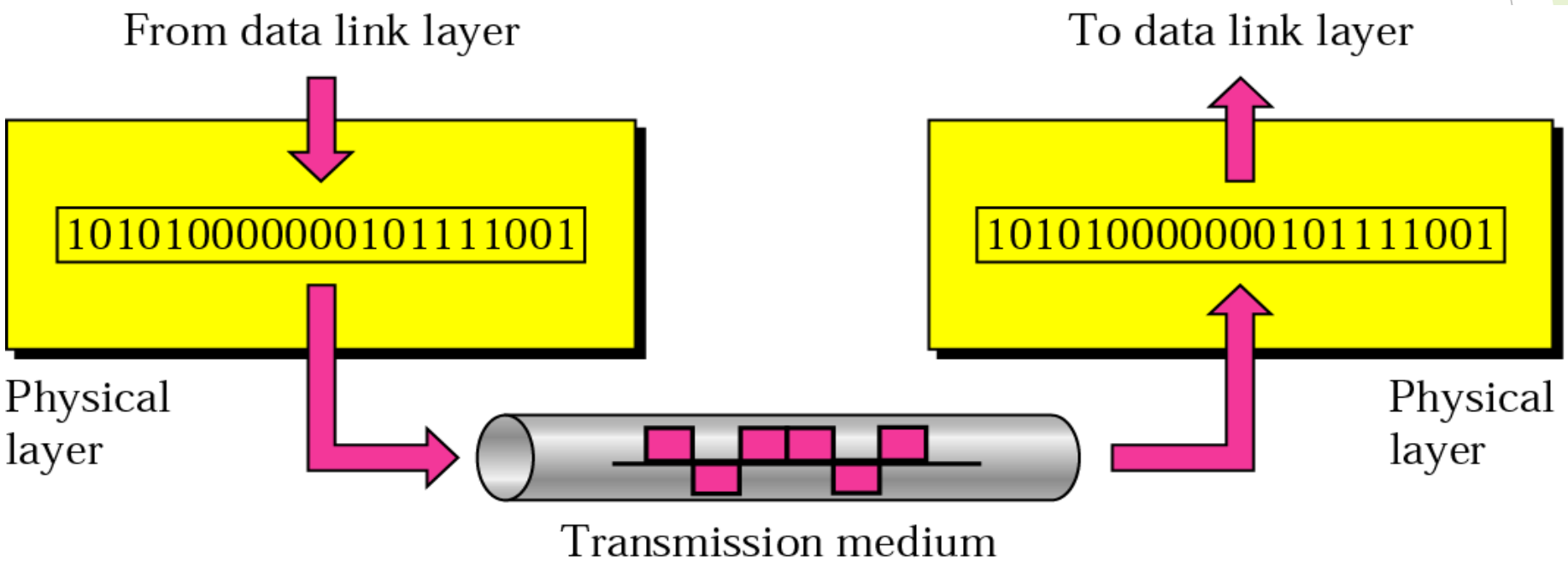
Application Layer	It provides user interfaces and support for services such as E-Mail, Remote Login and other types of Distributed Information Services.

Physical Layer

The physical layer is responsible for transmitting individual bits from one node to the next.



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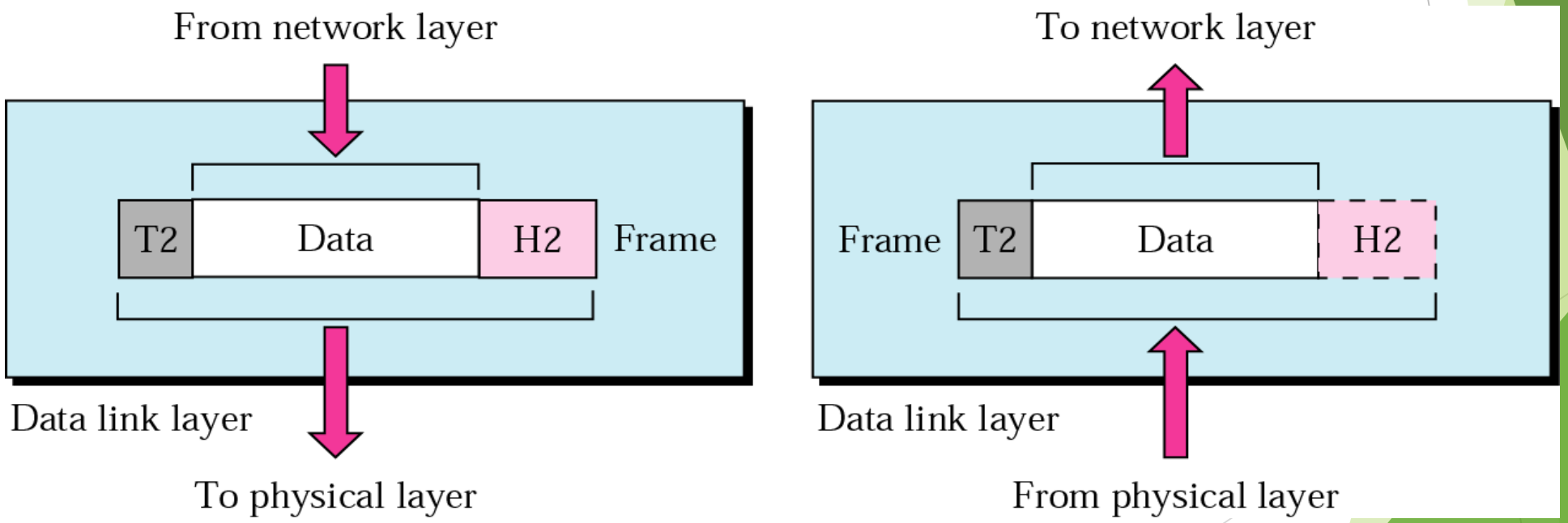
Responsibilities of Physical Layer :-

- Physical Characteristics of interfaces and medium
- Representation of bits
- Data rate
- Synchronization of bits
- Line configuration
- Physical topology
- Transmission mode

Data Link Layer

The data link layer is responsible for transmitting frames from one node to the next.



