

# Unit III

Network Devices and Network Layer

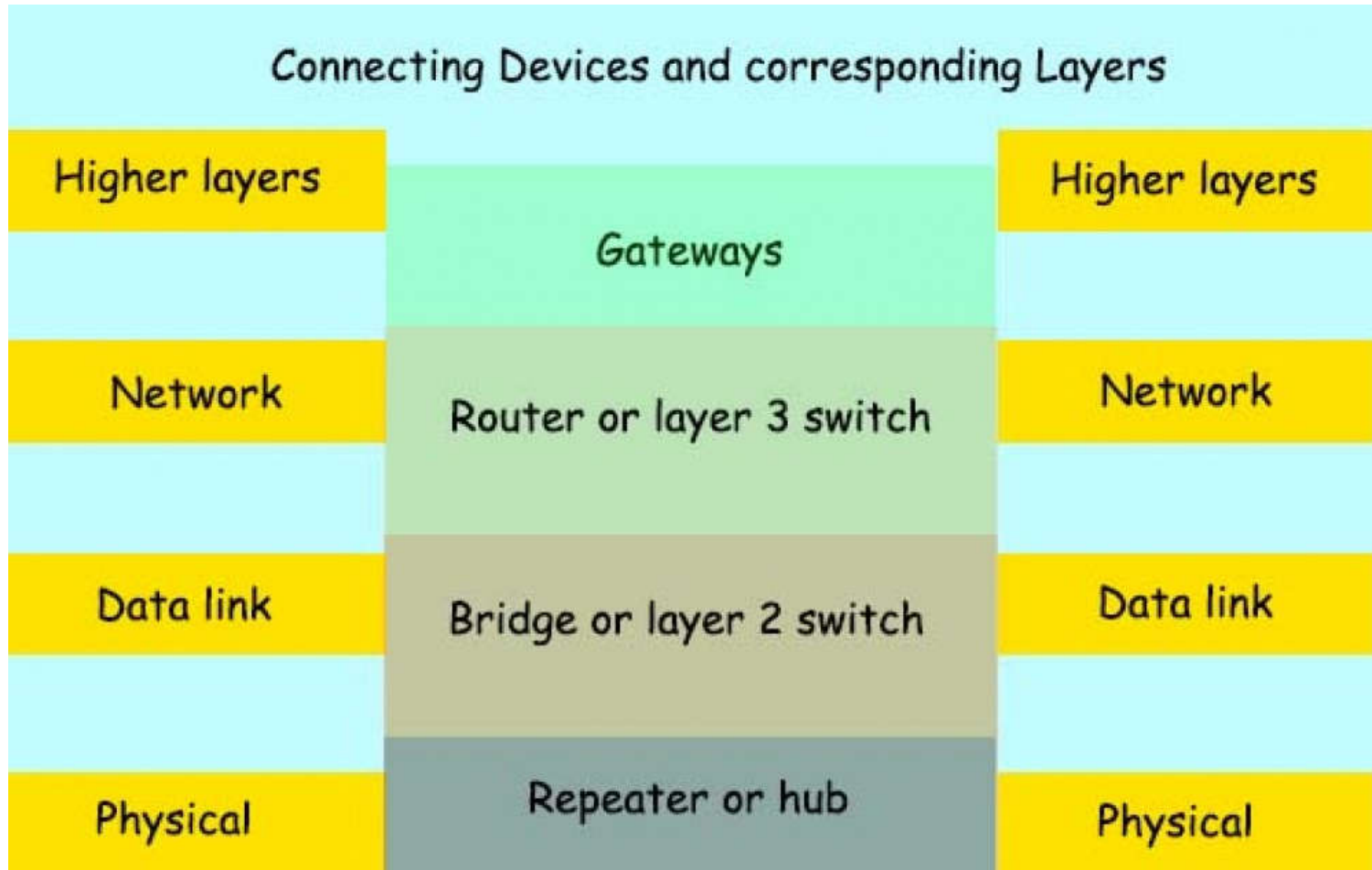
# Interconnecting Devices

- An Interconnecting device is any device that can enable computers to exchange data on a network.
- Backbone of a network.

# Interconnecting Devices

- Hubs
- Repeaters
- Bridges
- Switches
- Routers
- Gateways

# Interconnecting Devices and Corresponding Layers



# Repeater Vs Hub Vs Switch Vs Bridge Vs Router

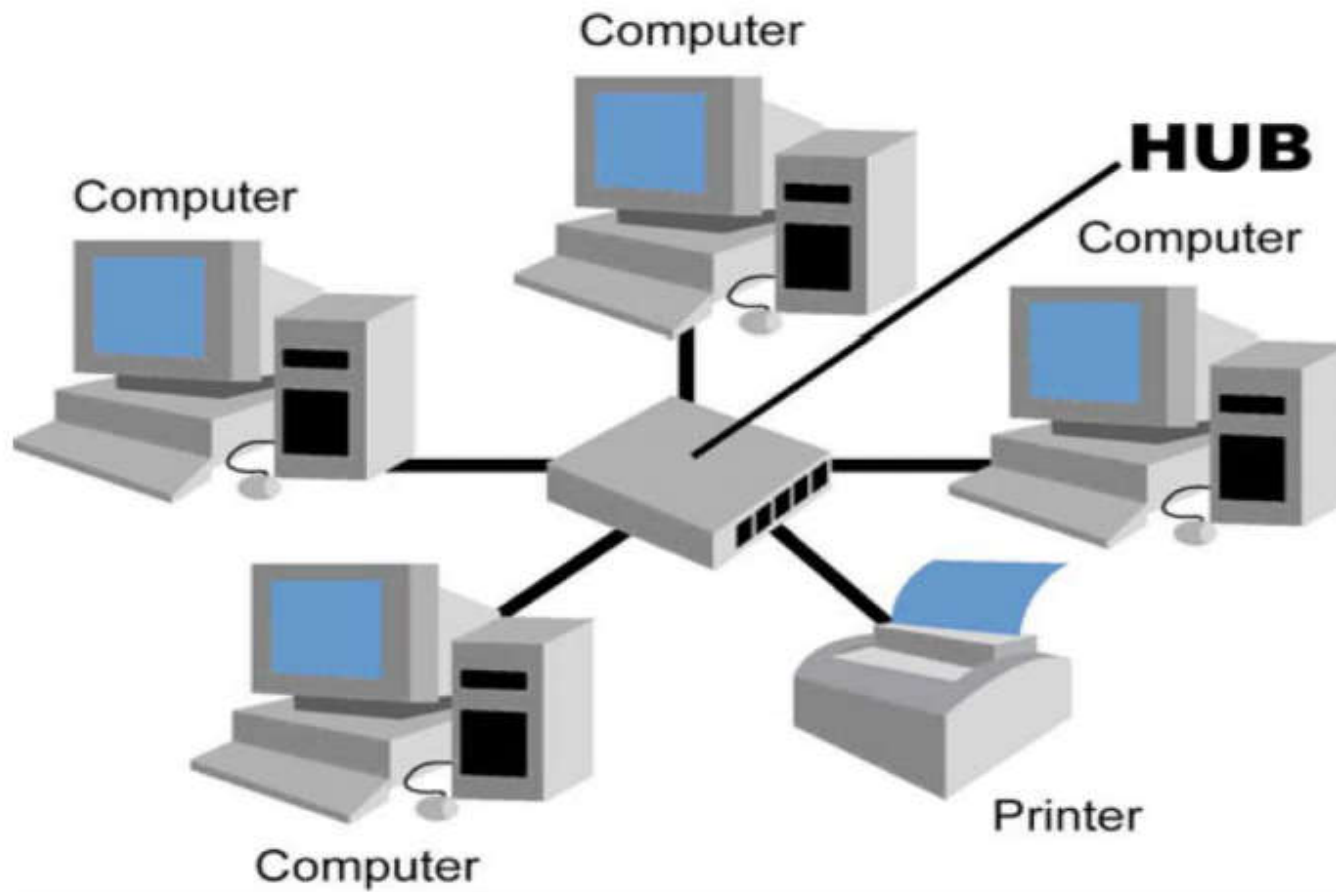
Device	OSI Layer	MAC Address/IP Address	Functionality
Repeater	Physical Layer	-	Repeaters are used to extend transmissions so that the signal can cover longer distances or be received on the other side of an obstruction
Hub	Physical Layer	-	-Hub broadcast message to all the connected devices. -Dumb Device
Layer 2 Switch	Data Link Layer	MAC Address	-Switch send message to only required device. -MAC Address -More intelligent than Hub
Bridge	Data Link Layer	MAC Address	-Similar to Switch. -MAC Address -Bridge has the capacity to store frames and act as a storage and forward device
Router	Network Layer	IP Address	-More intelligent than all the above devices -By examining the IP address, the router can make intelligent decisions to direct the packet to its destination.

