INTRODUCTION

UNIT-I (Part-A)

Contents:

- Definition
- Components
- Classification of Networks

Definition & Components

- A network is the interconnection of a set of devices capable of communication.
- Components:
  - Devices(End Devices, Connecting Devices)
  - Transmitter / Receiver
  - Media – Wired / Wireless
  - Data (Text/Multimedia/File..)
  - Rules/Protocols

Fundamental Characteristics

- **Delivery**:

  The system must deliver data to the correct destination.

- **Accuracy:**

  The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.

- **Timeliness**:

  The system must deliver data in a timely manner without significant delay. Strict kind of delivery is called real-time transmission.

- **Jitter:**

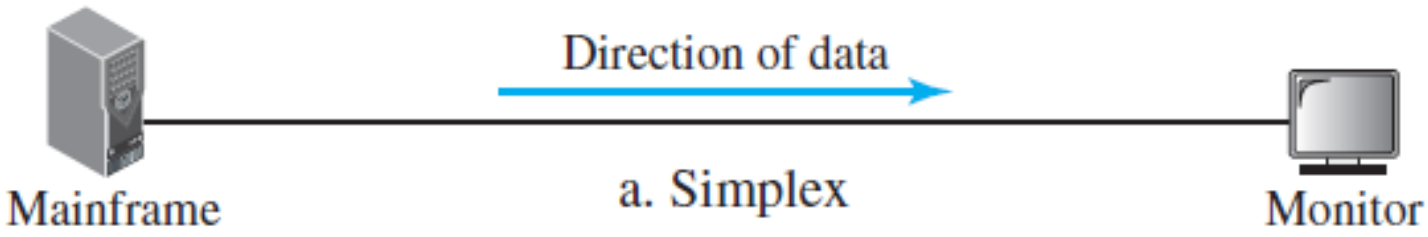
  Jitter refers to the variation in the packet arrival time.

Classification of Networks

- Data Flow
  - Simplex / Half Duplex / Full Duplex
- Size/Scale
  - PAN / LAN / MAN / WAN
- Type of connection
  - Point-to-point / Multipoint or Broadcast
- Physical Topology
  - Mesh / Star / Bus / Ring / Hybrid
- Network Media Connectivity
  - Wired / Wireless / Adhoc / Heterogeneous
- Service offered
  - Connection oriented / Connection less
- Data Forwarding mechanism (Switching)
  - Circuit / Message / Packet Switching

Classification based on Data Flow

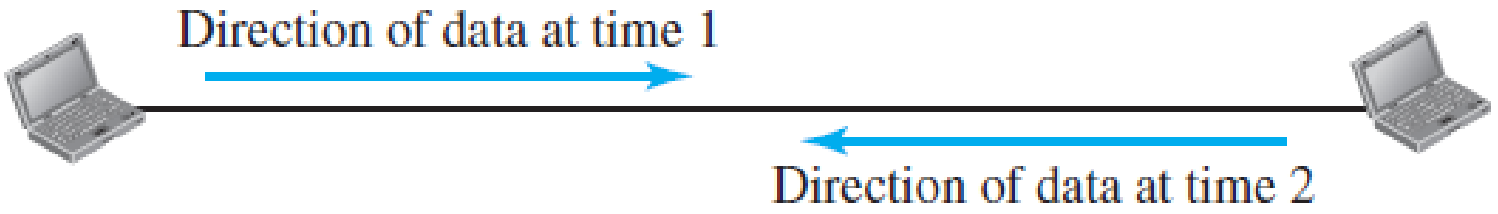
- Simplex:
  - the communication is unidirectional
  - Only one of the two devices on a link can transmit; the other can only receive
  - Ex: keyboard can only introduce input; the monitor can only accept output