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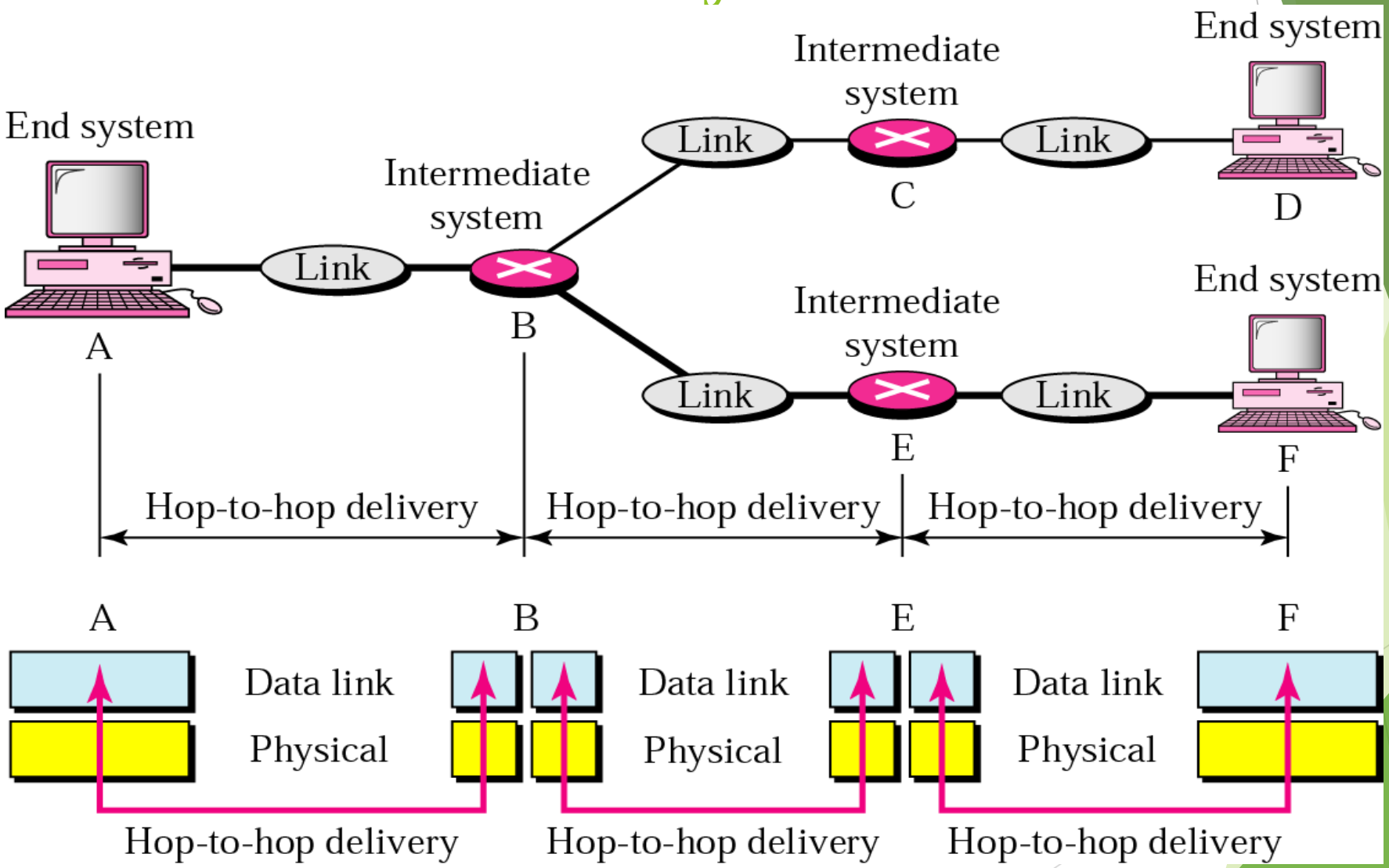
Responsibilities of Data Link Layer :-

- Framing
- Physical Addressing
- Flow Control
- Error Control
- Access Control

Node to Node Delivery



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Example

- In Figure, a node with physical address 10 sends a frame to a node with physical address 87.
- The two nodes are connected by a link. At the data link level this frame contains physical addresses in the header. These are the only addresses needed.
- The rest of the header contains other information needed at this level. The trailer usually contains extra bits needed for error detection

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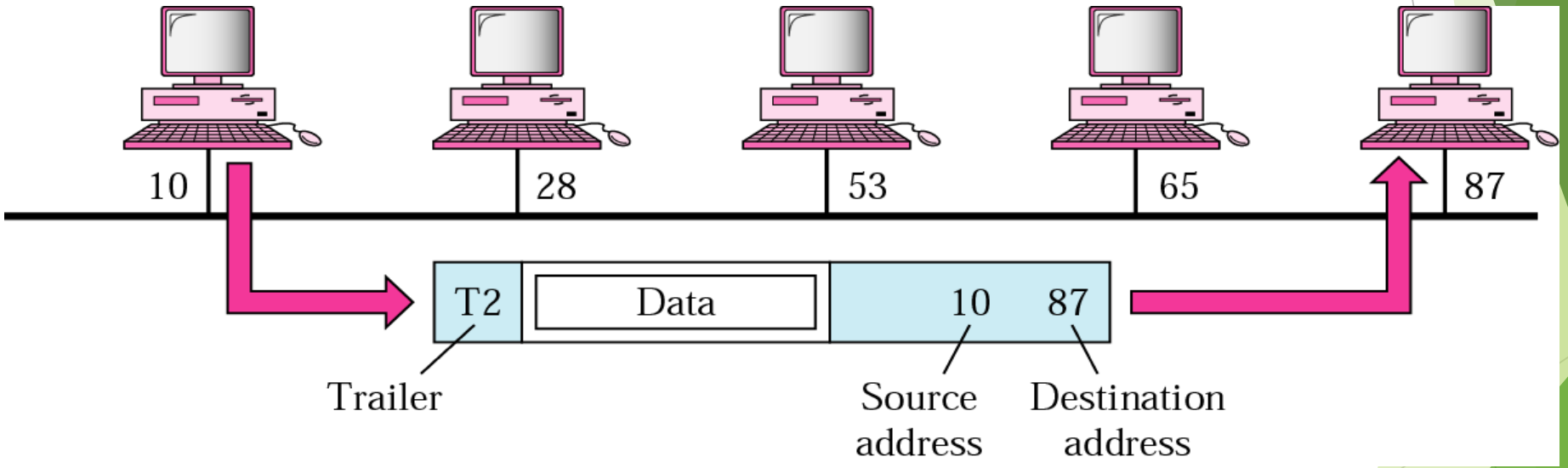
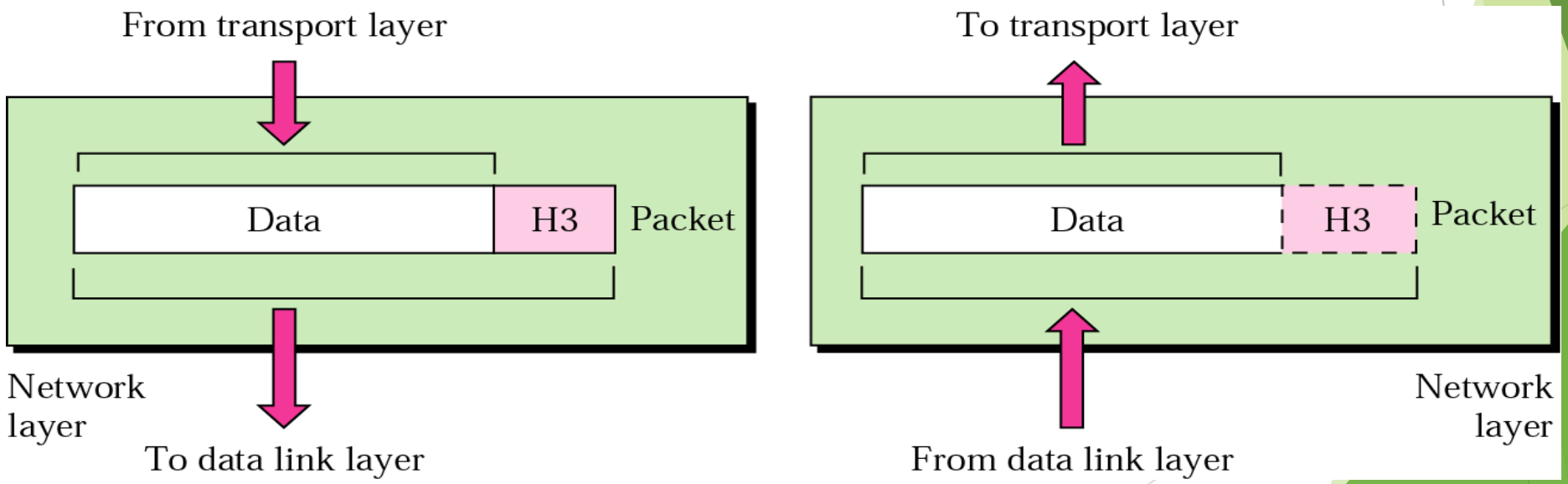
Example



Network Layer

The network layer is responsible for the delivery of packets from the original source to the final destination.