# Detailed Explanation for Interconnecting Devices

# Hub

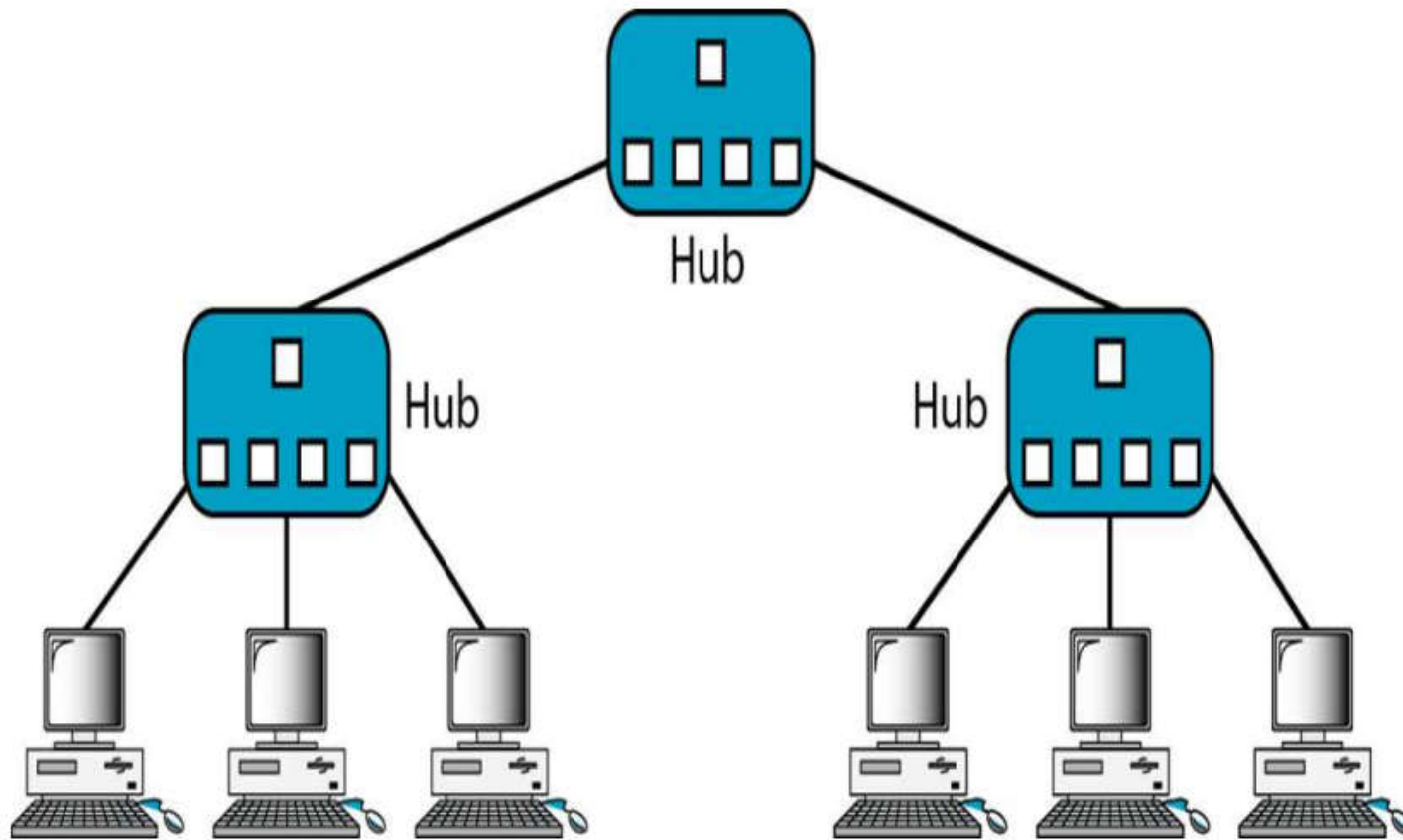
- A hub is basically a multiport repeater.
- Hubs are a common connection point for devices in a network and are commonly used to connect segments of a LAN and have multiple ports.
- A hub takes the incoming data packet that comes into a port and copies it out to all the other ports in the hub.
- It doesn't perform any filtering or redirection of data.
- It operates on physical layer of OSI model.
- Hubs cannot filter data, so data packets are sent to all connected devices.