a. Simplex

Classification based on Data Flow…

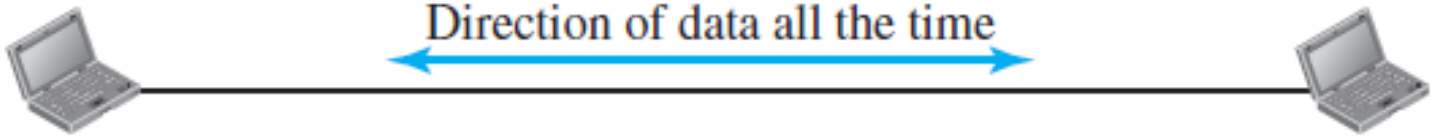
- Half Duplex:
  - each station can both transmit and receive, but not at the same time.
  - When one device is sending, the other can only receive, and vice versa.
  - Ex: Walkie-talkies and CB (citizens band) radios



b. Half-duplex

Classification based on Data Flow…

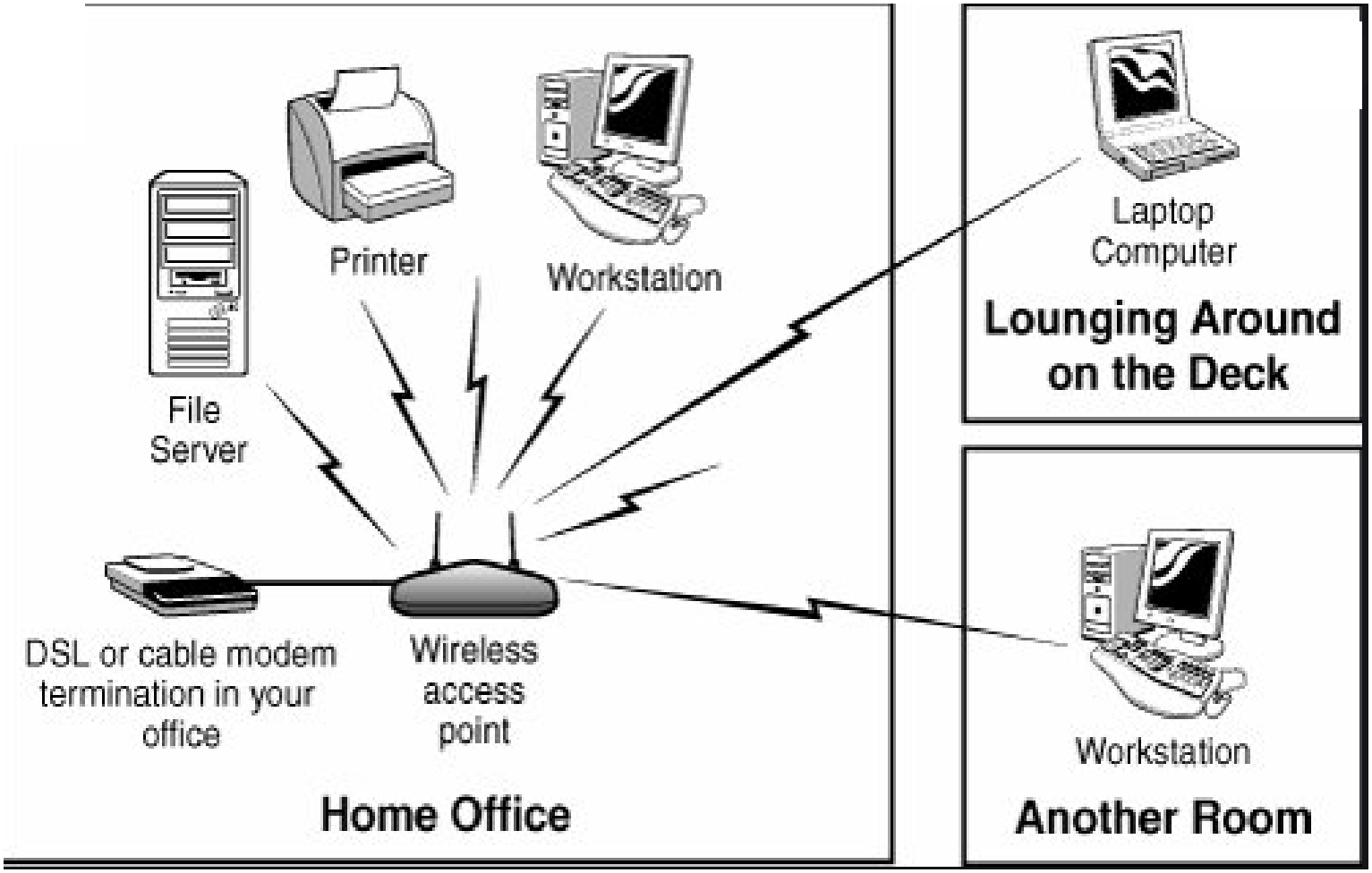
- Full Duplex:
  - both stations can transmit and receive simultaneously.
  - the link must contain two physically separate transmission paths, one for sending and the other for receiving (or) the capacity of the channel is divided between signals traveling in both directions (or) using software mechanism.
  - Ex: Telephone network