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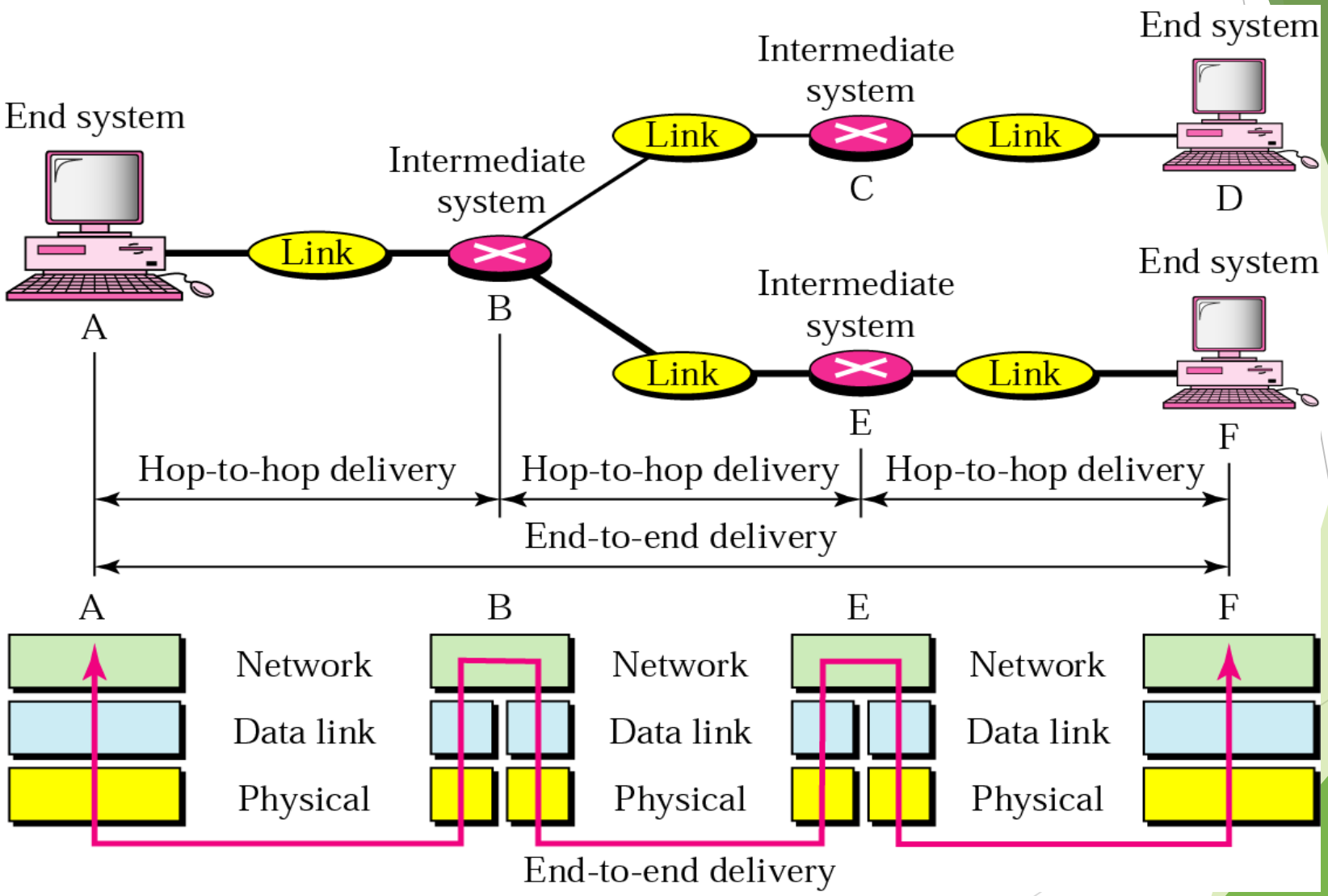
Responsibilities of Network Layer :-

•Logical Addressing

•Routing

Source – to - Destination



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Example

- In Figure, we want to send data from a node with network address A and physical address 10, located on one LAN, to a node with a network address P and physical address 95, located on another LAN.
- Because the two devices are located on different networks, we cannot use physical addresses only; the physical addresses only have local jurisdiction.
- What we need here are universal addresses that can pass through the LAN boundaries. The network (logical) addresses have this characteristic.