# Hub

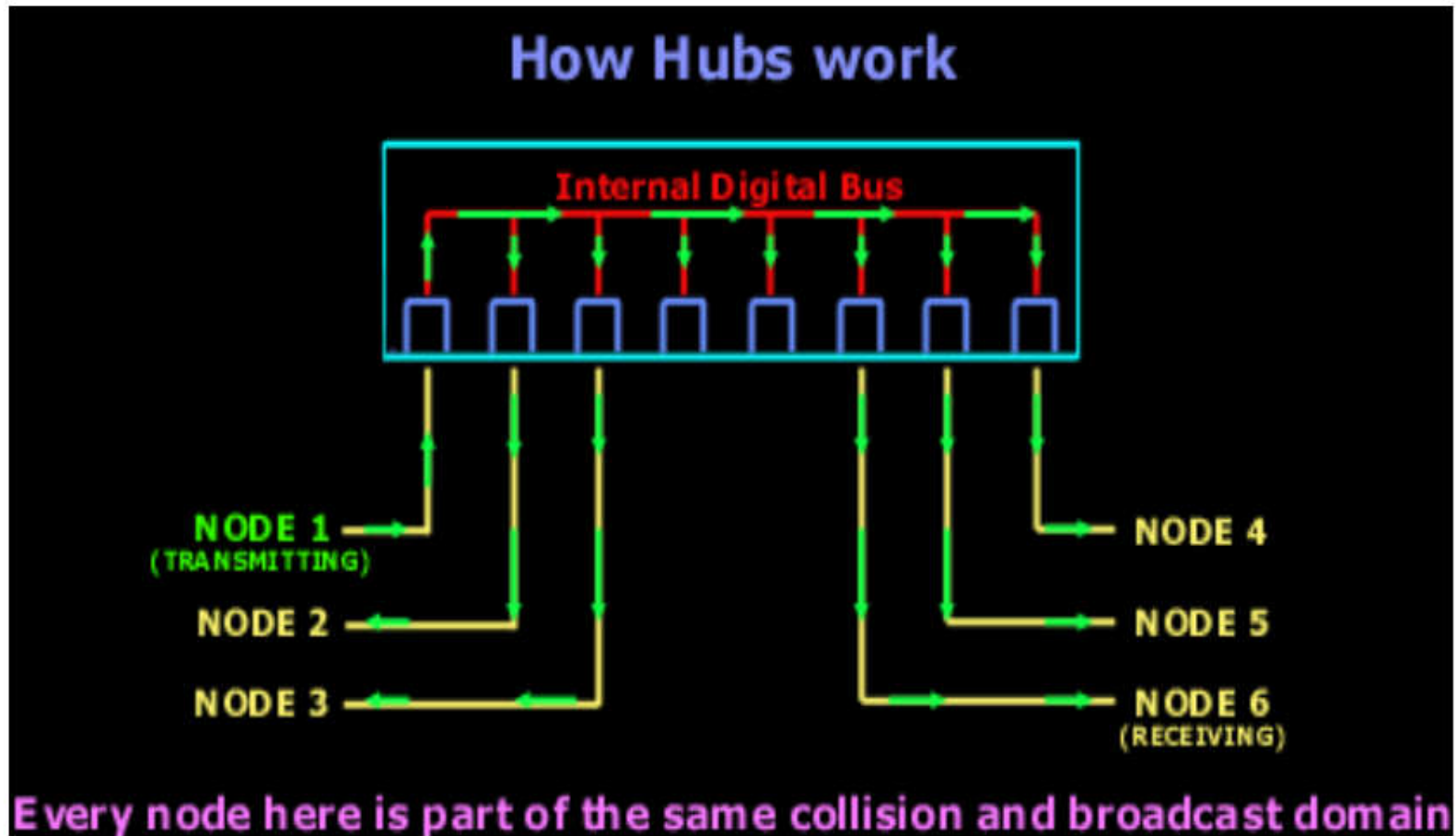




# Hierarchy of Hub



# How Hubs Work?



# Two Types of Hubs

- Passive Hub
- Active Hub

# Passive Hub

- A passive hub is just a connector, it simply transmit and receive data from end devices connected to the LAN.
- It does not amplify the signal.

# Active Hub

- Active Hub is a hub which can amplify or regenerate the information signal.
- This type of hub has an advantage as it also amplifies the incoming signal as well as forward it to multiple devices.
- This hub is also known as Multiport Repeater.
- It strengthens the incoming signal before sending them to destination.

# Advantages of Hub

- Hub is less expensive.
- Active hubs can extend maximum network media distance.
- No processing is done at the hub to slow down performance.

# Disadvantages of Hub

- No intelligence to filter traffic.
- It will broadcast to all the ports which leads to inefficiencies and wastage of the bandwidth.

