

# The Basic Components of Computer Network

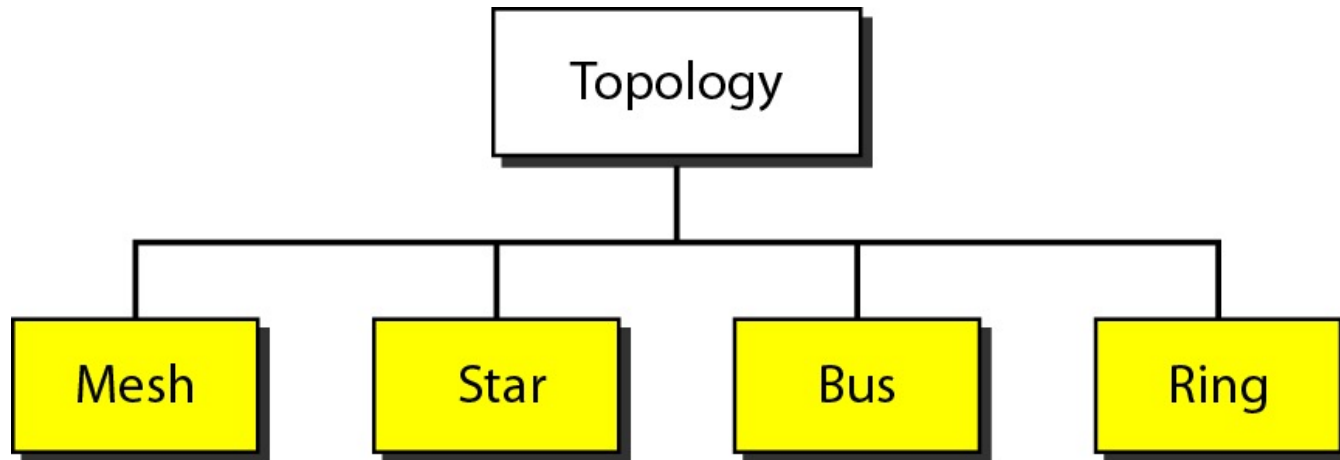
Presented By  
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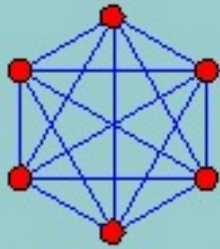
# Book Reference

1. TCP/IP Protocol Suite --- Fourth Edition  
by Behrouz A. Forouzan
2. CCNA Guide to Cisco Networking Fundamentals  
Fourth or upper Edition

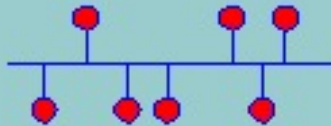
# Network topology

Network topology is the **geometric** representation of all the links and linking devices(usually called **nodes**) to one another.

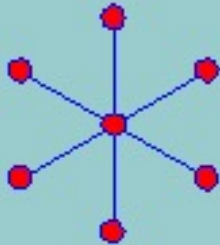




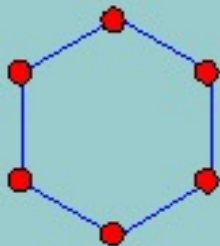
a) Fully Connected Topology



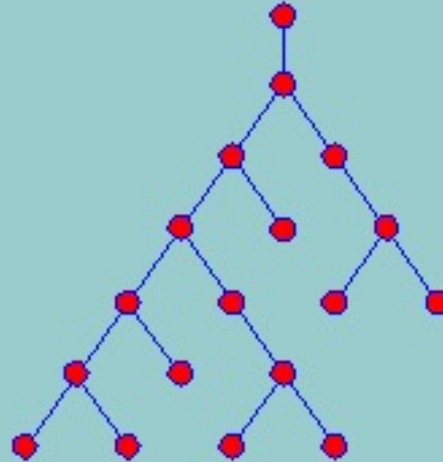
b) Bus Topology



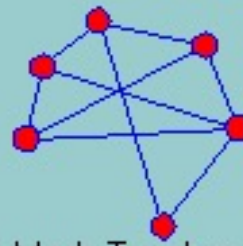
c) Star Topology



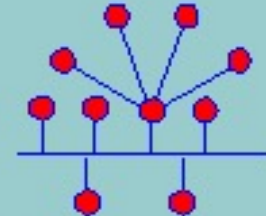
d) Ring Topology



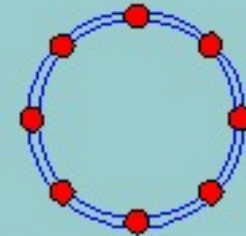
e) Tree Topology



f) Mesh Topology



g) Hybrid Topology  
(example: combination of  
Star topology and Bus topology)



h) Dual Ring Topology



i) Linear Topology

Nodes ● — Branches

# A fully connected mesh topology (five devices)

- Dedicated point-to-point link
- If  $n$  nodes exist, then each node connected  $n-1$  nodes or link.
- So, for  $n$  nodes need to connected total  $n(n-1)$  physical links
- For duplex mode, divide the total number of links by 2 means
$$\frac{n(n-1)}{2}$$
Duplex mode links present in a mesh network

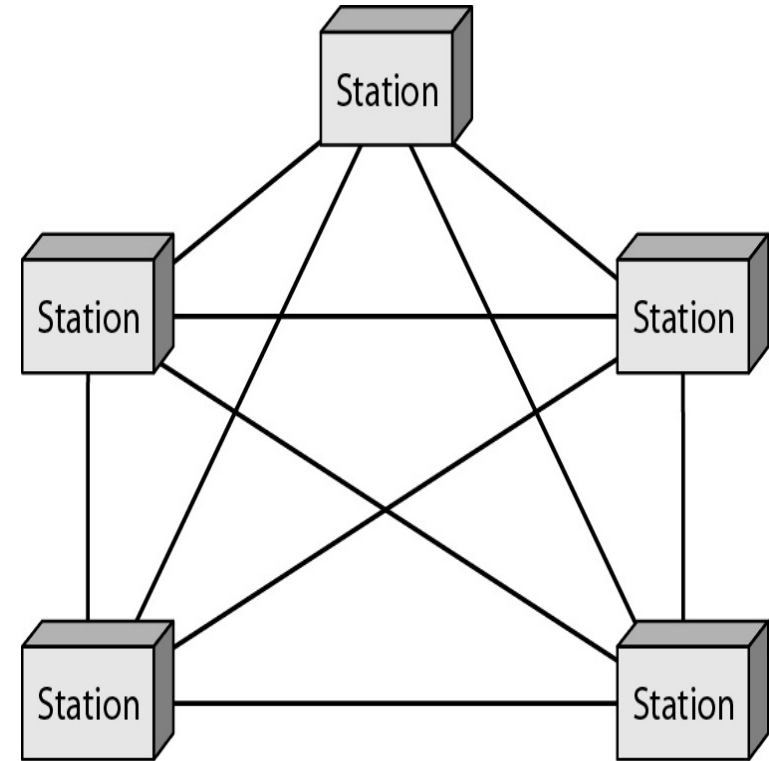


Fig. Mesh Topology

# Star topology

- Dedicated point-to-point link to a central hub
- No direct link between nodes
- Hub or controller acts as media to send data to one another
- Each node connected to the controller via a single (one) links
- If only one link fails, only that links affected.
- This topology used in LAN communication.