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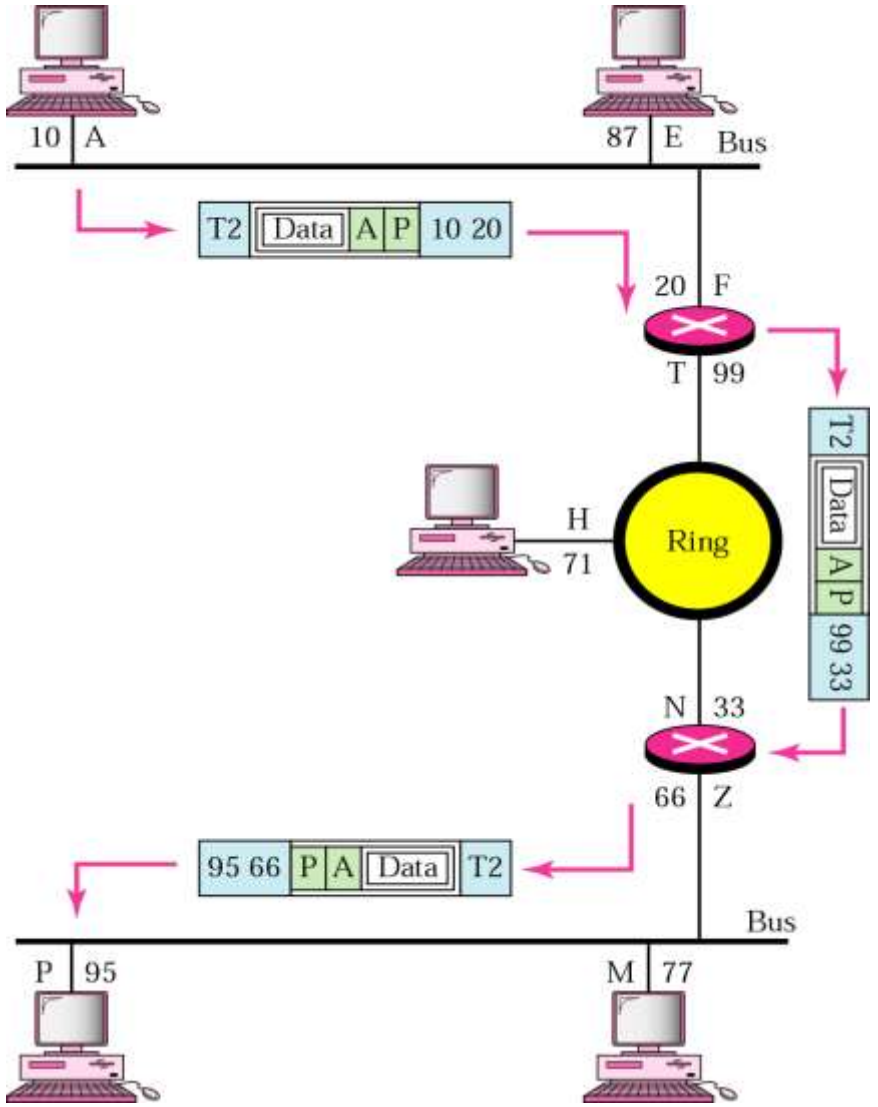
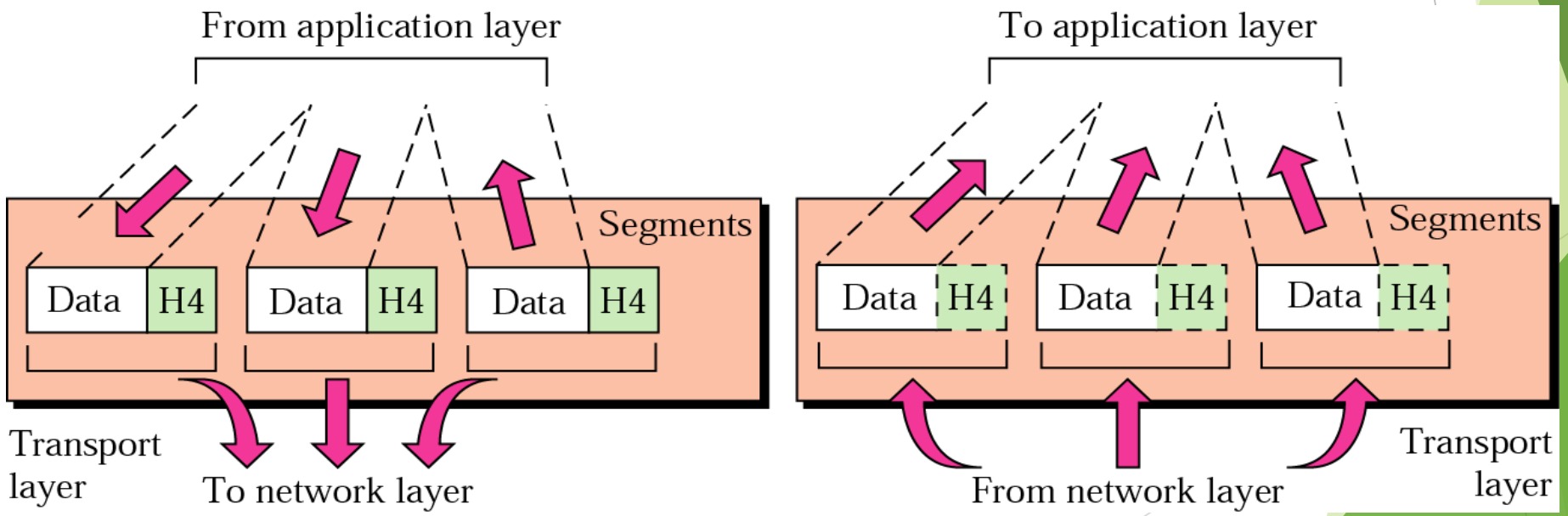
Example



Transport Layer

The transport layer is responsible for delivery of a message from one process to another.



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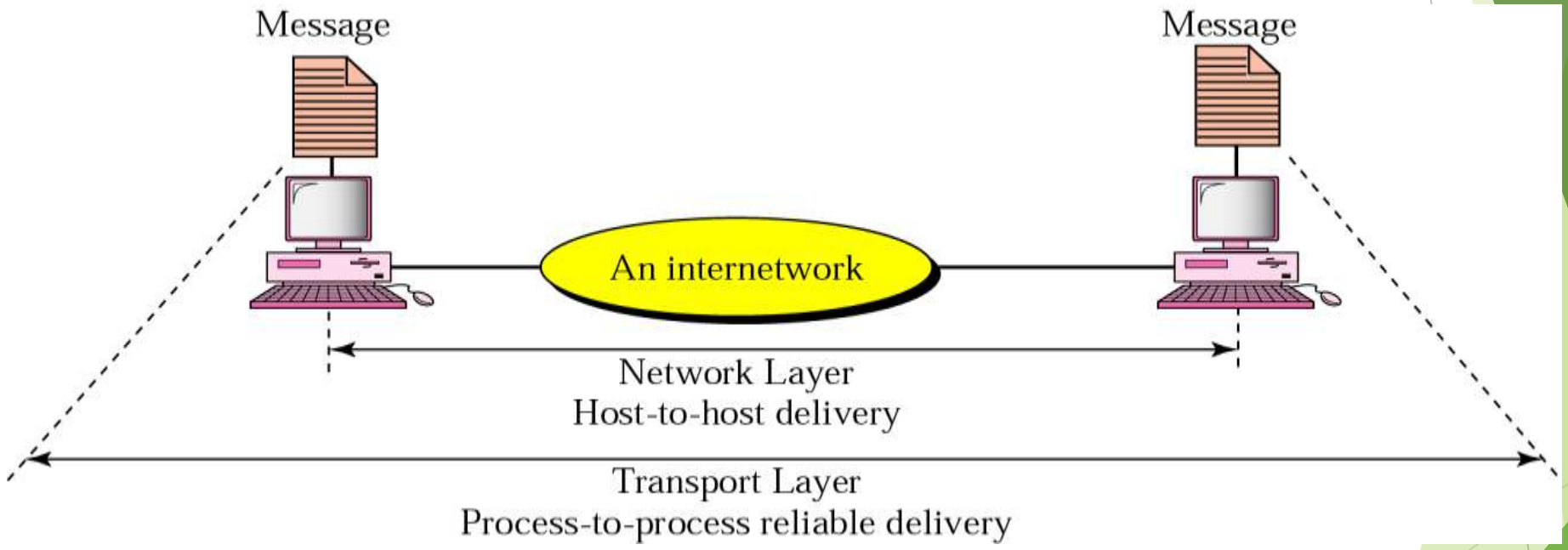
Responsibilities of Transport Layer :-

- Service-point addressing
- Segmentation and reassembly
- Connection control
- Flow control
- Error Control

Process to Process



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Example

- Figure, shows an example of transport layer communication. Data coming from the upper layers have port addresses j and k (j is the address of the sending process, and k is the address of the receiving process).
- Since the data size is larger than the network layer can handle, the data are split into two packets, each packet retaining the port addresses (j and k). Then in the network layer, network addresses (A and P) are added to each packet.