c. Full-duplex

Classification based on Size/Scale

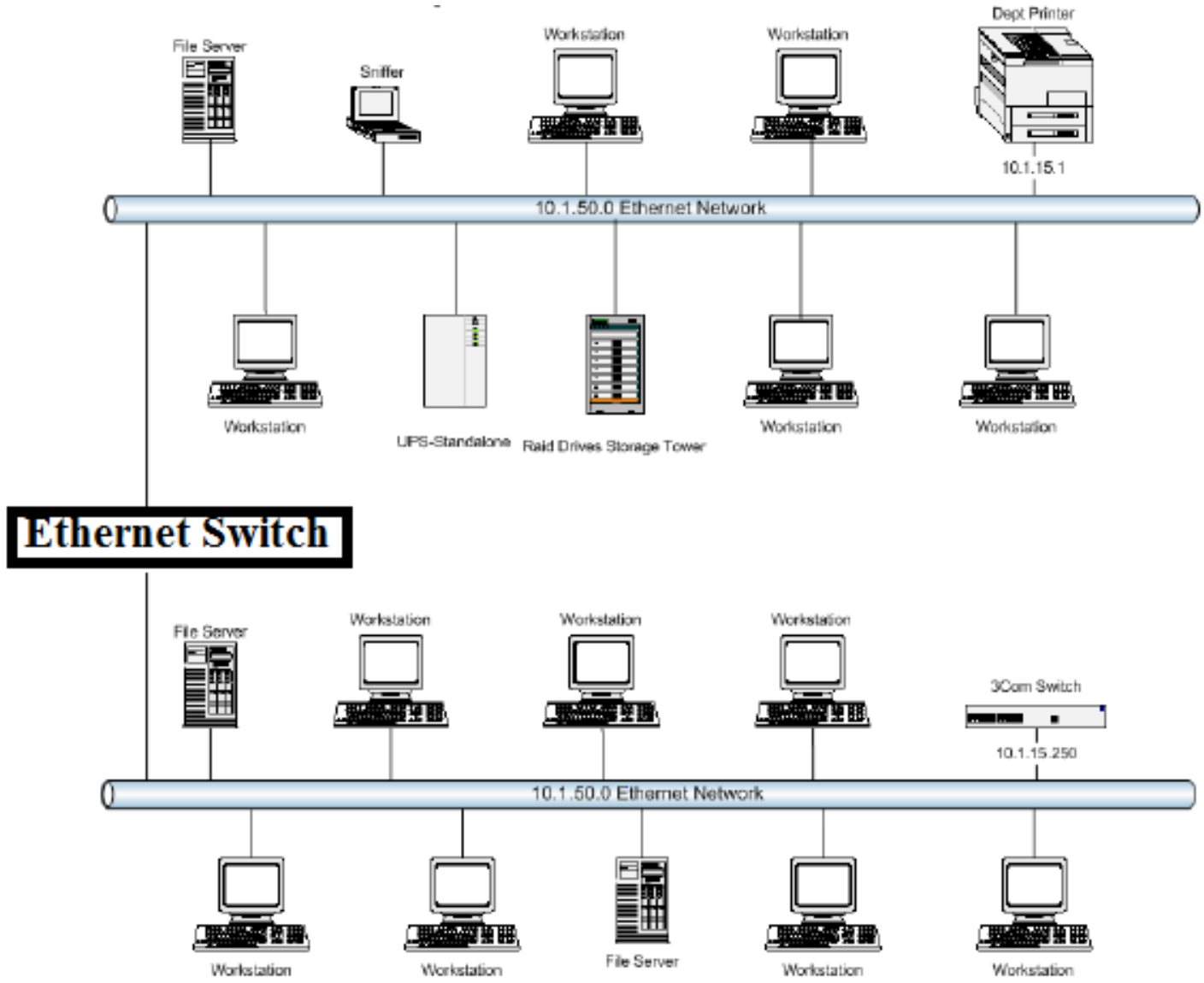
- Personalized Area Network (PAN)
  - The interconnection of devices within the range of an individual person, typically within a small office (SOHO) or residence.
  - Ex: a wireless network connecting a computer with its keyboard, mouse, mobile or printer