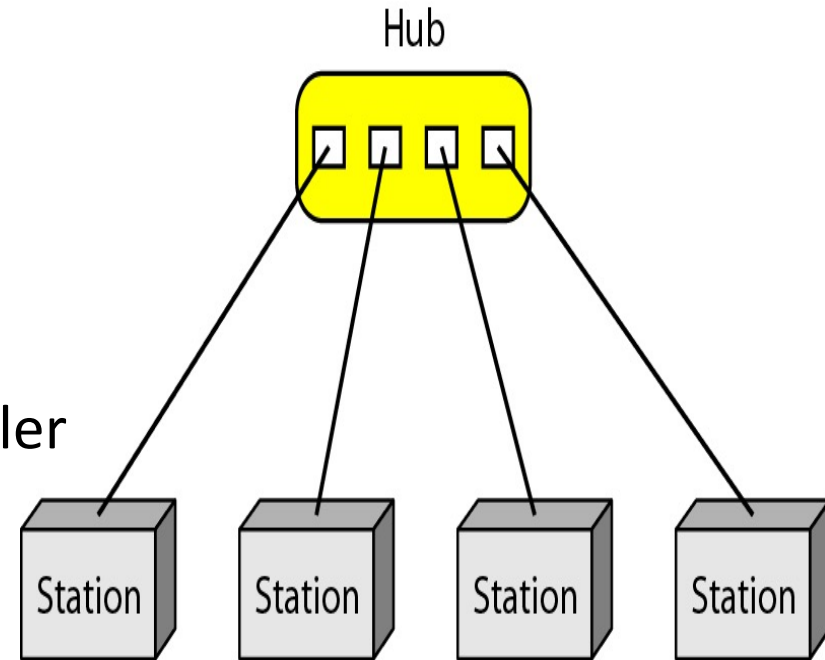


Fig. Star Topology

# Bus topology

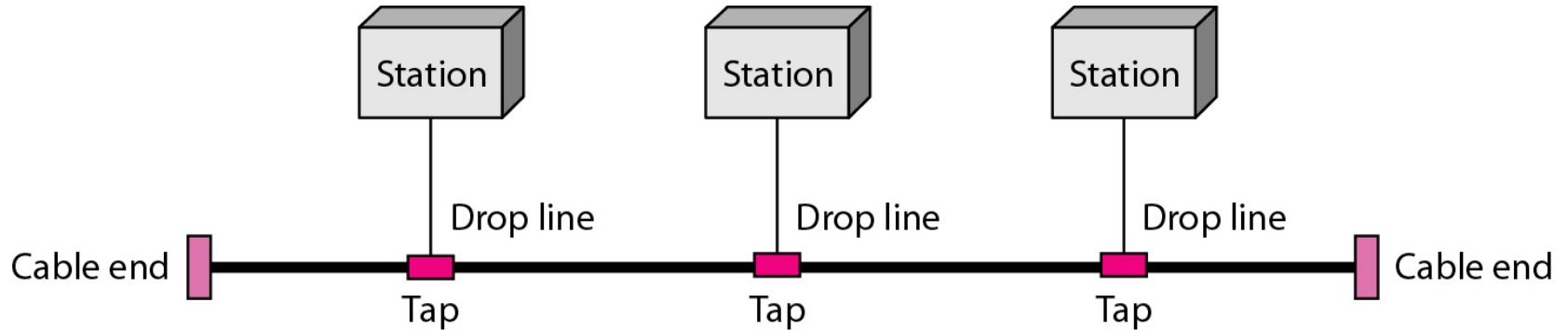


Fig. Bus Topology

- Single connection is shared(multipoint) by multiple nodes
- Signal becomes weak as it travels further distance
- Signal reflection at tapes reduces the signal quality.
- A fault or break in the bus cable stops all transmission.
- Advantages:
  - Ease of Installation.
  - Uses less cables.
  - Less complex.
- Disadvantages:
  - Difficult to fault isolation and reconnection.
  - Difficult to add new devices.

# Ring topology

- Dedicated point-to-point connection with two neighbor devices on each side
- Signal passed along the ring in one direction, until it reaches the destination.
- Each device has a repeater to regenerate the bits
- If the signal is not intended to a receiver that repeater regenerate the signal and passes through the ring.
- Advantages:
  - Easy to install and reconfigure
  - Fault isolation is simplified
- Disadvantages:
  - Unidirectional traffic(maximum ring length and number of devices)
  - A break in the ring (such as a disabled station) can disable the entire network. Solution: Dual Ring.

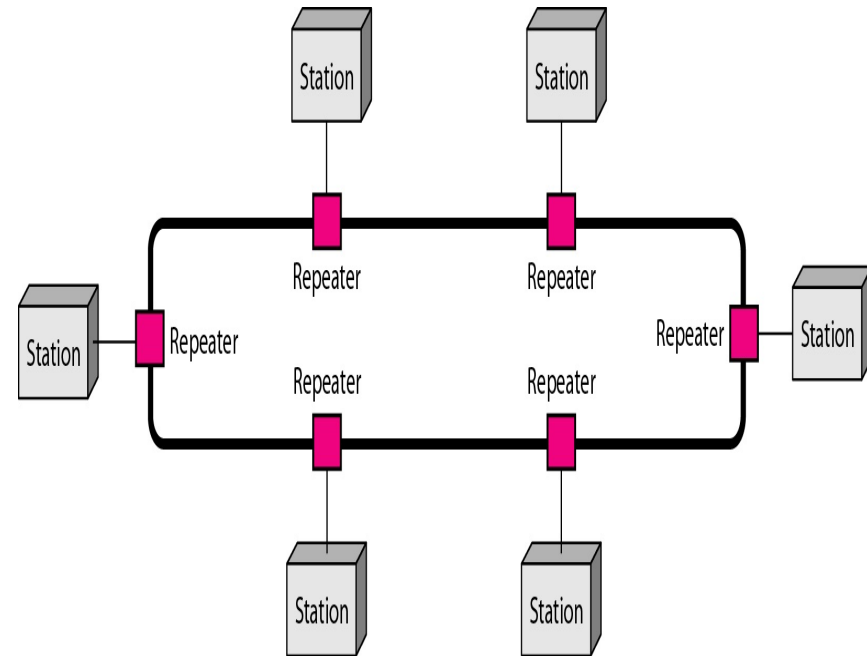
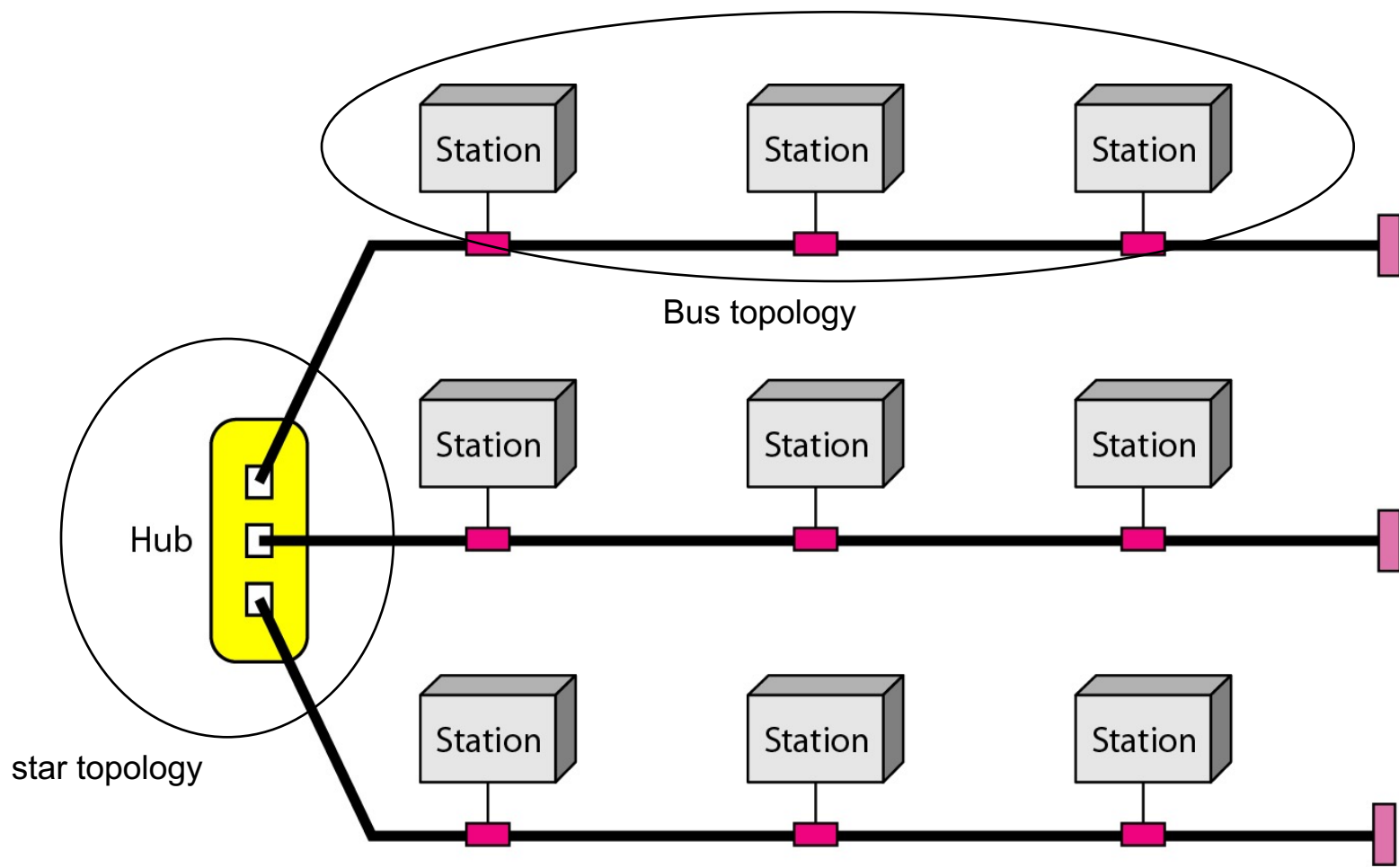


Fig. Ring Topology



# A hybrid topology: a star backbone with three bus networks



# Client Server Configuration Scenario

- A client server is a server that hosts, delivers, and manages the majority of resources and services that a client requests.
- A client-server system has mainly two parts
  - Client
  - Server
- A client is a user or application that connects to the server to access its services.
- A server is usually receives request for services from its client and responsible for providing it.
- In a client-server model, the server provides services without having to communicate directly with the client.
- Ex. Bangladesh Railway Train Tracking System