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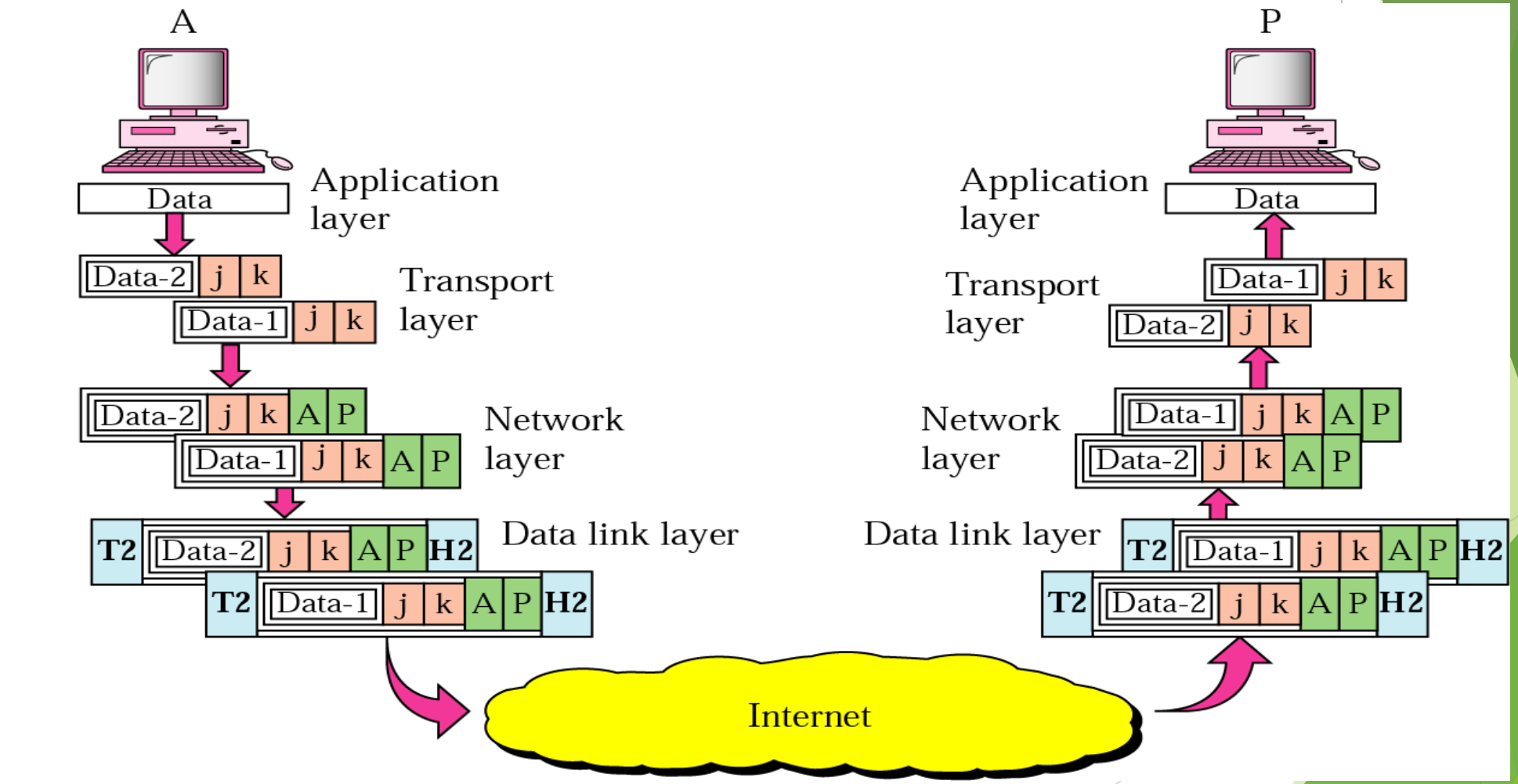
Example



Session Layer

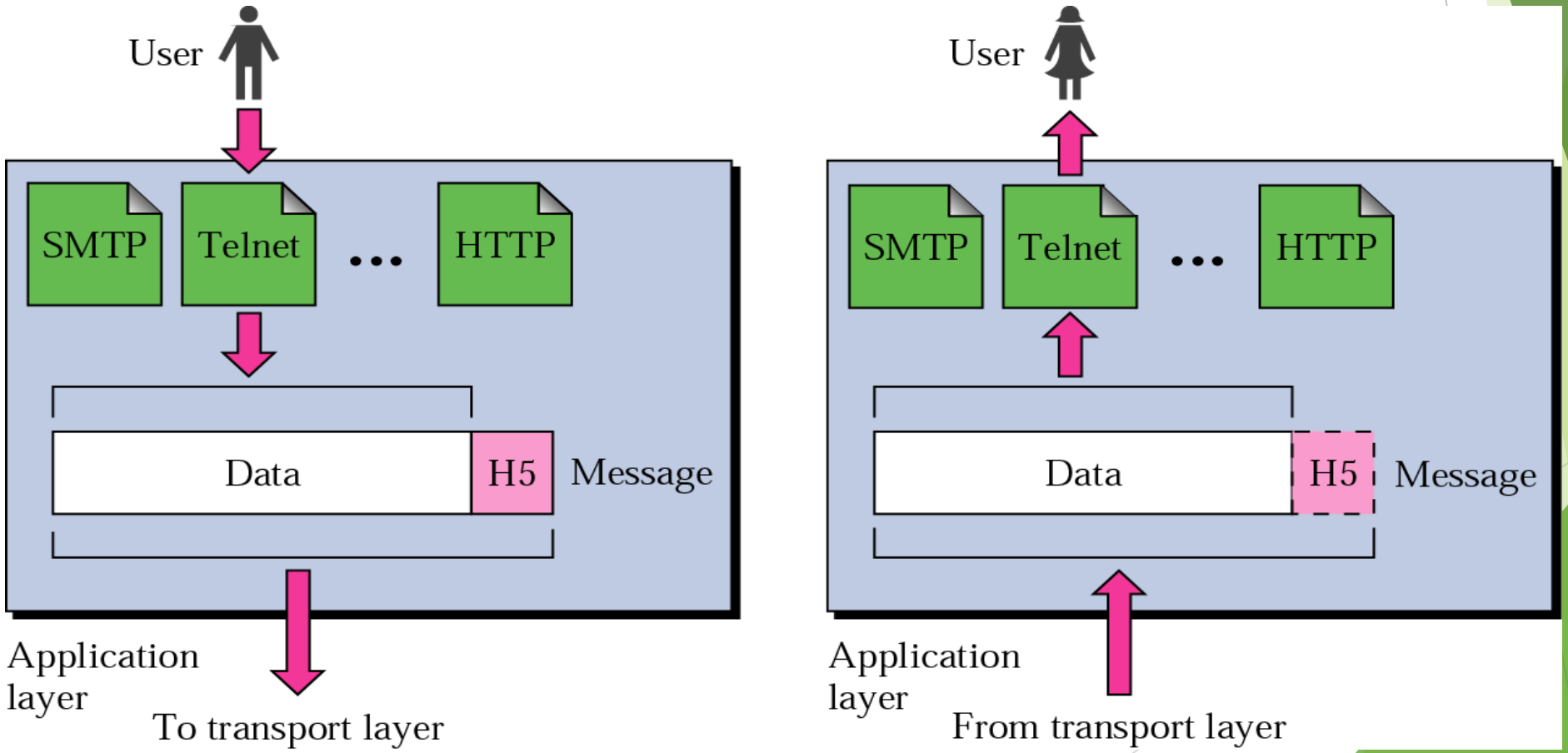
The session layer is responsible for dialog control and synchronization.