Small Office Home Office(SOHO) Network

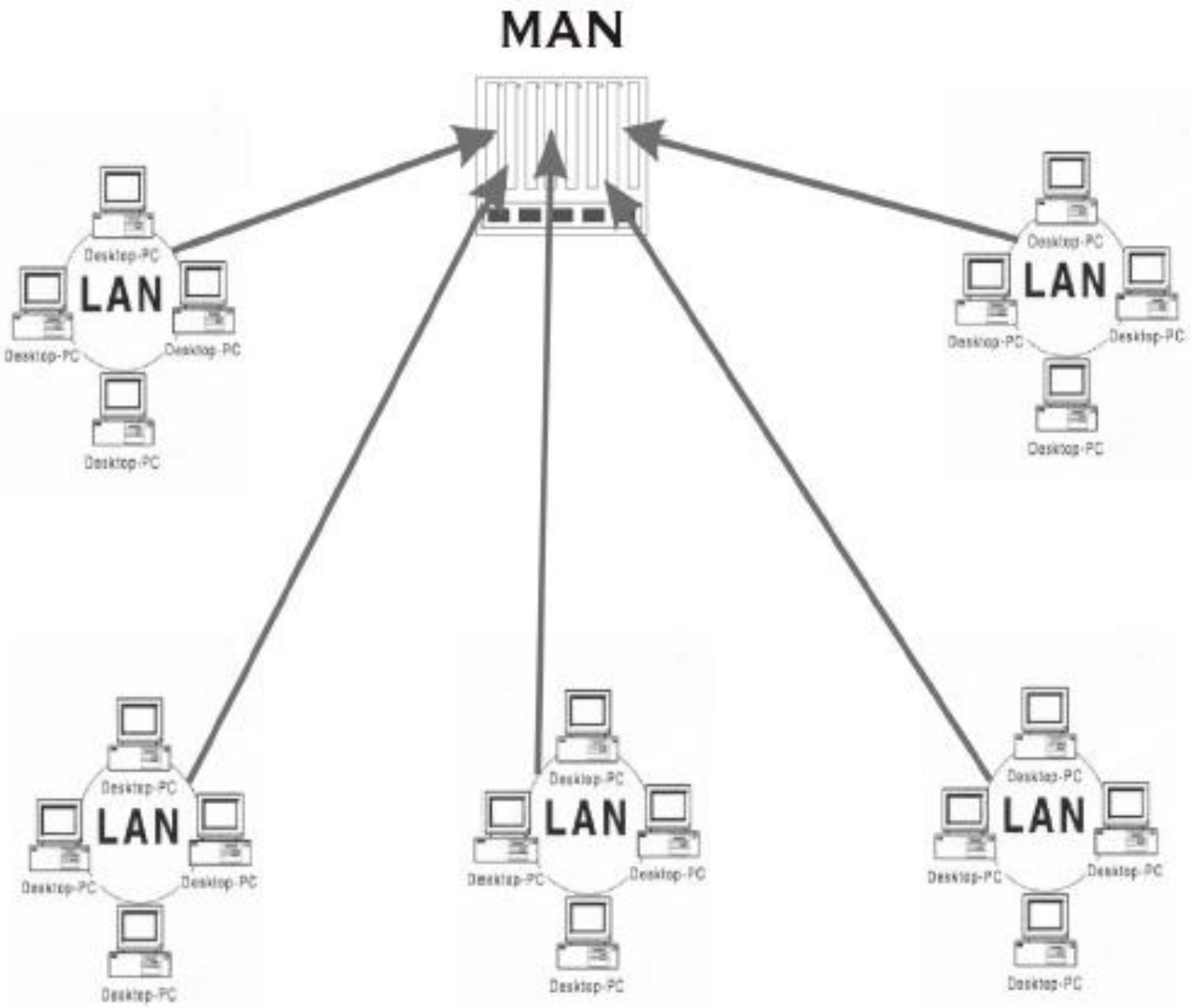
Classification based on Size/Scale…

- Local Area Network (LAN)
  - consists of a computer network at a single site, typically an individual office building.
  - typically used for single sites where people need to share resources among themselves but not with the rest of the outside world.
  - Ex: Network with in our college


File Server
Sniffer
Workstation
Workstation
Dept Printer
10.1.15.1
10.1.50.0 Ethernet Network
Workstation
UPS-Standalone
Raid Drives Storage Tower
Workstation
Workstation
Ethernet Switch
File Server
Workstation
Workstation
Workstation
3Com Switch
10.1.15.250
10.1.50.0 Ethernet Network
Workstation
Workstation
File Server
Workstation
Workstation