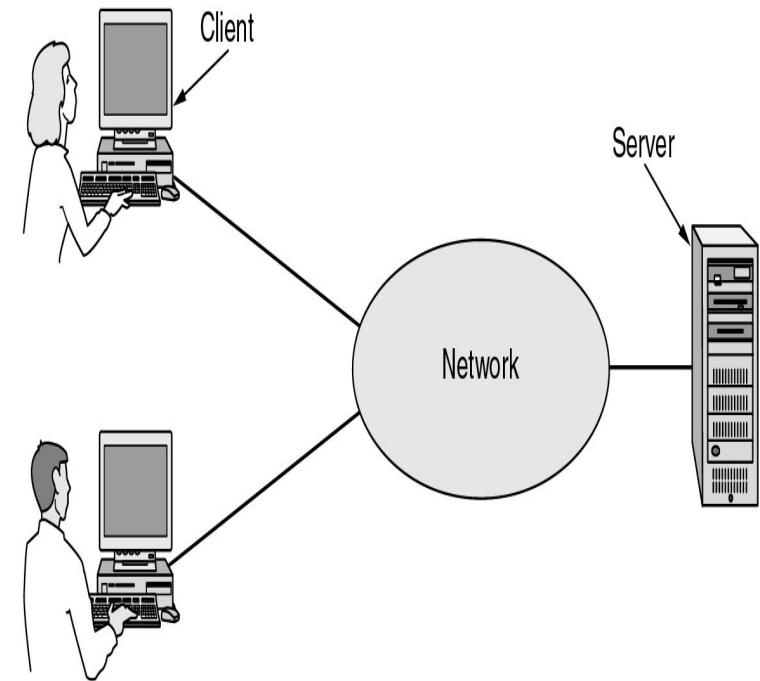


Fig. A network with two clients and one server

# Client Server Service Flow

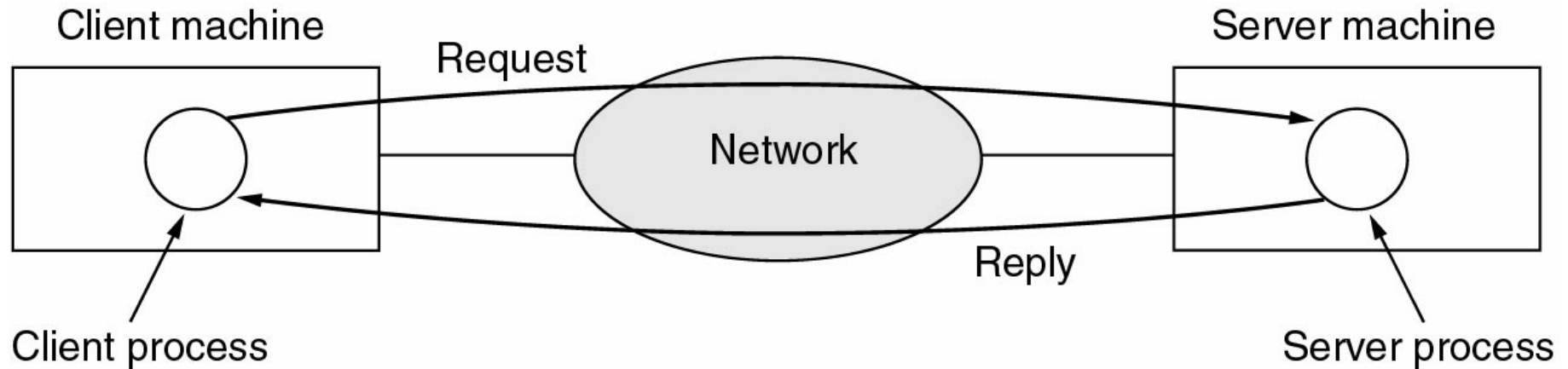
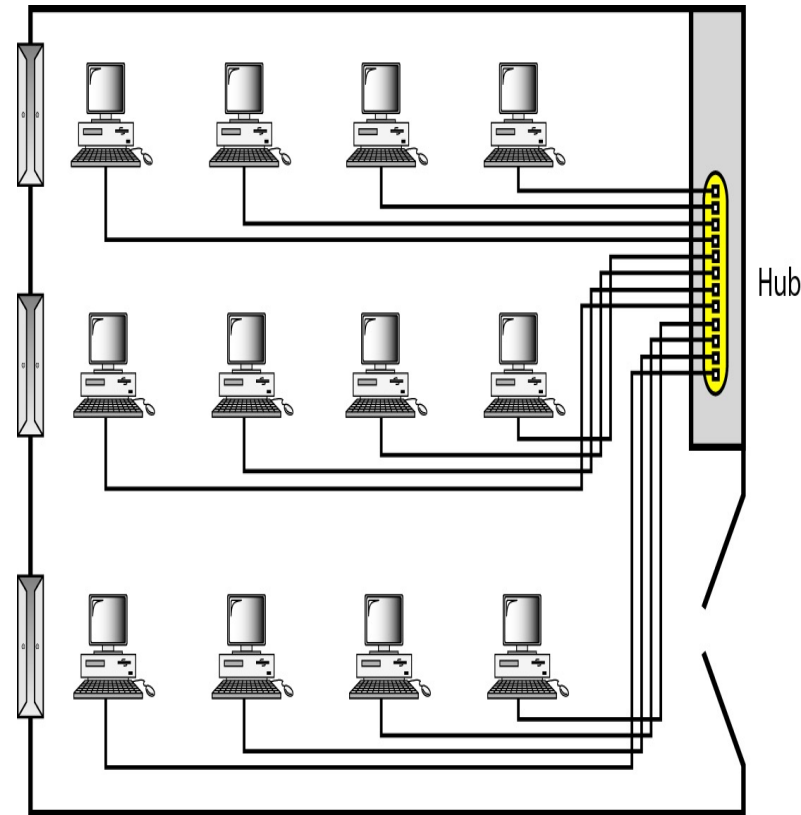


Fig. the client-server model involves requests and replies.

- The Client-server model is a distributed application structure that partitions task or workload between the providers of a resource or service, called servers, and service requesters called clients
- **Advantages of Client-Server model:**
  - Centralized system with all data in a single place.
  - Cost efficient requires less maintenance cost and Data recovery is possible.
  - The capacity of the Client and Servers can be changed separately.
- **Disadvantages of Client-Server model:**
  - Clients are prone to viruses, Trojans and worms if present in the Server or uploaded into the Server.
  - Server are prone to Denial of Service (DOS) attacks.
  - Data packets may be spoofed or modified during transmission.
  - Phishing or capturing login credentials or other useful information of the user are common and MITM(Man in the Middle) attacks are common.

# Local Area Network(LAN)

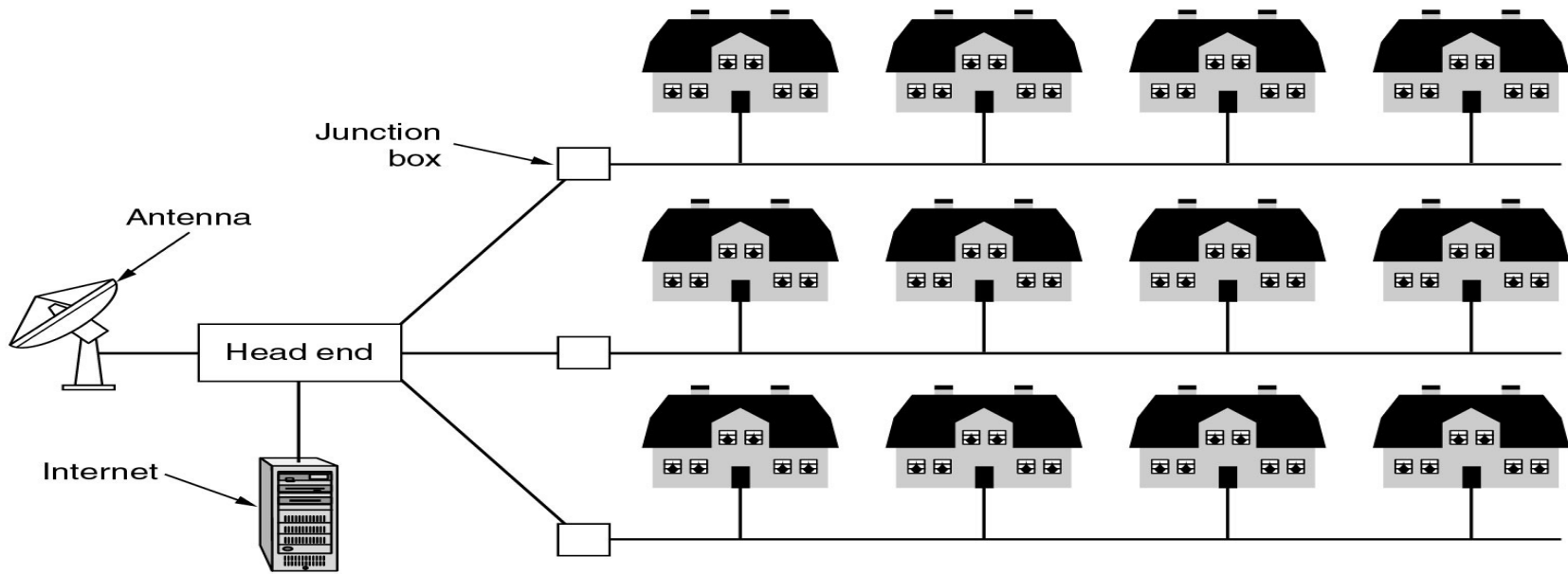
- Local Area Network(LAN) – Privately owned network and links a single office, building, or campus.
- Connect personal computers and workstations to share resources (e.g., printers) and exchange information.
- Distinguished from other networks by three characteristics: (1) size, (2) transmission technology, and (3) topology.
- Currently, LAN size is limited to a few kilometers.
- Early LANs had data rates in 4 to 16 Mbps but traditional LANs run at speeds of 10 Mbps to 100 Mbps, have low delay (microseconds or nanoseconds), and make very few errors.