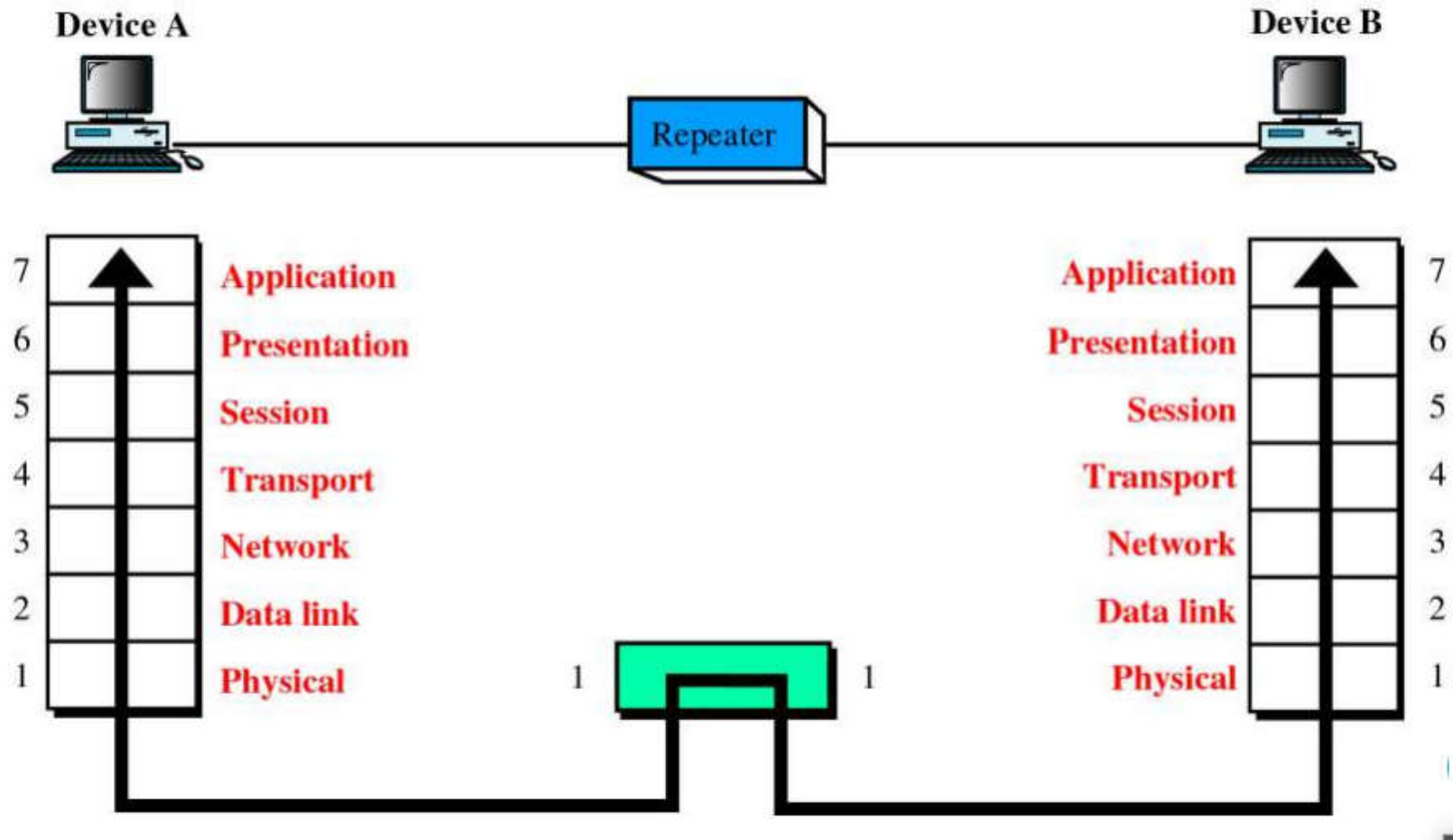
# Repeaters



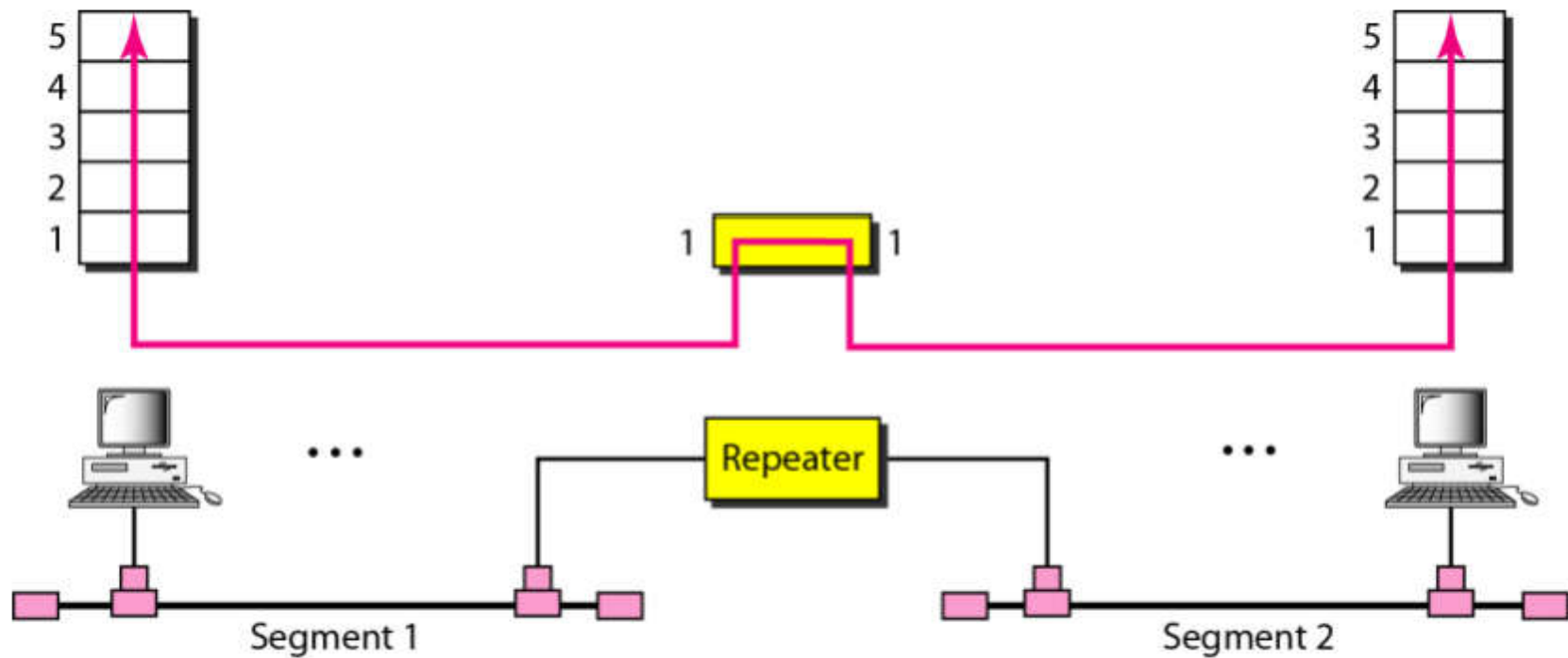
# Repeaters

- Repeater is a device used to regenerate the signal over same network.
- A repeater connects segments of a LAN.
- A repeater is a device that operates only at the Physical layer of OSI model.
- As the distance of the two segments increases, the signal strength automatically keeps decreasing due to attenuation (loss of energy due to cable resistance and external noise factors).
- To overcome this, devices like repeaters that span long distances.