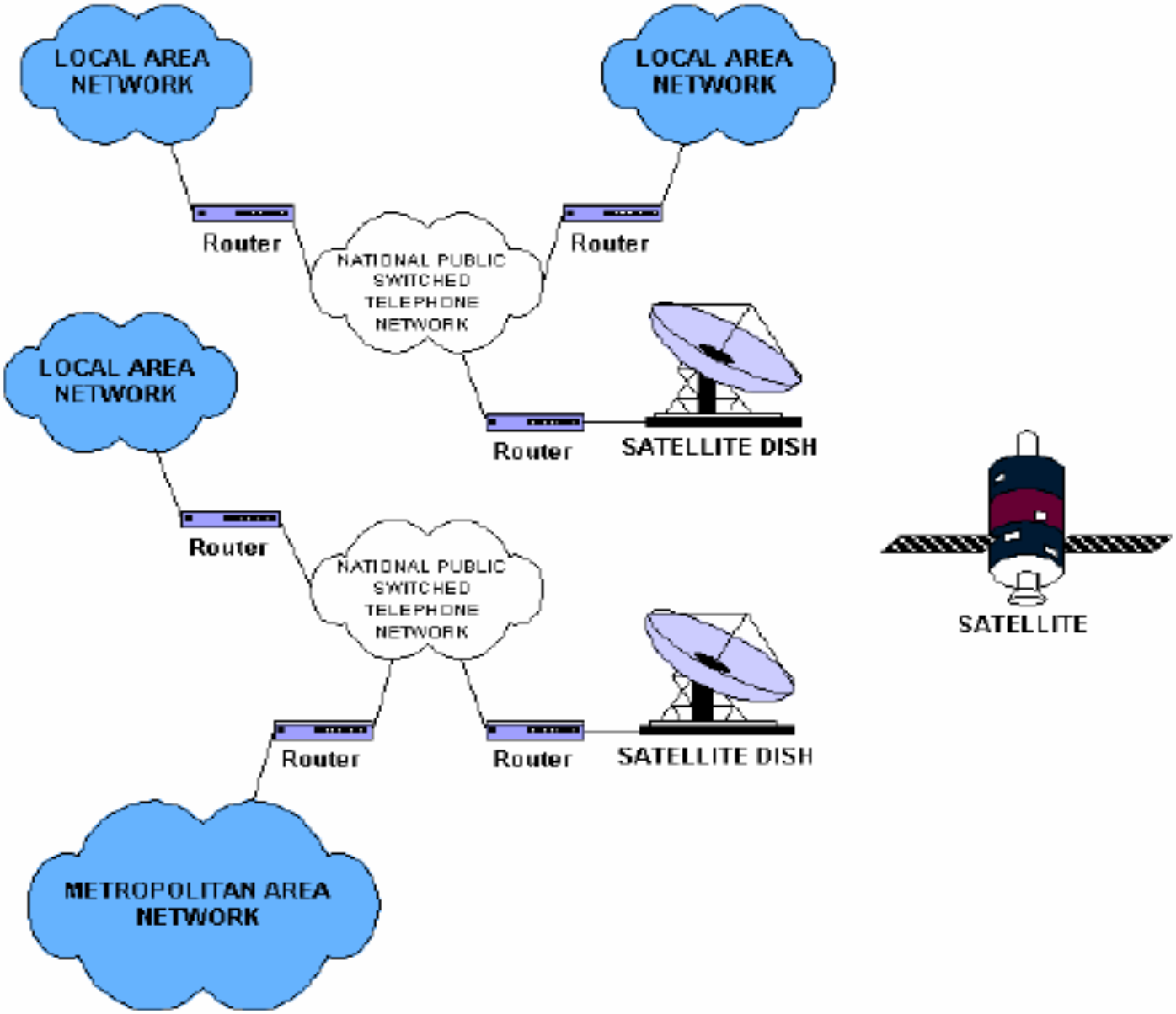
Classification based on Size/Scale…

- Metropolitan Area Network (MAN)
  - consists of a computer network across an entire city, or small region.
  - It is often used to connect several LANs of an organization together to form a bigger network.
  - Ex: Cable Network


MAN
LAN
Desktop-PC
LAN
Desktop-PC
LAN
Desktop-PC
LAN
Desktop-PC
LAN
Desktop-PC

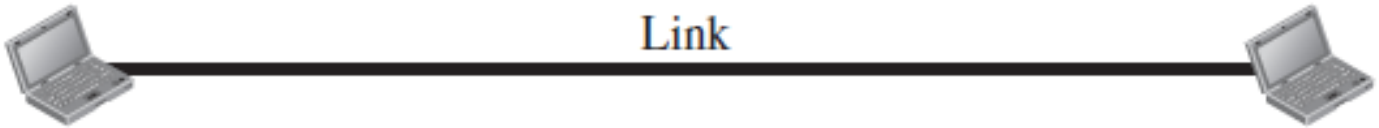
Classification based on Size/Scale…

- Wide Area Network
  - is a computer network that spans a large geographical area
  - are implemented to connect a large number of LANs and MANs.
  - may contain large number of heterogeneous networks.
  - Ex: Telecommunication Network, Internet.