***Fig. An isolated LAN connecting 12 computers to a hub in a closet***

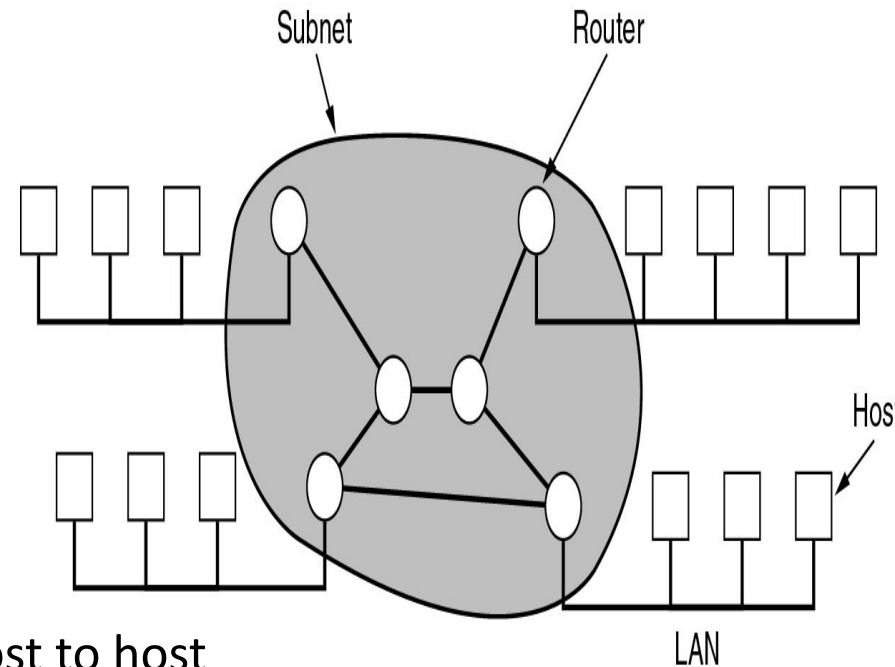
# Metropolitan Area Network(MAN)

- Large network that connects different organizations
- IEEE 802.16 wireless broadband is a form of MAN network
- It might connect different corporate LANs together
- Controlled or own by multiple organization
- Maintain by a group or single network provider(Link3)
- Share regional resources.
- Apex or different showroom`s are interconnected
- A telephone network which share high speed DSL distributed to customer also a good example of MAN
- Best example of a MAN is the cable television network available in many cities.



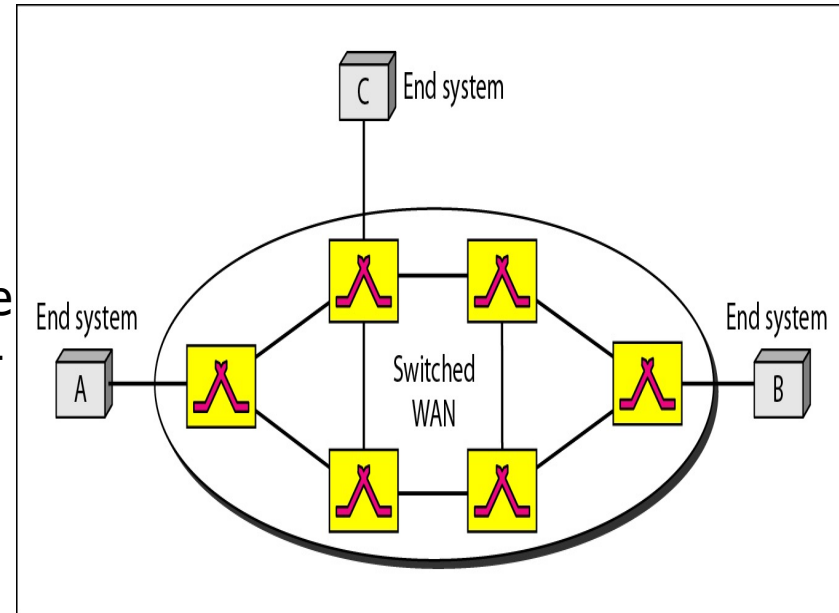
# Wide Area Network(WAN)

- A group of MANs or LANs or mixed of both constitute a WAN network
- Covers a large geographical area, often a country or continent.
- Follows a *MESH* topology network
- The popular example of MAN network is internet.
- Subnet is used to carry messages from host to host
- Subnet consists of two distinct components:
  - transmission lines and switching elements
- Transmission lines move bits between machines
- Switching element helps to choose an outgoing line to forward bits

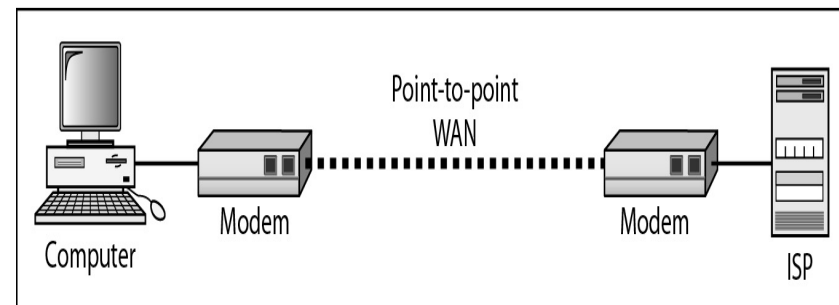


# Wide Area Network(WAN)

- A WAN can be
  - Complex backbone network that connects the internet called switched WAN or
  - Simple dial up line that connects a home computer to the internet called point-to-point WAN
- Early example of switched WAN is X.25 and also current ATM service example of WAN service.



a. Switched WAN

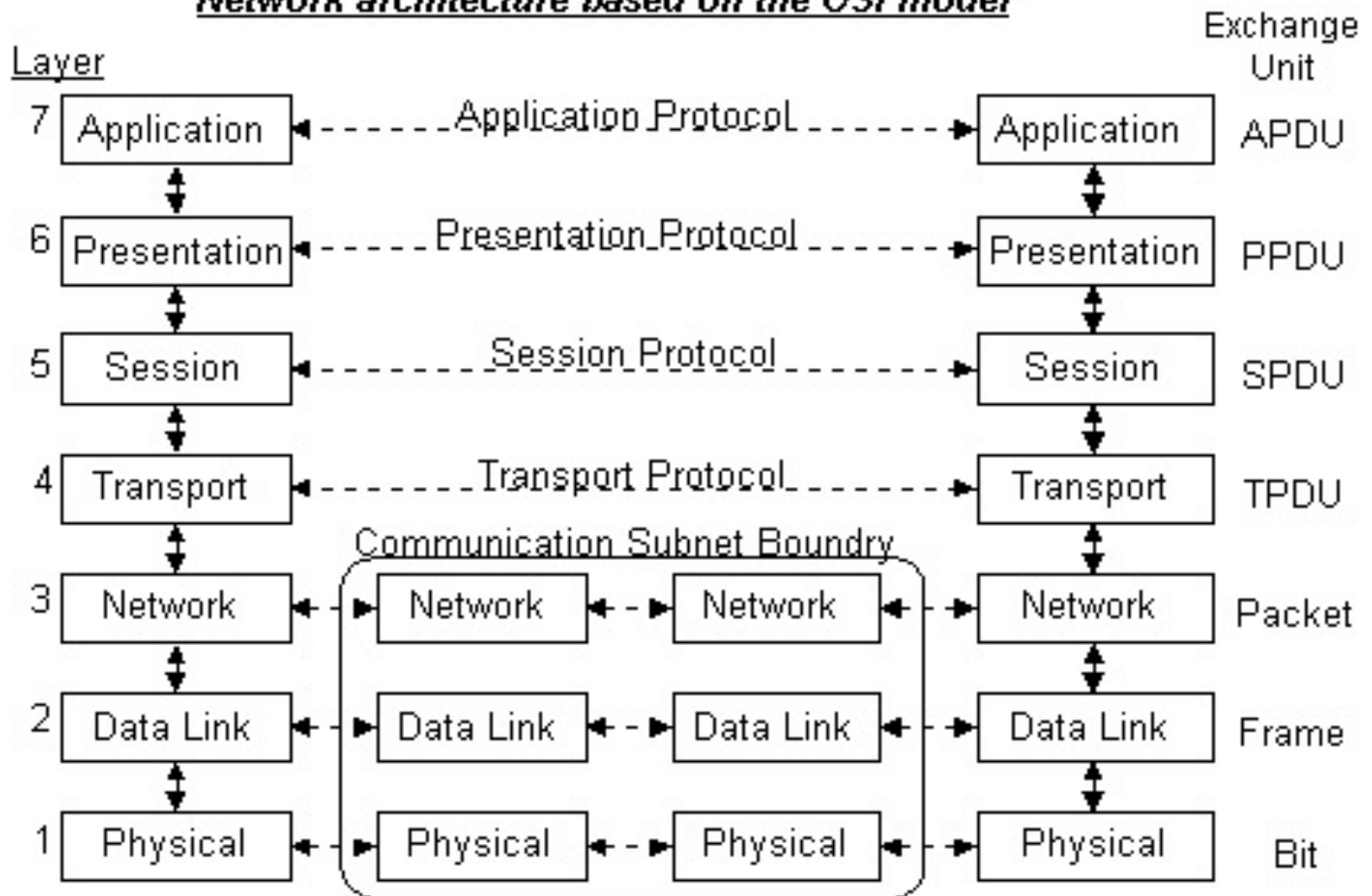


b. Point-to-point WAN

***Fig. WANs: a switched WAN  
and a point-to-point WAN***

# ISO OSI System Model

## Network architecture based on the OSI model





# Network Components

- The devices used for transmitting and processing the signal inside a communication platform.
- A network operation needs devices that are designed to handle certain network functions are often called networking devices or equipment and specifically referred to as **Network Components**.
- Each network component has a name that is related to its functions.
- A network component's functions are not necessarily handled by a specific device. Therefore, there are many products combine several networking components in a device.