# A Repeater in the OSI Model



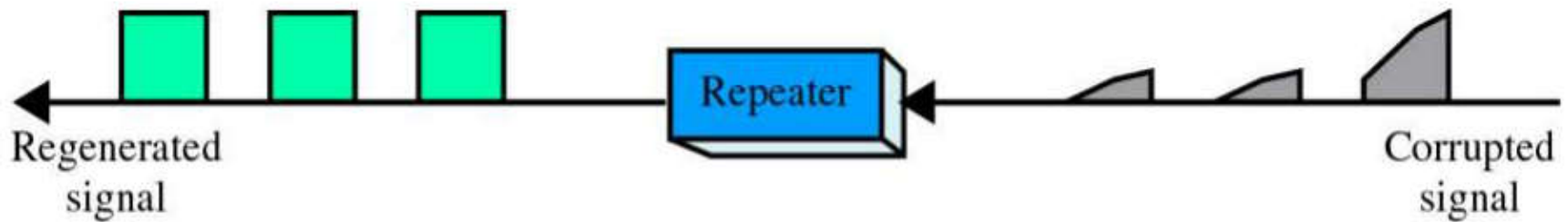
# A Repeater Connecting Two Segments of a LAN



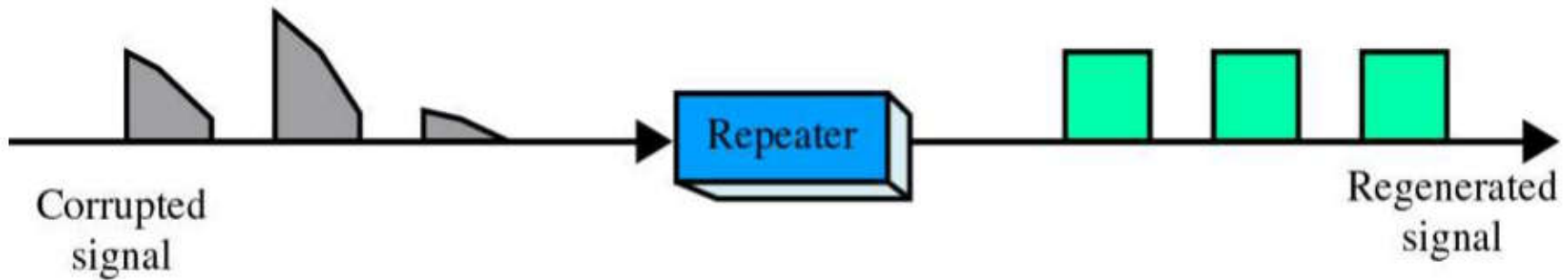
# Function of Repeaters

- Repeaters receive signals from one network segment and it regenerates, and retransmit those signals to another network segment.
- When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength.
- A repeater can extend only the physical length of network.
- A repeater forwards every frame; it has no filtering capability.

# Function of a Repeater



(a) Right-to-left transmission.



(b) Left-to-right transmission.

# Advantages of Repeater

- Extend length of network.
- It strengthens the weak signal.
- Removes the unwanted noise in an incoming signal.

# Disadvantages of Repeater

- It has no filtering capacity.
- It cannot connect two different architecture such as token ring and Ethernet etc..
- Number of repeaters used must be least, otherwise cause propagation delay.

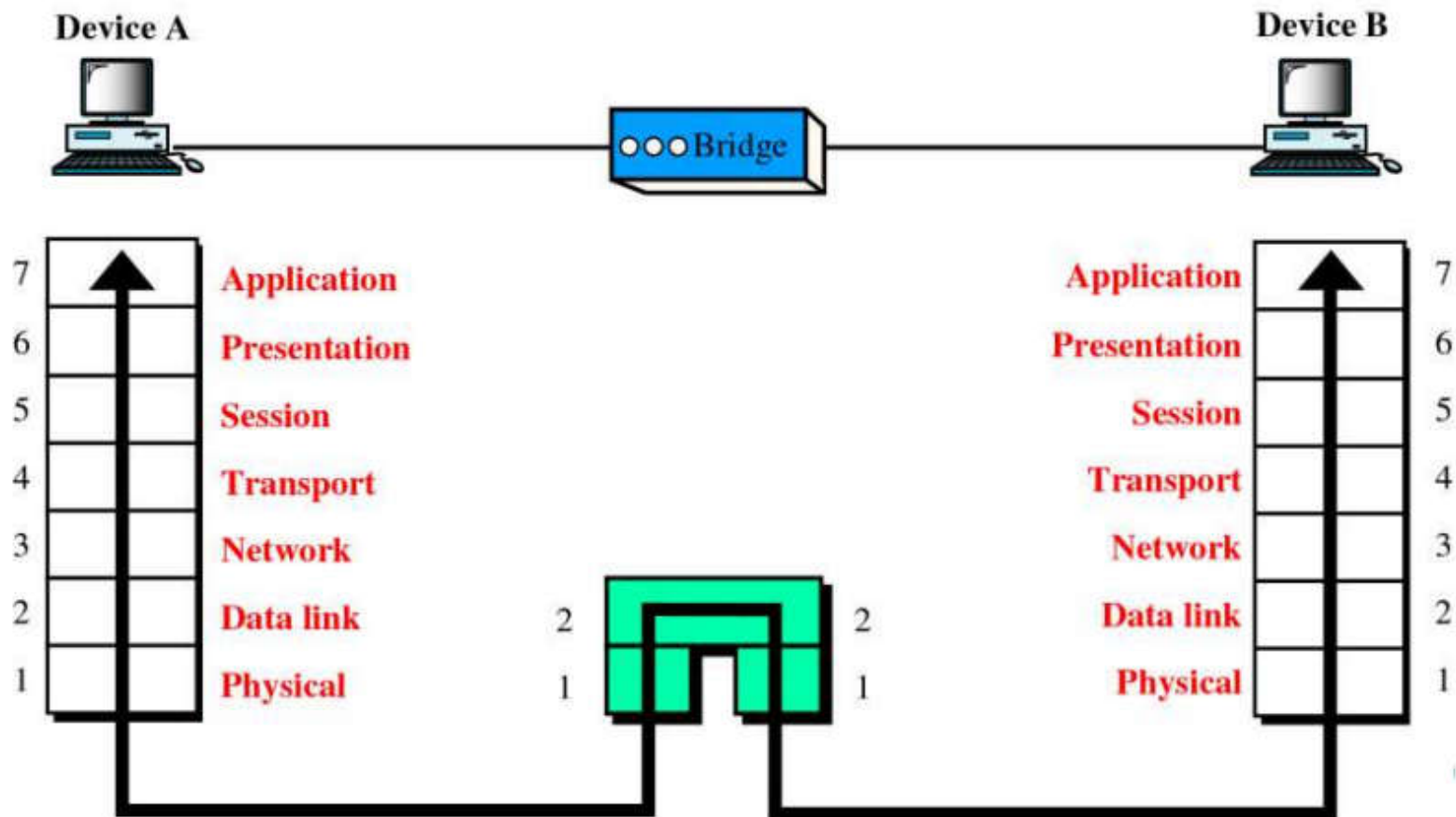
# Bridges



# Bridge

- Bridge is a device used to connect two separate Ethernet networks into one extended Ethernet that uses same protocol.
- Bridging occurs at the data link layer of the OSI model, which means the bridge cannot read IP addresses, but only the outermost hardware address of the packet.
- The hardware address is also called the MAC (media access control) address.