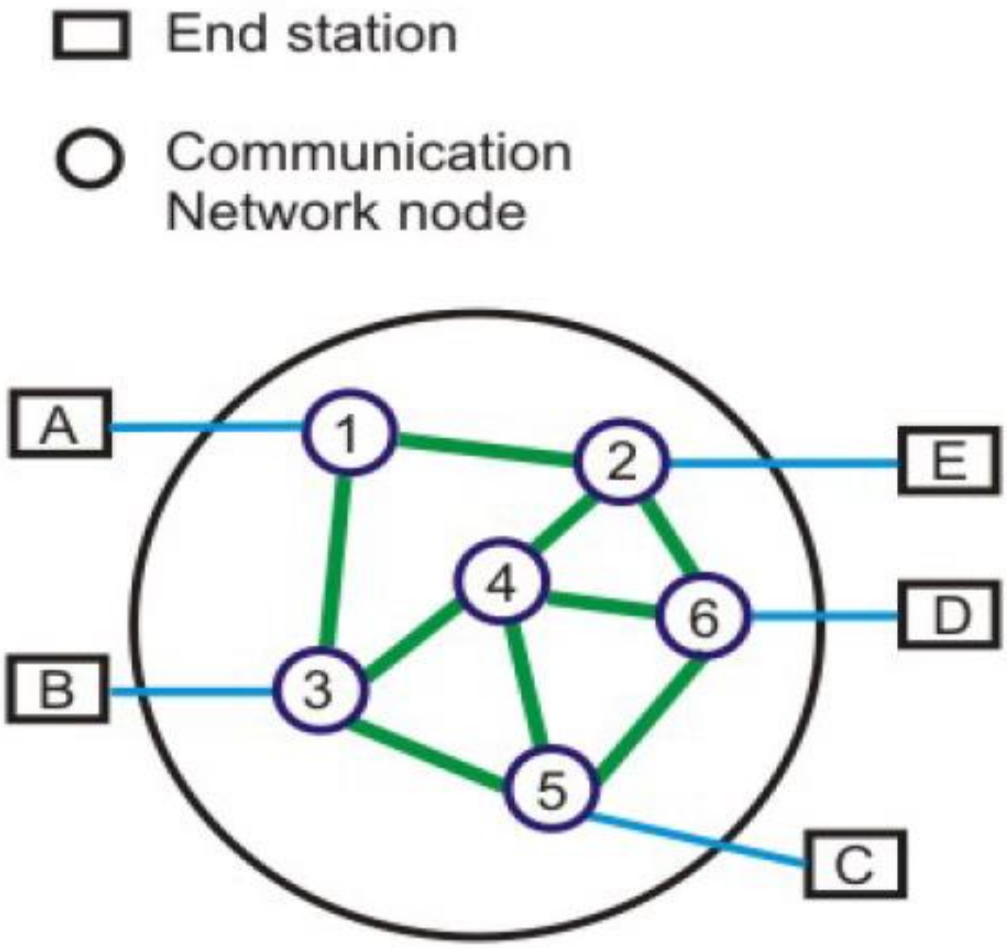

LOCAL AREA NETWORK
LOCAL AREA NETWORK
Router
NATIONAL PUBLIC SWITCHED TELEPHONE NETWORK
Router
LOCAL AREA NETWORK
Router
SATELLITE DISH
Router
NATIONAL PUBLIC SWITCHED TELEPHONE NETWORK
SATELLITE
Router
Router
SATELLITE DISH
METROPOLITAN AREA NETWORK

Classification based on Type of Connection

- Point to Point Networks (P2P)
  - provides a dedicated link between two devices.
  - the entire capacity of the link is reserved for transmission between those two devices.
  - Ex: remote control and the television.