# The Main Components of any Computer Network

The Main Components of any Computer Network are:

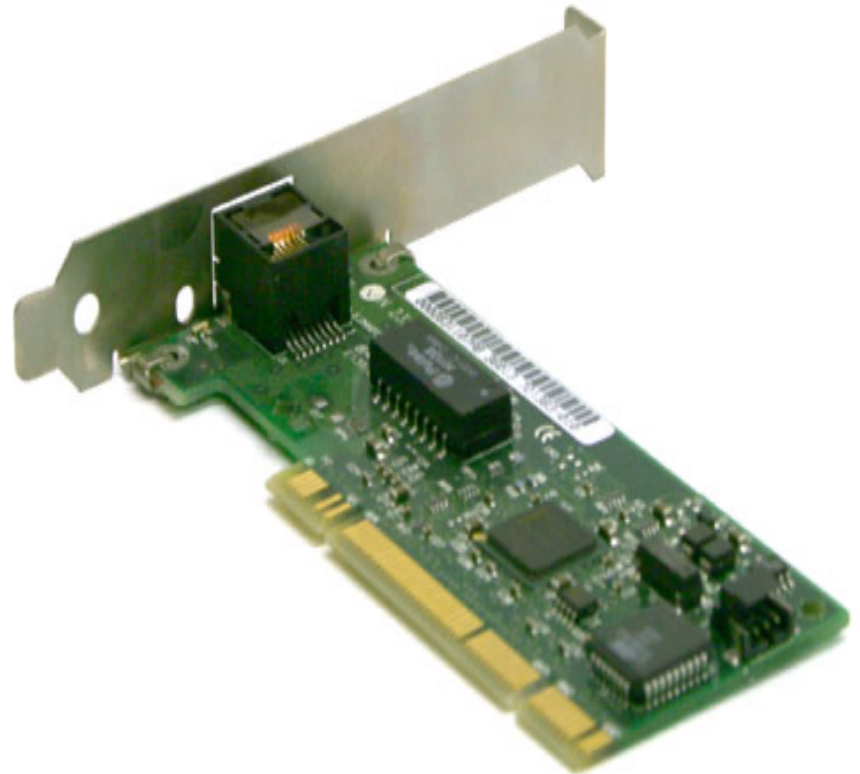
1. Network Adapter OR Network Interface Card (NIC).
2. Hubs and Repeaters
3. Bridges and Switches
4. Routers

Application layer	Application gateway
Transport layer	Transport gateway
Network layer	Router
Data link layer	Bridge, switch
Physical layer	Repeater, hub

*Fig: Devices in different layers*

# Network Adapter OR Network Interface Card (NIC)

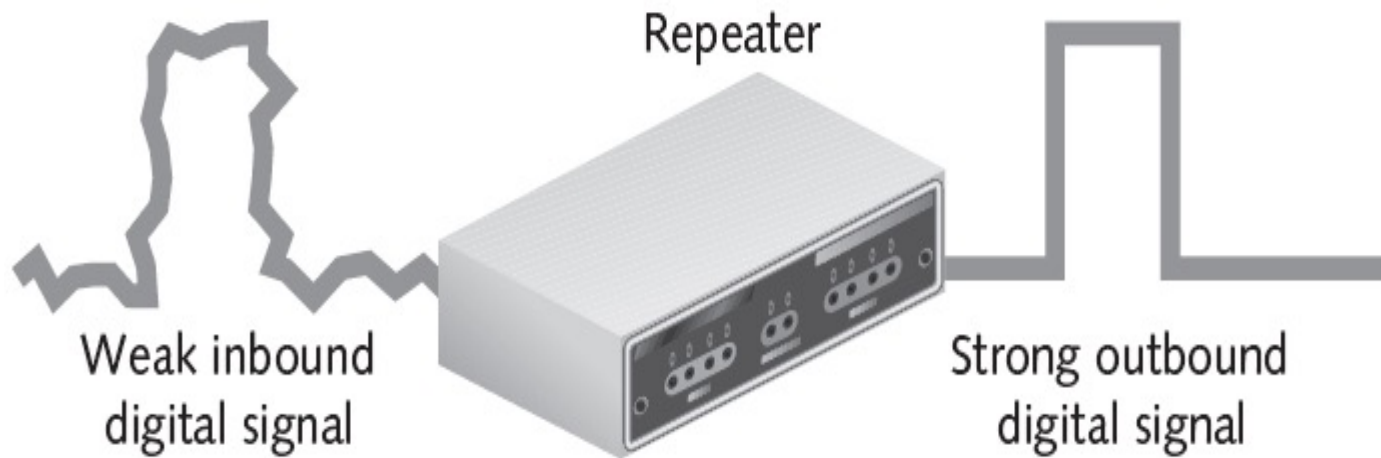
- Act as an interface between a communication device and a network.
- Work as a physical and data link layer device
- Converts a computer message into electrical or optical signals for transmission across the network.
- provides a low-level unique addressing system through the use of MAC addresses
- Connected to a computer via serial port, parallel port, and mostly USB port



# Repeaters

- The number of **nodes** on a network and the length of cable used
  - Influence the quality of communication on the network
- **Attenuation**
  - The degradation of signal clarity
- **Repeaters**
  - Work against attenuation by repeating signals that they receive on a network
    - Typically cleaning and regenerating the digital transmission in the process

## Repeaters (continued)

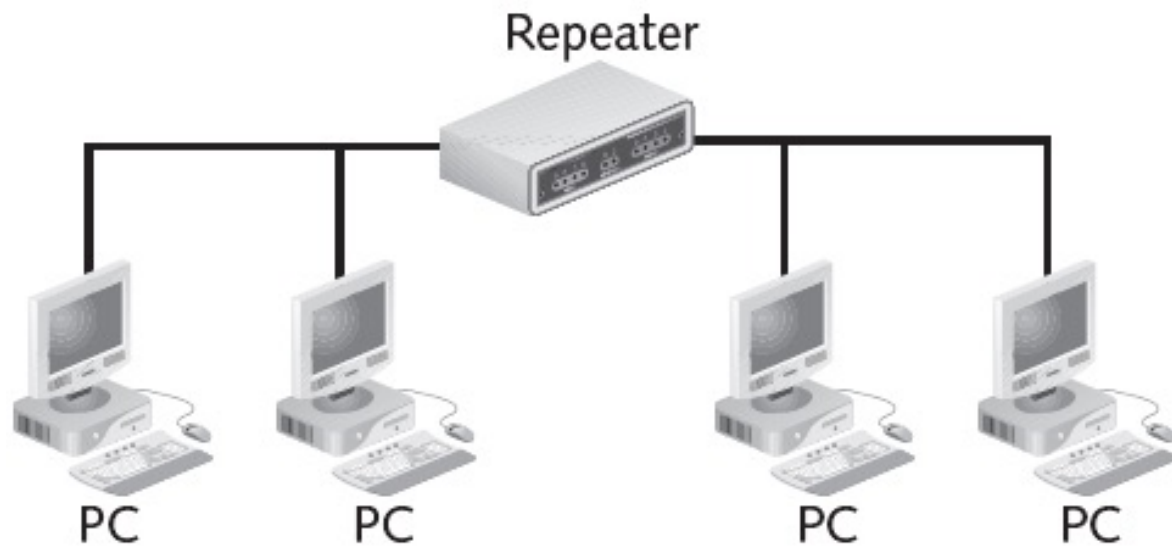


**Figure 2-1** Repeater

## Repeaters (continued)

- Note that on **analog** networks, devices that boost the signal are called **amplifiers**
- These devices do not have the same signal regeneration capabilities as repeaters
  - Because they must maintain the shape of the received signal
- Repeaters work in the Physical layer (layer 1)
- On optical networks, signal amplification is handled by **optical repeaters**
- Some repeaters can be used to connect two physically different types of cabling