Presentation Layer

The presentation layer is responsible for translation, compression, and encryption.

Application Layer

The application layer is responsible for providing services to the user.



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Services provided by the Application Layer :-

- Network virtual terminal
- File transfer, access and management
- Mail services
- Directory services

Network Devices

- Repeater
- Hub
- Bridge
- Switch
- Router
- Gateways
- Brouter

Repeater

- A repeater operates at the physical layer.
- Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network.
- An important point to be noted about repeaters is that they do not amplify the signal. When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength.
- It is a 2 port device.

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- A repeater connects different segments of a LAN
- A repeater forwards every bit it receives
- A repeater is a regenerator, not an amplifier
- It can be used to create a single extended LAN

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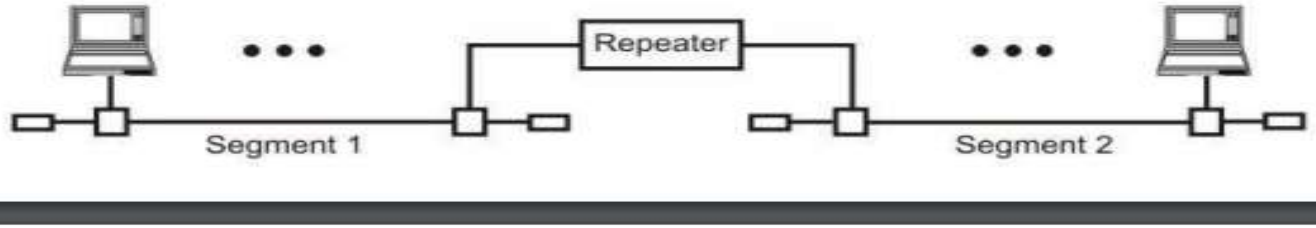
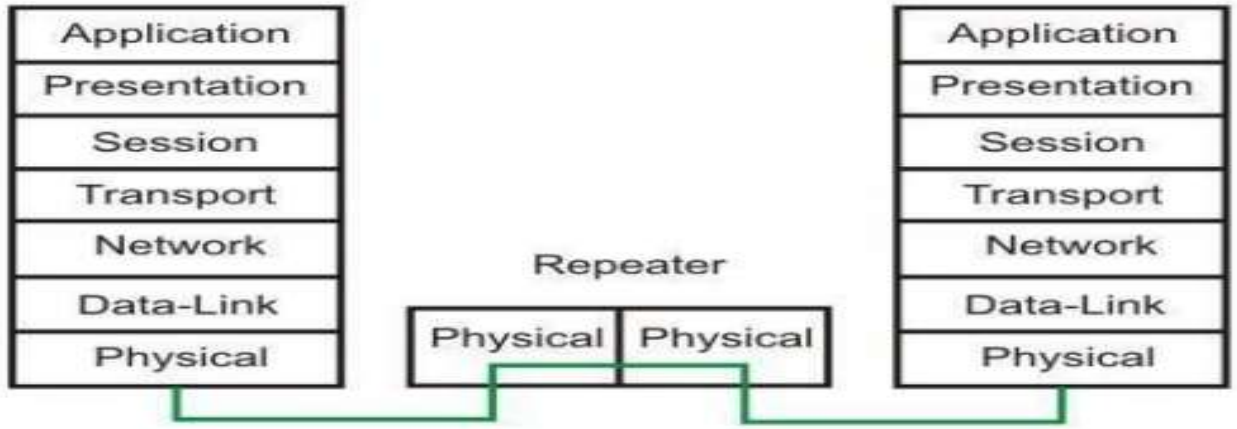

Repeater
Segment 1
Segment 2


Application
Presentation
Session
Transport
Network
Data-Link
Physical
Repeater
Physical
Physical
Application
Presentation
Session
Transport
Network
Data-Link
Physical

HUB

- A hub is basically a multiport repeater.
- A hub connects multiple wires coming from different branches, for example, the connector in star topology which connects different stations.
- Hubs cannot filter data, so data packets are sent to all connected devices.
- Also, they do not have the intelligence to find out best path for data packets which leads to inefficiencies and wastage.

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Types of Hub

- **Active Hub:-** These are the hubs which 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 wiring centre. These are used to extend the maximum distance between nodes.
- **Passive Hub :-** These are the hubs which collect wiring from nodes and power supply from 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 :-** It work like active hubs and include 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.

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- A hub is used to connect workstations and peripheral devices to the network, each being plugged into one of the hub’s ports.
- A hub receives a signal from one port and passes the signal on to all of its other ports and therefore to all devices and workstation that are attached to the hub.
- A hub is sometimes called a multi-port repeater.

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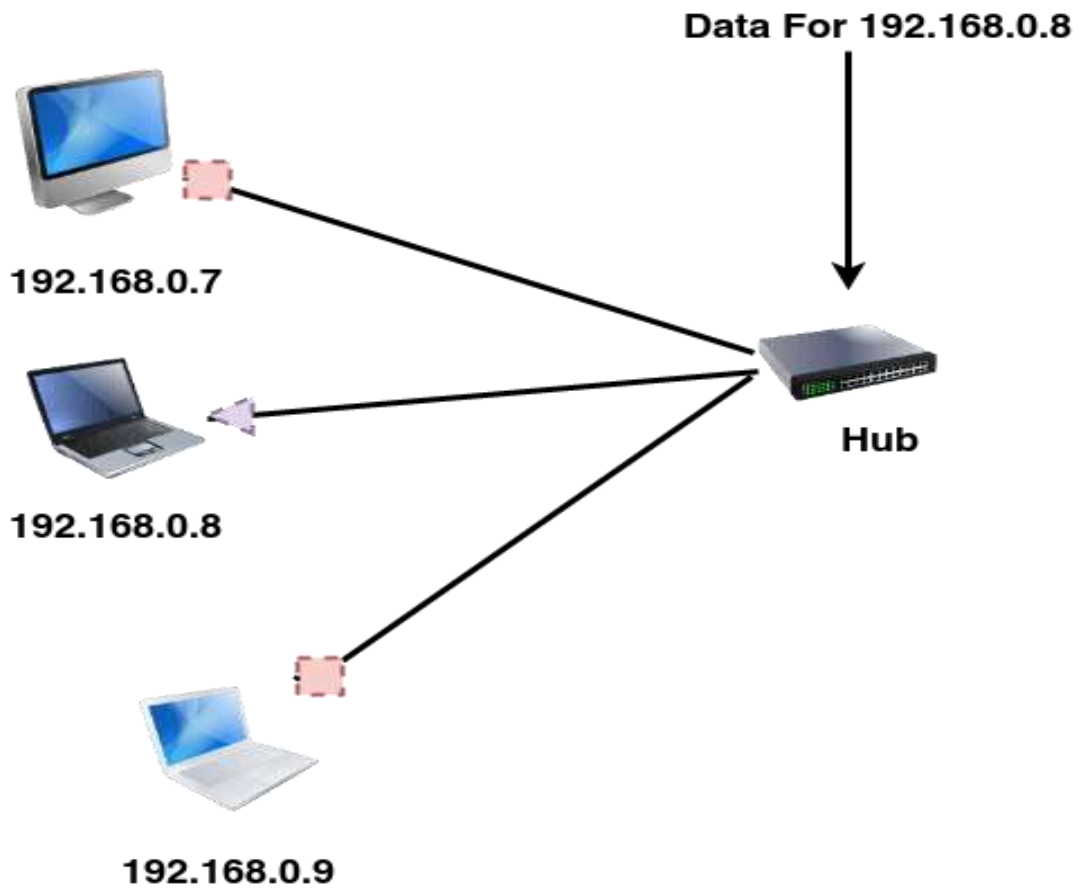