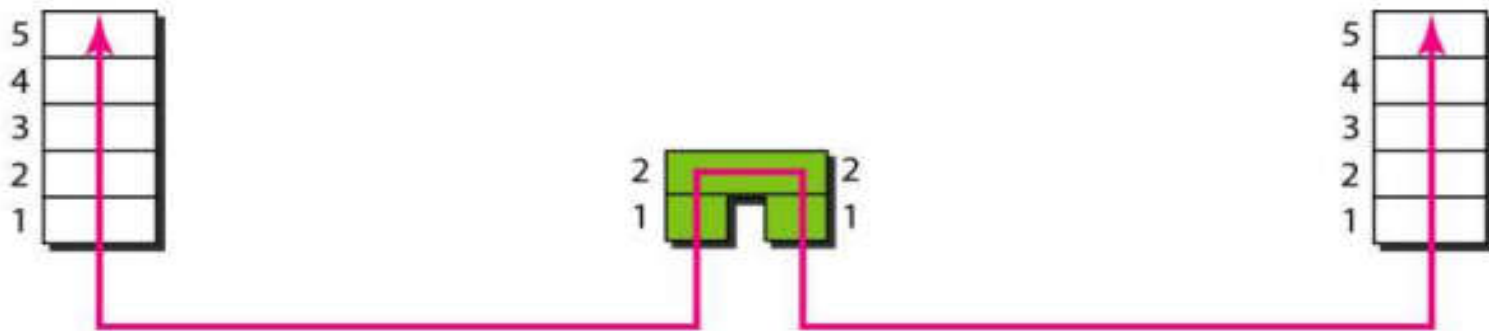
# A Bridge in the OSI Model



# Functions of a Bridge

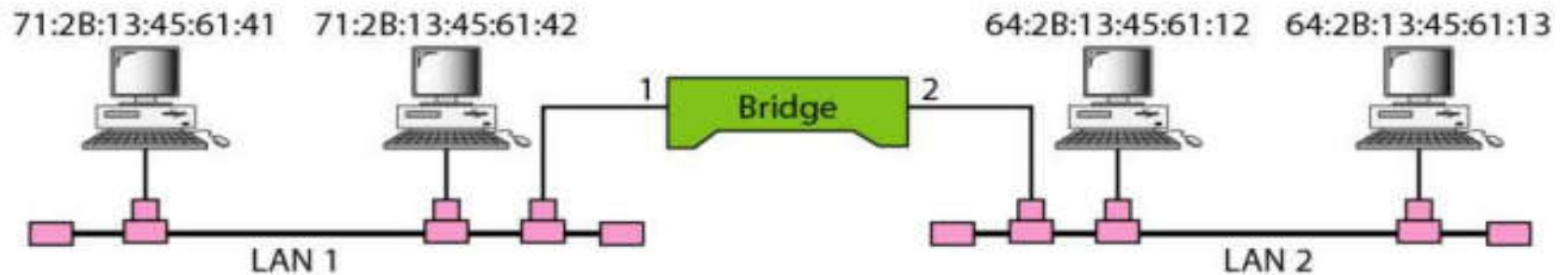
- When the frame enters it not only regenerates the signal it receives.
- As a data link layer device it checks the source and destination addresses in the frame.
- It maintains a table that maps addresses to ports.
- It sends data frames only to the concerned destination.
- If destination address is in the same segment as the source address, stops transmit.
- Otherwise, forwards to the other segment.

# Functions of a Bridge Contd....



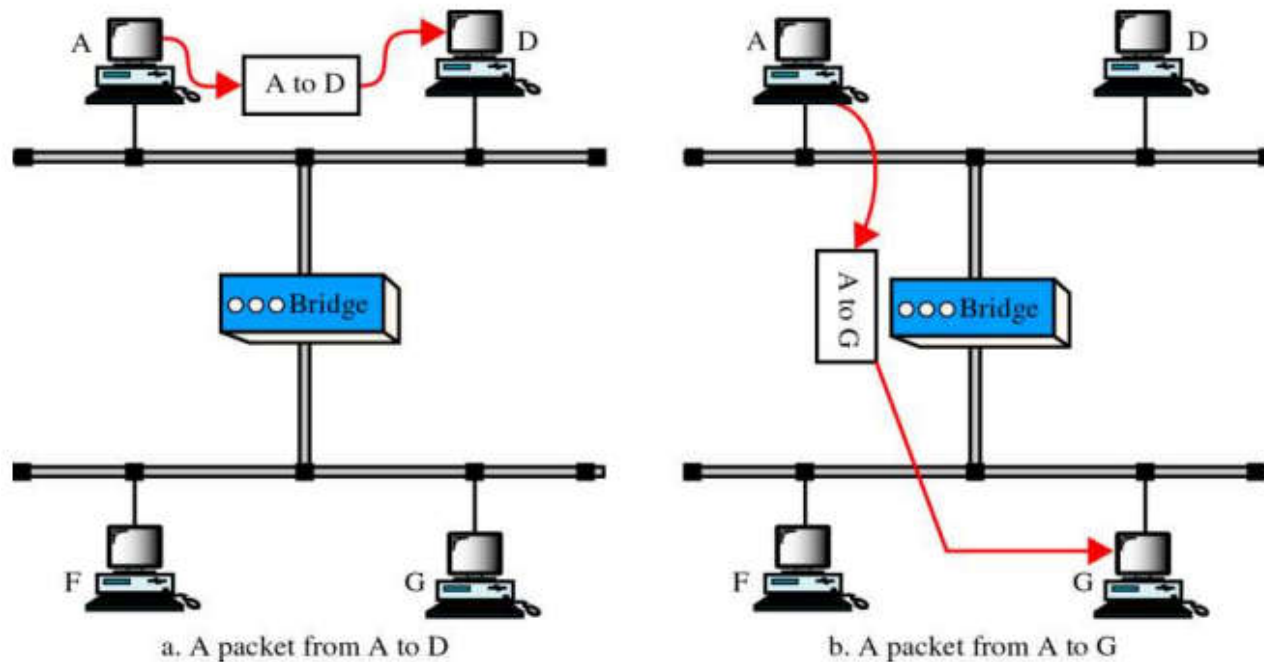
Address	Port
71:2B:13:45:61:41	1
71:2B:13:45:61:42	1
64:2B:13:45:61:12	2
64:2B:13:45:61:13	2

Bridge Table



# Functions of a Bridge Contd....

## FUNCTION OF A BRIDGE



# Advantages of Bridges

- It minimizes unwanted traffic and it acts as a filter.
- It minimizes network congestion.
- Error links can be identified and then isolated.
- Bridges help to lower the data load over the data link layer.