## Repeaters (continued)



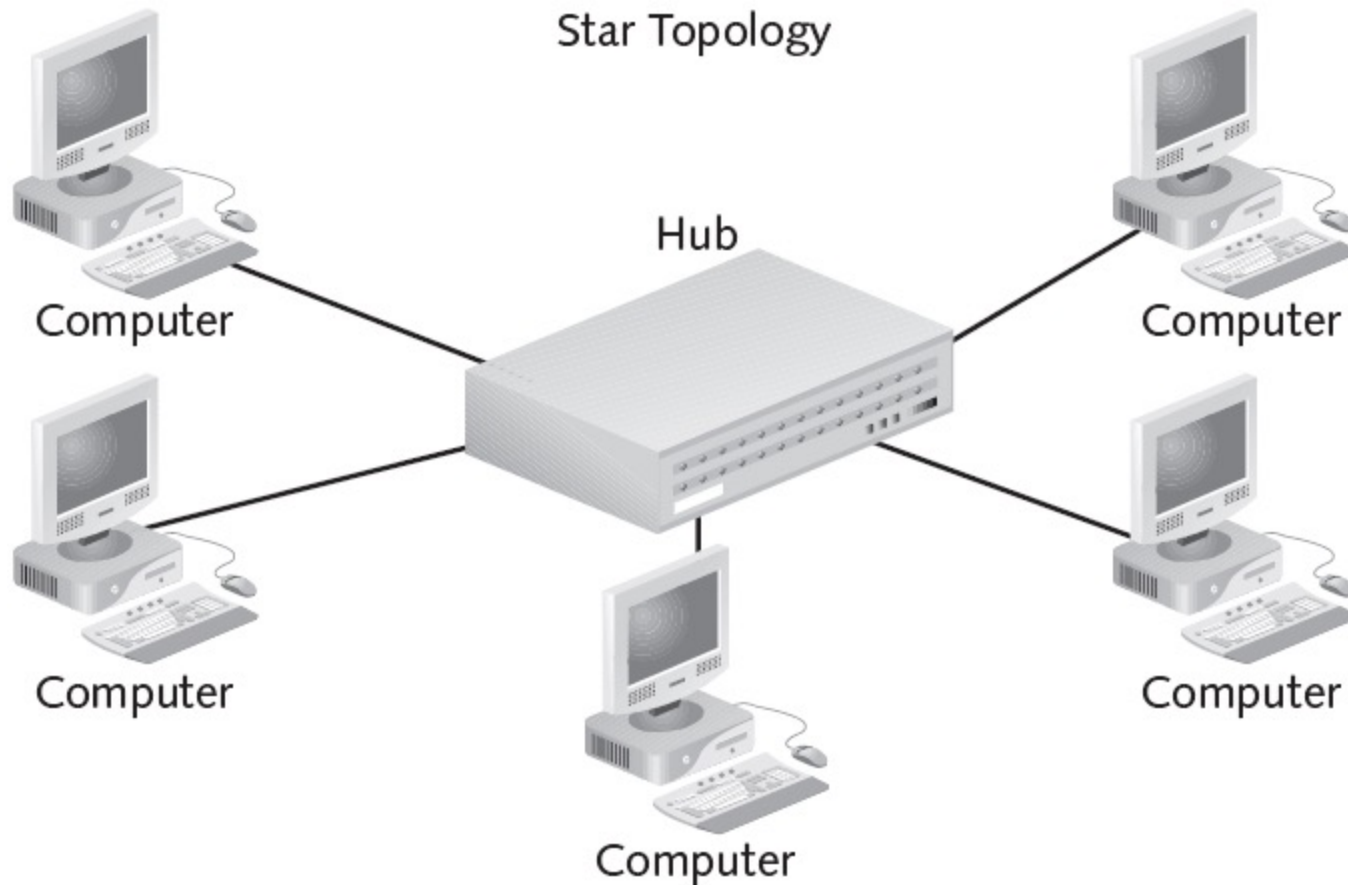
**Figure 2-2** Repeater in the network

# Hubs

- **Hub**
  - Generic connection device used to tie several networking cables together to create a link between different stations on a network
- **Active hubs**
  - Amplify or repeat signals that pass through them
- **Passive hub**
  - Merely connects cables on a network and provides no signal regeneration
- **Topology** refers to the physical layout of network cable and devices



# Hubs (continued)



**Figure 2-3** Star topology

# Advantages and Disadvantages of Repeaters and Hubs

- Advantages
  - Can extend a network's total distance
  - Do not seriously affect network performance
  - Certain repeaters can connect networks using different physical media

# Advantages and Disadvantages of Repeaters and Hubs (continued)

- Disadvantages
  - Cannot connect different network architectures, such as Token Ring and Ethernet
  - Do not reduce network traffic
    - They repeat everything they receive
  - Do not segment the network
  - Do not reformat data structures
    - Cannot connect networks that require different types of frames

# Advantages and Disadvantages of Repeaters and Hubs (continued)

- Repeaters do not segment a network
  - Frames that are broadcast on a given segment may collide
- Devices that “see” the traffic of other devices are said to be on the same **collision domain**

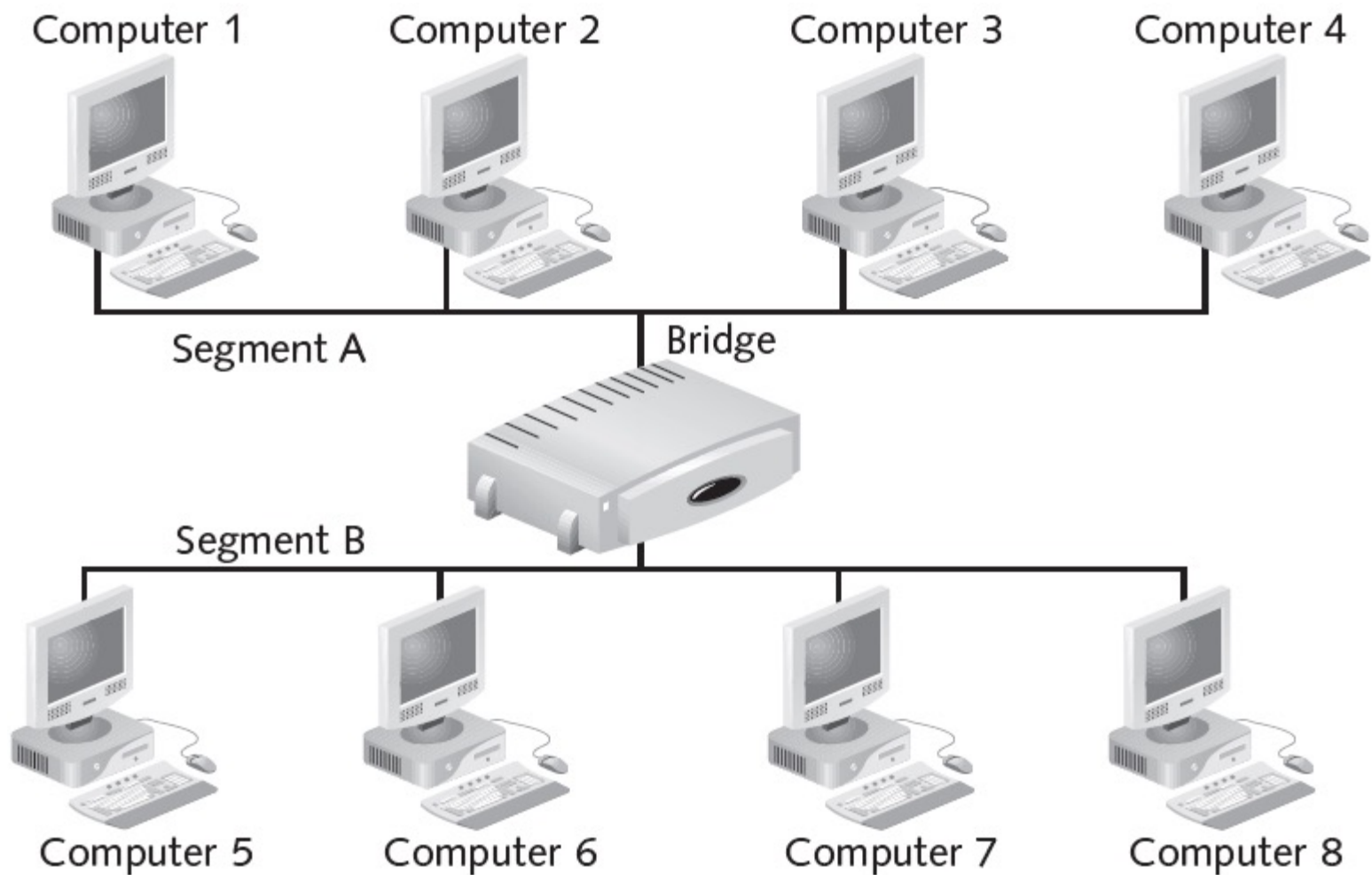
# Bridges

- **Bridges**

- Operate at the Data Link layer of the OSI model
- Filter traffic between network segments by examining the destination MAC address
  - Based on the destination MAC address, the bridge either forwards or discards the frame
- Reduce network traffic by keeping local traffic on the local segment

- **Broadcast frame**

- Frame destined for all computers on the network



**Figure 2-6** Bridge

# Transparent Bridges

- Also called learning bridges
  - Because they build a table of MAC addresses as they receive frames
- They “learn” which addresses are on which segments
- The bridge uses the source MAC addresses to determine which addresses are on which segments
  - By determining a frame’s origin, the bridge knows where to send frames in the future
- Ethernet networks mainly use transparent bridges