Bridge

- A bridge operates at data link layer.
- A bridge is a repeater, with add on functionality of filtering content by reading the MAC addresses of source and destination.
- It is also used for interconnecting two LANs working on the same protocol.
- It has a single input and single output port, thus making it a 2 port device.
- Because a bridge sends messages only to the part of the network on which the destination node exists, it results in reduced network traffic and fewer message bottlenecks.

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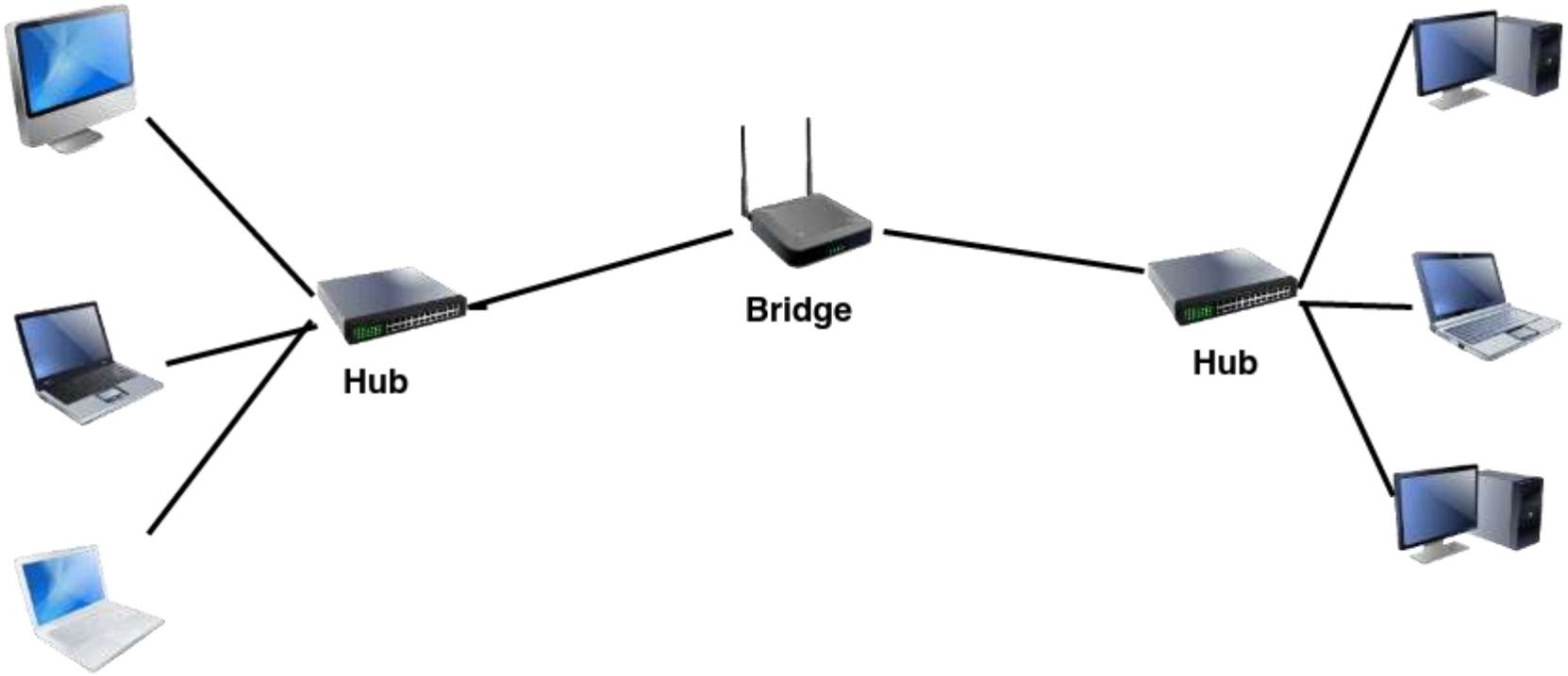

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Types of Bridges

- **Transparent Bridges:-** These are the bridge in which the stations are completely unaware of the bridge's existence (i.e. whether or not a bridge is added or deleted from the network).
- **Source Routing Bridges:-** In these bridges, routing operation is performed by source station and the frame specifies which route to follow.

Switch

- A switch is a multiport bridge with a buffer and a design that can boost its efficiency and performance.
- A switch is a data link layer device.
- The switch can perform error checking before forwarding data, that makes it very efficient as it does not forward packets that have errors and forward good packets selectively to correct port only.
- The primary difference between a hub and a switch is that a switch does not broadcast an incoming message to all ports, but instead sends the message out only to the port on which the addressee workstation exists, based on a MAC table.