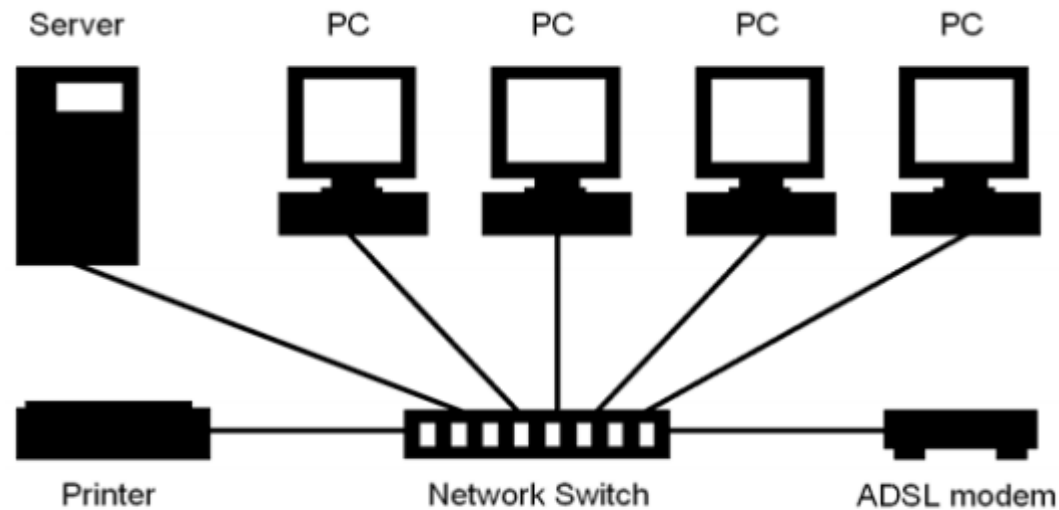
# Disadvantages of Bridges

- The speed is slower than repeaters but it is fast than that of the routers.
- Cost is expensive than repeaters but a bit cheaper than routers.
- Not able to handle multiple paths.
- Bridges are unable to read specific IP address; they are more concerned with the MAC addresses.

# Switches



# Switches



# Switches

- A network switch is a networking device that connects devices together on a computer networks, by using packet switching to receive, process and forward data to the destination device.
- It process the data at the data link layer and network layer of the OSI model. ☐ Performs the data link layer function, that is it looks at each packets or data unit and determines from a physical address(MAC address).
- Also called as Multilayer Switch because it works on two different layers.

# Functions of Switches

- Allows more than one device connected to the switch directly to transmit simultaneously.
- Can operates in Full-duplex mode(can send and receive frames at the same time).
- Performs MAC address recognition and frame forwarding in hardware.

# Advantages of Switches

- Only forwards frames as needed.
  - Filters frames to avoid unnecessary load on segments.
  - Sends frames only to segments that need to see them.
- Extends the geographical span of the network.
  - Separate segments allow longer distances.
- Improves privacy by limiting scope of frames.

# Disadvantages of Switches

- While limiting broadcasts, switches are not as good as routers.
- Handling multicast packets needs configuration and proper designing.
- It is difficult to reconfigure if any network error occurs in multicast.
- If switches are in promiscuous mode they are vulnerable to security attacks like spoofing IP address or capturing of Ethernet Frames.
- Higher cost.

# Routers



# Routers

- A router is a three-layer device: It operates in the physical, data link, and network layers.
  - As a physical layer device: It regenerates the signal it receives.
  - As a data link layer device: The router checks the physical addresses (source and destination) contained in the packet.
  - As a network layer device: A router checks the network layer addresses (addresses in the IP layer).

# Routers

- A router can connect LANs together.
- A router can connect WANs together.
- A router can connect LANs and WANs together.
- In other words, a router is an internetworking device.
- It connects independent networks together to form an internetwork.
- According to this definition, two networks (LANs or WANs) connected by a router become an internetwork or an internet.

A three-layer switch is a router

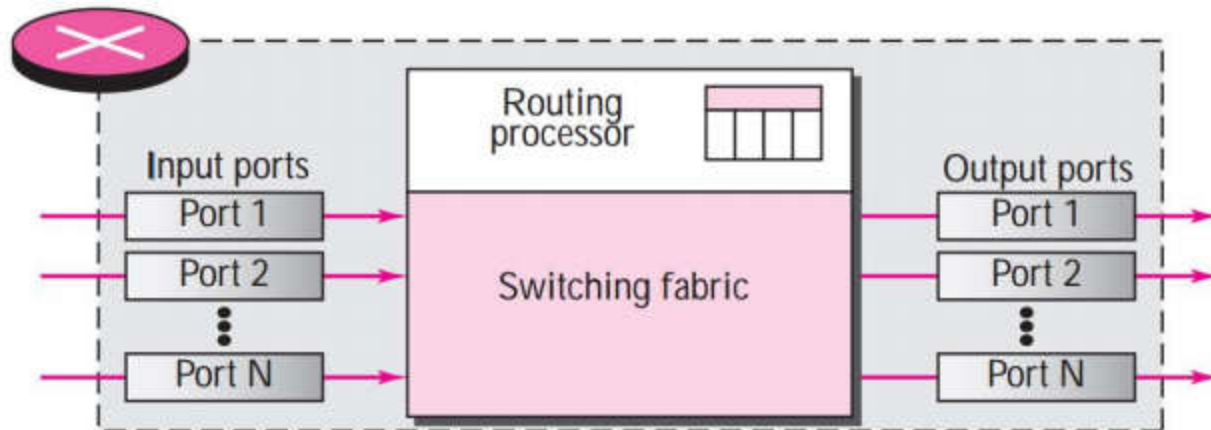


# Routers

- There are three major differences between a router and a repeater or a bridge.
  - A router has a physical and logical (IP) address for each of its interfaces.
  - A router acts only on those packets in which the physical destination address matches the address of the interface at which the packet arrives.
  - A router changes the physical address of the packet (both source and destination) when it forwards the packet.