# Source-Routing Bridges

- Rely on the source of the frame transmission to provide the routing information
  - The source computer determines the best path by sending out explorer frames
- The source includes the routing information returned by its explorer frames in the frame sent across the network
  - The bridge uses this information to build its table



# Translation Bridges

- Can connect networks with different architectures, such as Ethernet and Token Ring
- These bridges appear as:
  - Transparent bridges to an Ethernet host
  - Source-routing bridges to a Token Ring host

# Advantages and Disadvantages of Bridges

- Advantages

- Can extend a network by acting as a repeater
- Can reduce network traffic on a segment by subdividing network communications
- Increase the available bandwidth to individual nodes because fewer nodes share a collision domain
- Reduce collisions
- Some bridges connect networks using different media types and architectures

- Disadvantages

- Slower than repeaters and hubs
  - Extra processing by viewing MAC addresses
- Forward broadcast frames indiscriminately, so they do not filter broadcast traffic
- More expensive than repeaters and hubs

- **Broadcast storm**

- When two or more stations engage in the transmission of excessive broadcast traffic

# HUB vs Bridge

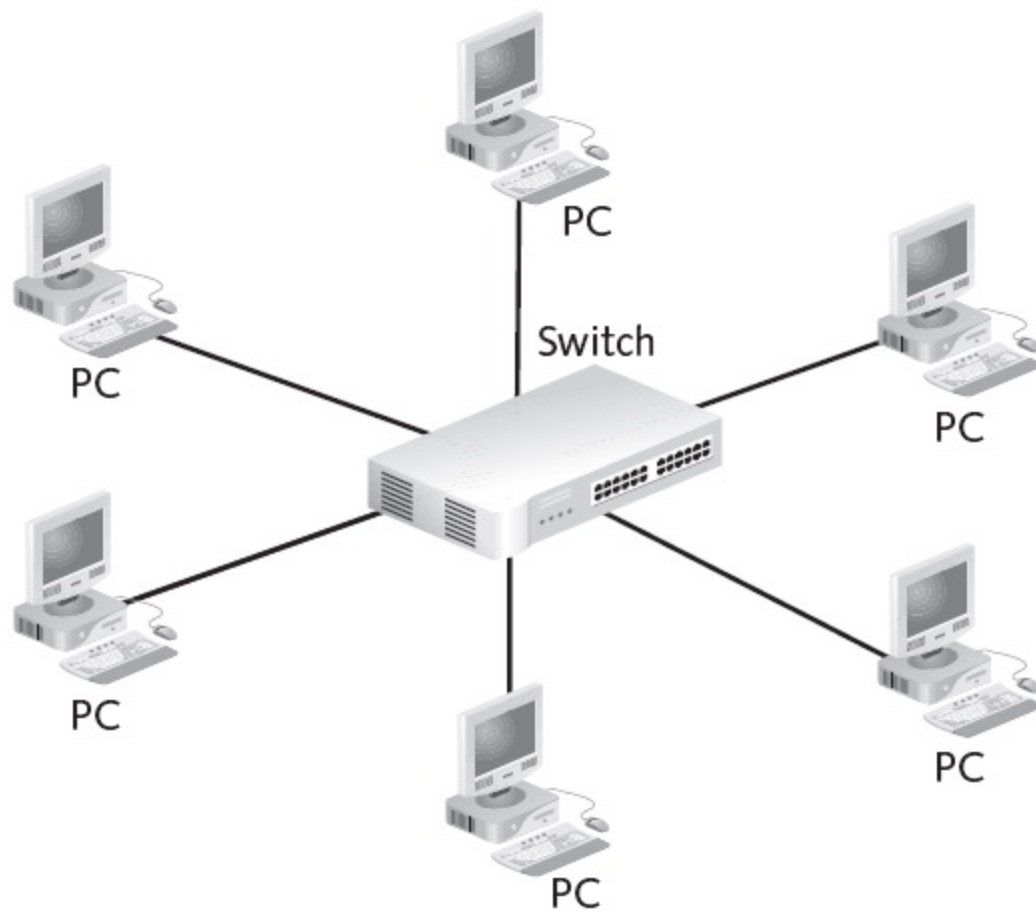
BASIS FOR COMPARISON	HUB	BRIDGE
Basics	Used to connect a number of devices.	Facilitates in the segmentation of the larger network.
Types	Active and Passive	Transparent, translational and source route.
Data filtration	Not performed	Conducted
Uses	Multiple ports	Single incoming and outgoing port
Links	Segments of LAN	Two different LAN employing same protocol.

# Switches

- **Switches**
  - Operate at the Data Link layer of the OSI model
  - Increase network performance by reducing the number of frames transmitted to the rest of the network
- Switch opens a **virtual circuit** between the source and the destination
  - Prevents communications between just two computers from being broadcast to every computer on the network or segment Called **microsegmentation**

# Switches (continued)

- When two machines have a virtual circuit
  - They do not have to share the bandwidth with any other computers
- Multiple virtual circuits can be in use at the same time, each with its own full **bandwidth**
  - Called “switched bandwidth”
- When machines must share a wire and compete for available bandwidth with other machines, they experience **contention**



**Figure 2-7** Star topology using a switch

# Advantages and Disadvantages of Switches

- **Advantages**

- Switches increase available network bandwidth
- Switches reduce the workload on individual computers
- Switches increase network performance
- Networks that include switches experience fewer frame collisions because switches create collision domains for each connection (a process called microsegmentation)
- Switches connect directly to workstations

- **Disadvantages**

- Switches are significantly more expensive than bridges
- Network connectivity problems can be difficult to trace through a switch
- Broadcast traffic may be troublesome

# Hub vs Switch

**Comparison chart**

	<b>Hub</b>	<b>Switch</b>
<b>Layer</b>	Physical layer. Hubs are classified as Layer 1 devices per the OSI model	Data Link Layer. Network switches operate at Layer 2 of the OSI model
<b>Ports</b>	4/12 ports	Switch is multi port Bridge. 24/48 ports
<b>Device Type</b>	Passive Device (Without Software)	Active Device (With Software) & Networking device
<b>Transmission Type</b>	Hubs always perform frame flooding; may be unicast, multicast or broadcast	First broadcast; then unicast & multicast as needed.
<b>Table</b>	A network hub cannot learn or store MAC address.	A network switch stores MAC addresses in a lookup table.
<b>Data Transmission form</b>	Electrical signal or bits	Frame (L2 Switch) Frame & Packet (L3 switch)
<b>Transmission Mode</b>	Half duplex	Full duplex
<b>Function</b>	To connect a network of personal computers together, they can be joined through a central hub.	Allow to connect multiple device and port can be manage, Vlan can create security also can apply
<b>Used in (LAN, MAN, WAN)</b>	LAN	LAN
<b>Broadcast Domain</b>	Hub has one Broadcast Domain.	Switch has one broadcast domain [unless VLAN implemented]
<b>Definition</b>	An electronic device that connects many network device together so that devices can exchange data	A network switch is a computer networking device that is used to connect many devices together on a computer network. A switch is considered more advanced than a hub because a switch will not send msg to device that needs or request it
<b>Collisions</b>	Collisions occur commonly in setups using hubs.	No collisions occur in a full-duplex switch.
<b>Spanning-Tree</b>	No Spanning-Tree	Many Spanning-tree Possible
<b>Manufacturers</b>	Sun Systems, Oracle and Cisco	Cisco and D-link Juniper



# Bridge vs Switch

Bridge	Switch
Segments a Local Area Network (LAN) into a couple of smaller segments	Segments a large LAN into many smaller segments
Contains only a few ports for LAN connectivity	Contains many ports for LAN connectivity
Contains only one instance of spanning tree	Contains many instances of spanning tree

# Routers

- **Routers**

- Operate at the Network layer of the OSI model
- Provide filtering and network traffic control on LANs and WANs
- Can connect multiple segments and multiple networks

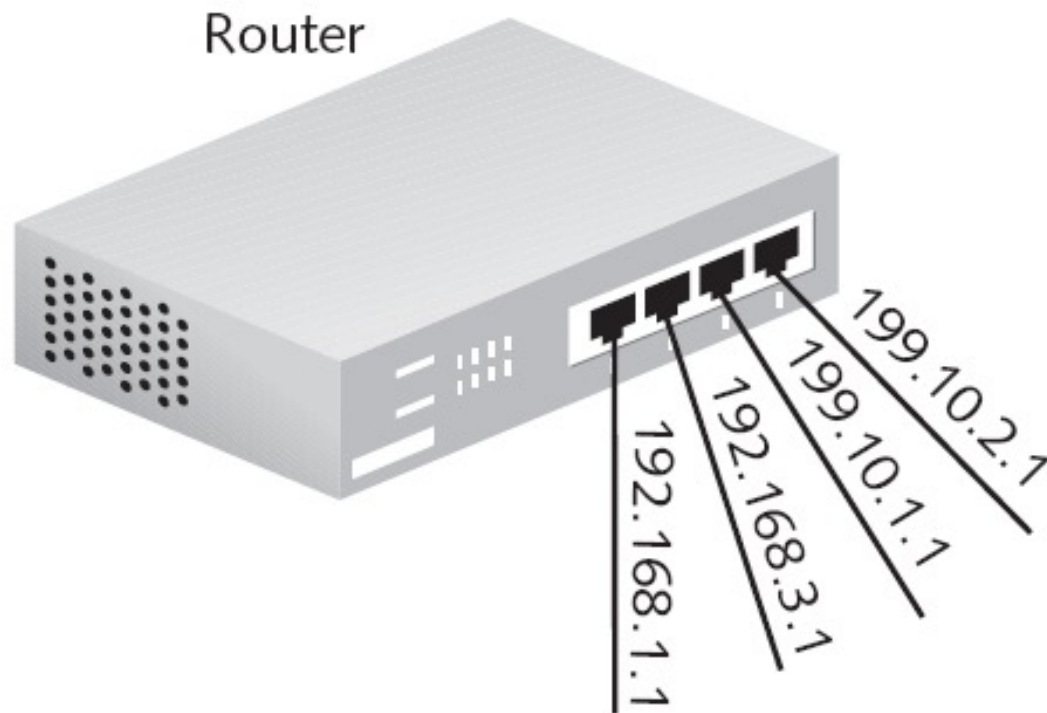
- **Internetworks**

- Networks connected by multiple routers
- Similar to switches and bridges in that they segment a network and filter traffic
  - Routers use the logical address