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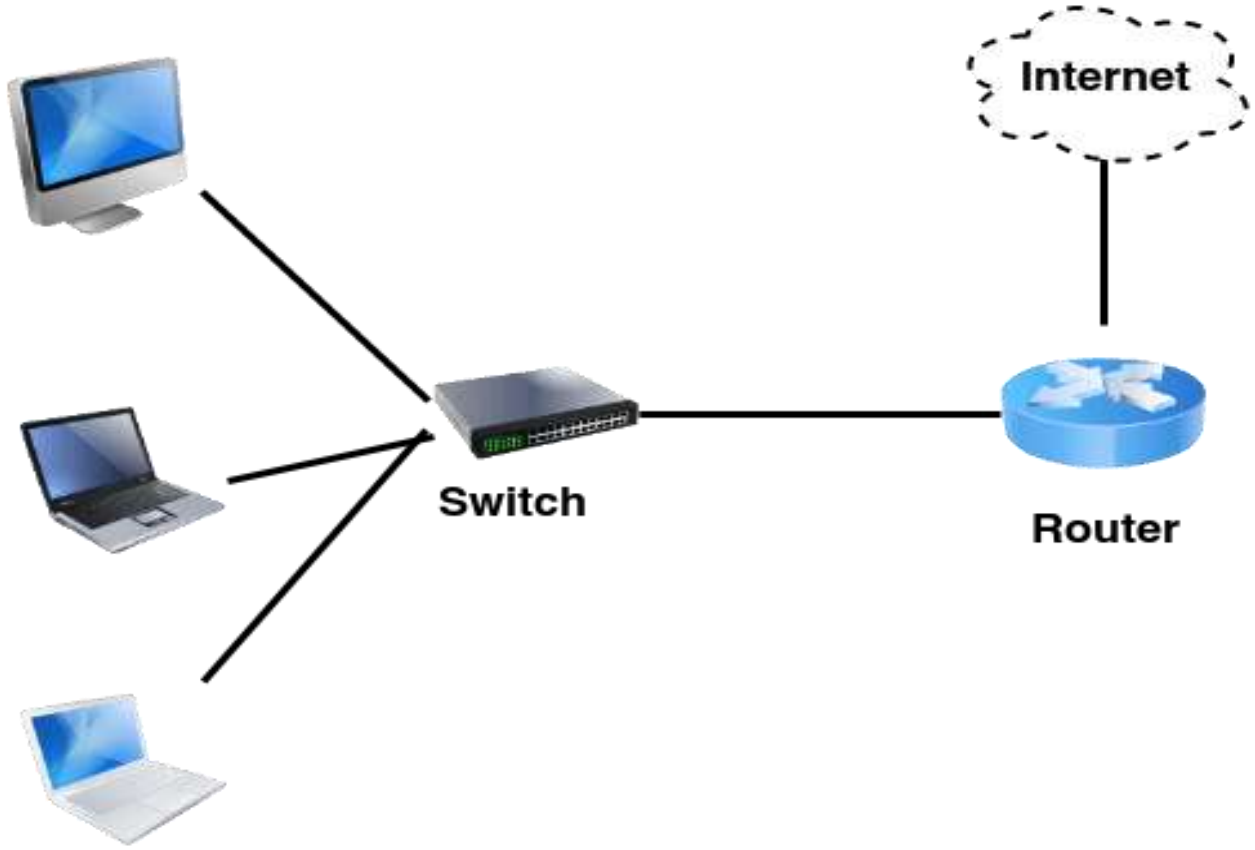

Router

- A router is a device like a switch that routes data packets based on their IP addresses.
- Router is mainly a Network Layer device.
- Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets.
- A router sends data across networks using the logical or network address of a message.

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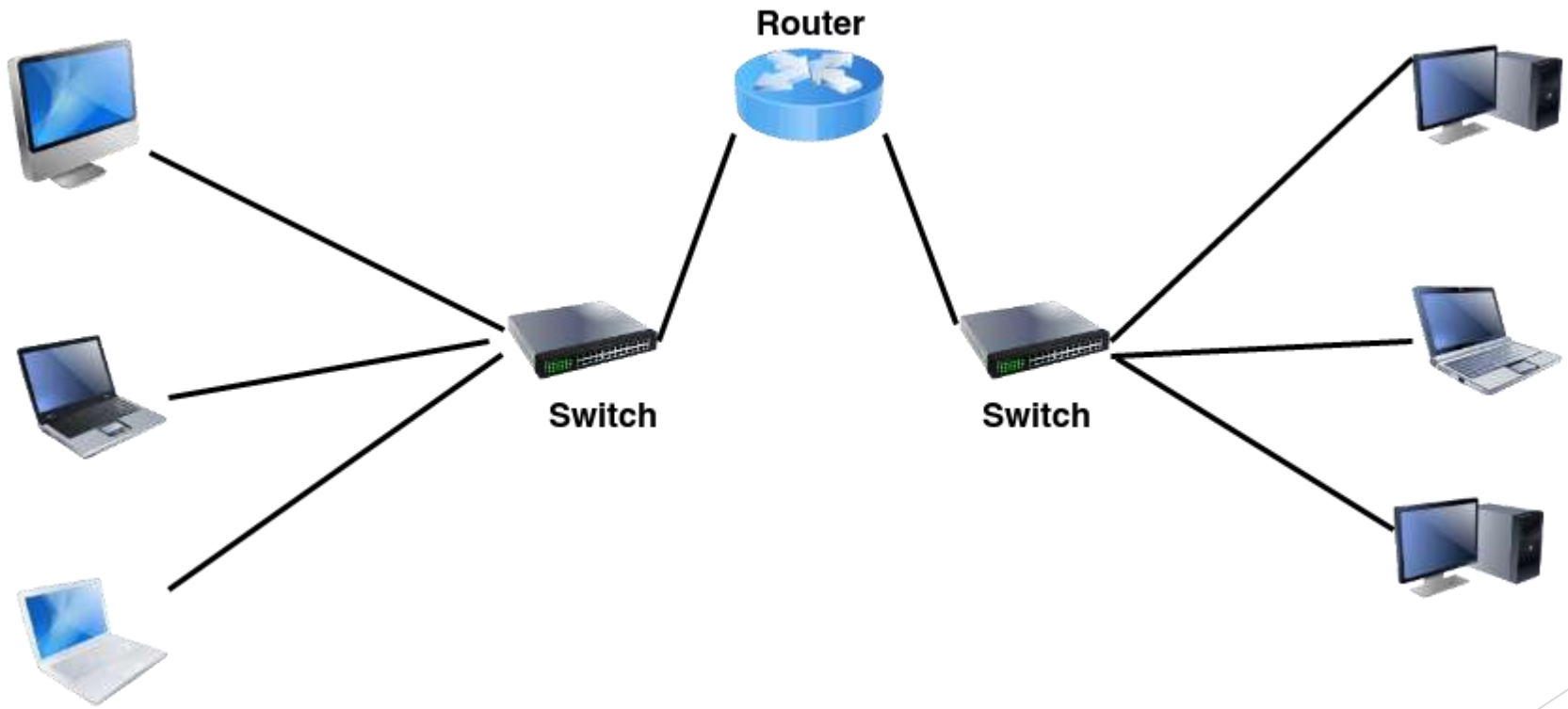

Gateway

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

Brouter

- It is also known as bridging router.
- It combines features of both bridge and router.
- It can work either at data link layer or at network layer.
- Working as router, it is capable of routing packets across networks and working as bridge, it is capable of filtering local area network traffic.

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Hub	Switch
Hub is operated on Physical layer.	While switch is operated on Data link layer.
Hub is a broadcast type transmission.	While switch is a Unicast, multicast and broadcast type transmission.
In hub, there is only one collision domain.	While in switch, different ports have own collision domain.
Hub is a half duplex transmission mode.	While switch is a full duplex transmission mode.
In hub, Packet filtering is not provided.	While in switch, Packet filtering is provided.
Hub is not an intelligent device hence it is comparatively inexpensive.	While switch is an intelligent device so it is expensive.
Hub is simply old type of device and is not generally used.	While switch is very sophisticated device and widely used.

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Bridge	Router
Bridge works in data link layer.	While Router works in network layer.
There are only two ports in bridge.	While there are more than two ports in router.
Bridge connects two different LANs.	While router is used by LAN as well as MAN for connection.
In bridge, routing table is not used.	While in routers, routing table is used.
Bridge focuses on MAC address .	While Router focuses on protocol address.
Bridge is comparatively inexpensive.	While Router is relatively expensive device.
Bridges are good for segment network and extends the existing network.	While Routers are good for joining remote networks.

Thank You