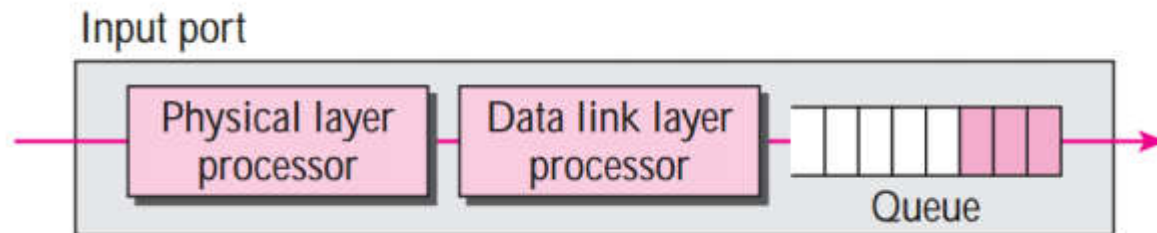
# Components

- The router has four components:
  - Input ports
  - Output ports
  - Routing processor
  - Switching fabric



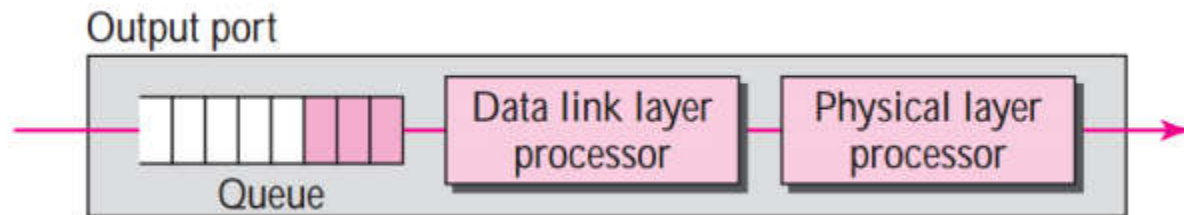
# Components: Input Ports

- An input port performs the physical and data link layer functions of the router.
- The bits are constructed from the received signal.
- The packet is decapsulated from the frame.
- Errors are detected and corrected.



# Components: Output Ports

- An output port performs the same functions as the input port, but in the reverse order.
- First the outgoing packets are queued, then the packet is encapsulated in a frame
- And finally the physical layer functions are applied to the frame to create the signal to be sent on the line.



# Components: Routing Processor

- The routing processor performs the functions of the network layer.
- The destination address is used to find the address of the next hop.
- This activity is sometimes referred to as table lookup because the routing processor searches the routing table.

Network Destination	Netmask	Gateway	Interface	Metric
0.0.0.0	0.0.0.0	192.168.0.1	192.168.0.100	10
127.0.0.0	255.0.0.0	127.0.0.1	127.0.0.1	1
192.168.0.0	255.255.255.0	192.168.0.100	192.168.0.100	10
192.168.0.100	255.255.255.255	127.0.0.1	127.0.0.1	10
192.168.0.1	255.255.255.255	192.168.0.100	192.168.0.100	10

# Components: Switching Fabric

- The most difficult task in a router is to move the packet from the input queue to the output queue.
- The speed with which this is done affects the size of the input/output queue and the overall delay in packet delivery.
- Routers use a variety of switching fabrics. Some of the switching fabrics are: 1) Crossbar Switch 2) Banyan switch

# Advantages of Routers

- Easily Shared Internet.
- Security and Adaptability.
- Router limits the collision domain.
- Router can function on LAN & WAN.
- Router can connects different media & architectures.

# Disadvantages of Routers

- Router is more expensive than Hub, Bridge & Switch.
- Routing updates consume bandwidth.
- Increase latency due to greater degree of packet filtering.
- Complicated Setup.



# Gateways

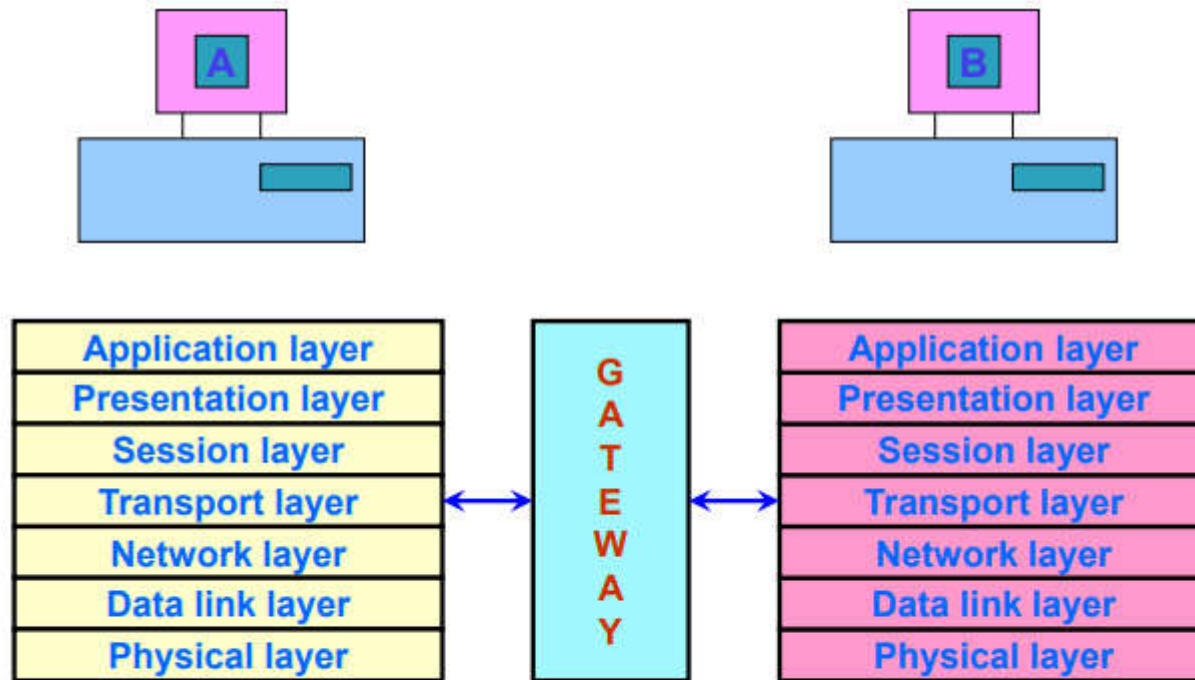
# Gateways



# Gateways

- Gateway is a component that is part of two networks, which use different protocols.
- It operates at all seven layers of OSI model.
- Unlike a router a gateway can forward packets across different networks that may also use different protocols.
- For example, If network A is token ring network using TCP / IP and network B is in a Ethernet network, a gateway can relay frames between these two networks.

# Gateways



Gateway at all OSI layers

# Functions of Gateways

- It has abilities to translate between different frame formats and also between different protocols.
- It is a very powerful computer system compared with bridge.
- Used to connect huge and incompatible networks.

# Advantages of Gateways

- The direct linking between internal and external hosts are denied.
- In network gateway, the user level authentication or protection is supported.
- Can connect or links two variant networks.
- The protocol conversion is done and it handles the traffic problems.

# Disadvantages of Gateways

- It is not an intellectual equipment.
- Protocol conversion is done so transmission rate is slower.
- Expensive.
- Little hard to handle.
- Needs internal client to know about them.