# Physical vs. Logical Addresses

- MAC address
  - Found at the Data Link layer of the OSI model
  - Used by bridges and switches to make forwarding decisions within a network or **subnetwork**
- **IP address**
  - Logical address when TCP/IP is used on an internetwork
- Routers use the IP address to route packets to the correct network segment

# Physical vs. Logical Addresses (continued)



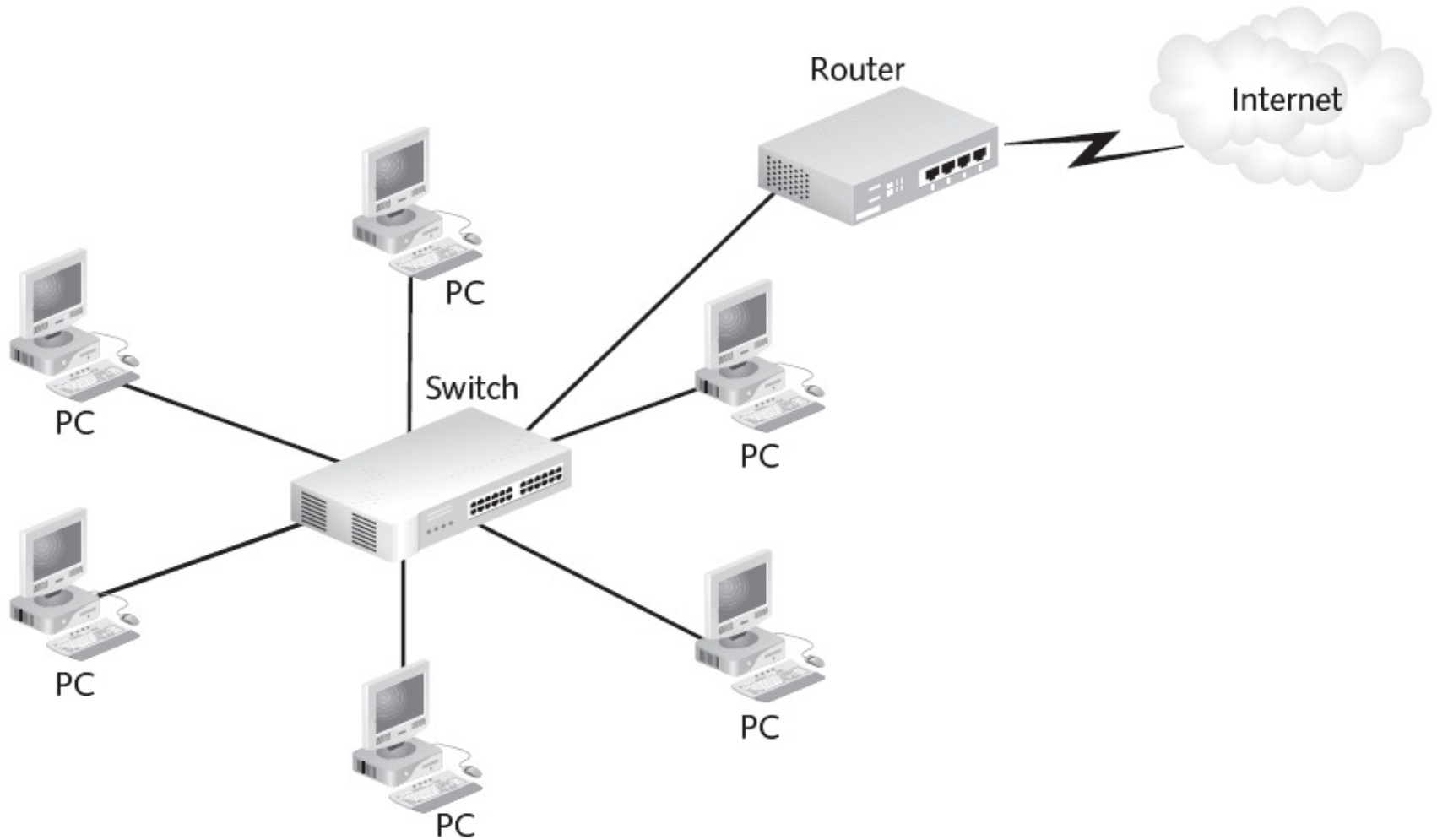
**Figure 2-8** Router

# Advantages and Disadvantages of Routers

- Advantages
  - Can connect different network architectures, such as Ethernet and Token Ring
  - Can choose the best path across an internetwork using dynamic routing techniques
  - Reduce network traffic by creating collision domains
  - Reduce network traffic by creating broadcast domains

# Advantages and Disadvantages of Routers (continued)

- Disadvantages
  - Routers work only with routable network protocols; most but not all protocols are routable
  - Routers are more expensive than other devices
  - Dynamic router communications (inter-router communication) cause additional network overhead, which results in less bandwidth for user data
  - Routers are slower than other devices because they must analyze a data transmission from the Physical through the Network layer



**Figure 2-9** Router connecting network to the Internet

# Brouters

- Hybrid device
- Functions as both a bridge for nonroutable protocols and a router for routable protocols
- Provides the best attributes of both a bridge and a router
- Operates at both the Data Link and Network layers and can replace separate bridges and routers
- A Brouter can connect networks that use different protocols.
- It can be programmed to work only as a bridge or only as a router.
- When it is configured as a bridge, it forwards data packets to the appropriate segment using a specific protocol.
- When it is configured as a router, it routes the data packets to the appropriate network using a routed protocol such as IP.



# Router vs. BRouter

S.No	Router	Brouter
1	A router is a networking device that forwards data packets between computer network.	Brouter is a networking device which is used both as a bridge and as a router,It is combination of network bridge and a router.
2	It operates at Network layer.	It operates either at Data link layer or a Network layer.
3	Router stores routing table.	Brouter stores routing table when it is configured as a router and stores MAC address when configured as a bridge.
4	It takes forwarding decisions based on IP address.	Forwarding decision are taken based on IP address when it is configured as a router, or It takes forwarding decisions based on MAC address when configured as a bridge.
5	Router transmits data in the form of packets.	Brouter transmits data in the form of packets when it is configured as a router and It transmits data in the form of frames when configured as a bridge.
6	Router works on more than one broadcast domain.	Brouter works on more than one broadcast domain when it is configured as a router and It works on single broadcast domain when configured as a bridge.
7	Router is full duplex.	Brouter is full duplex when it is configured as a router and it is half duplex when configured as a bridge.

# Routers Vs Switch

	Router	Switch
<b>Technical Specifications:</b>	Routers operate at Layer 3 (Network) of the OSI model.	Network switches operate at layer two (Data Link Layer) of the OSI model.
<b>Layer:</b>	Network Layer (Layer 3 devices)	Data Link Layer (Layer 2 devices)
<b>Transmission Type:</b>	At Initial Level Broadcast then Uni-cast & Multicast	At Initial Level Broadcast then Uni-cast & Multicast
<b>Table:</b>	Store IP address in Routing table and maintain address at its own.	Store MAC address in lookup table and maintain address at its own, Switch can Learn MAC address.
<b>Used in (LAN/MAN/WAN):</b>	LAN, WAN	LAN
<b>Device Type:</b>	Networking device	Networking device
<b>Ports:</b>	2/4/8	Switch is multi port Bridge. 24/48 ports
<b>Data Transmission form:</b>	Packet	Frame (L2 Switch) Frame & Packet (L3 switch)

# Routers Vs Bridge

Routers	Bridges
Routers operates in network layer of OSI Model.	Bridge operates in data link layer of OSI Model.
Router is use to connect the LAN and WAN.	Bridge is use to connect two different LAN segments.
Router transmits data in the form of packets.	Bridge transmit data in the form frames.
Router reads the IP Address of a device.	Bridge reads the MAC Address of a device.
Router has more ports compare to bridge.	Bridge has only two ports.
Router uses routing table for sending data.	Bridge does not use any routing table for sending data.

# Overview of network Device

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.