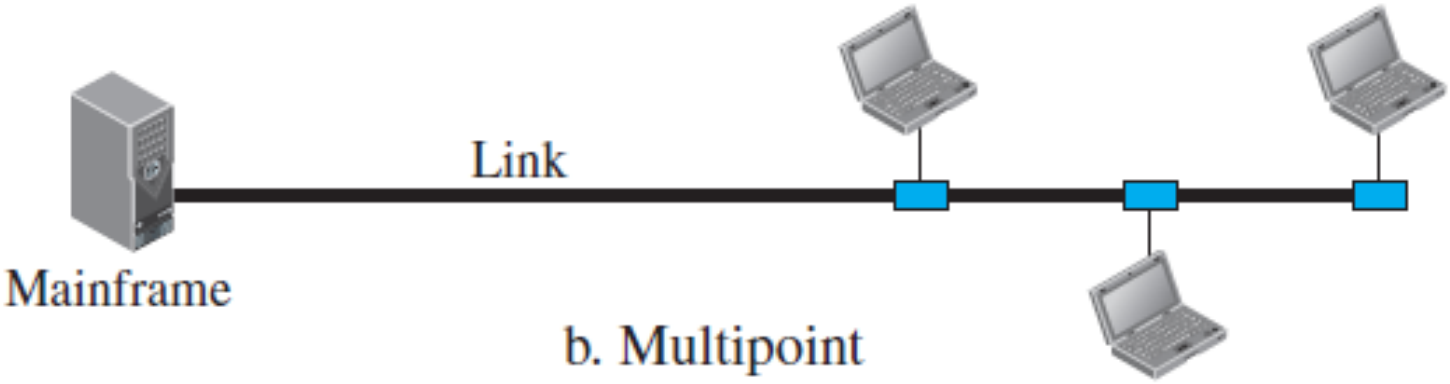
a. Point-to-point



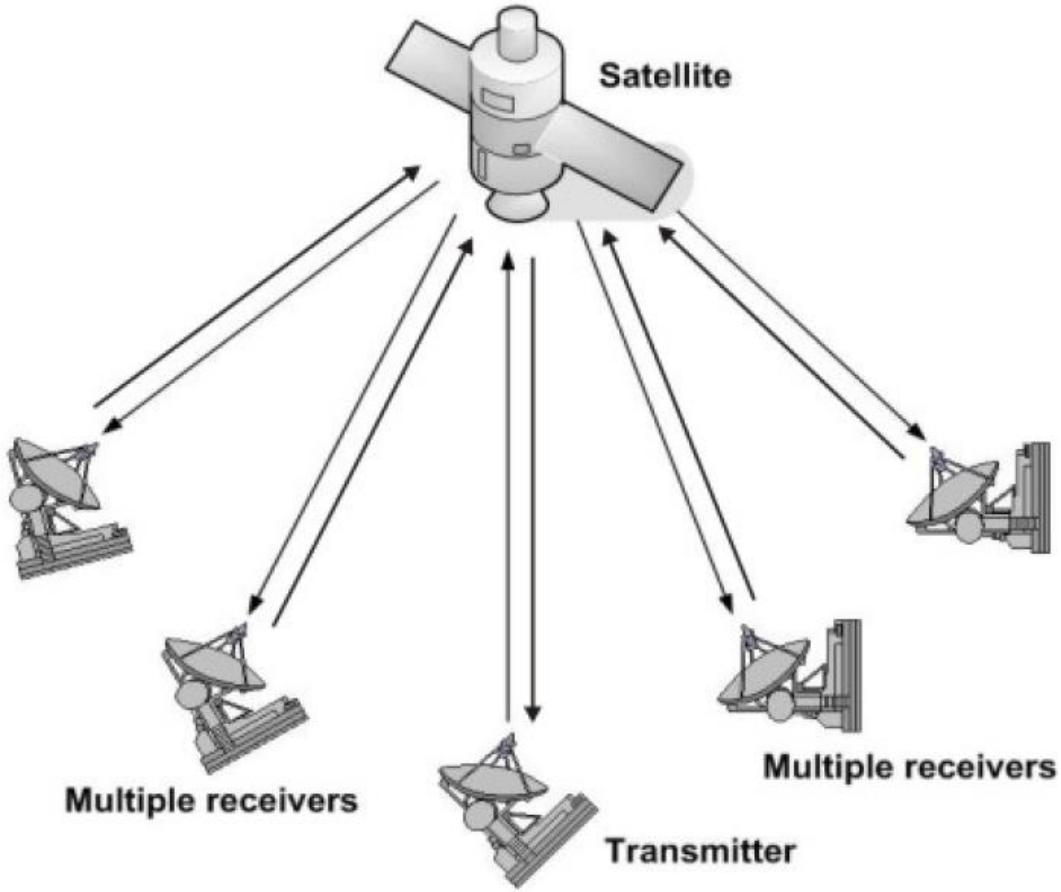
Communication network based on point-to-point communication

Classification based on Type of Connection...

- Multipoint / Broadcast Networks
  - is one in which more than two specific devices share a single link.
  - the capacity of the channel is shared, either spatially or temporally



b. Multipoint

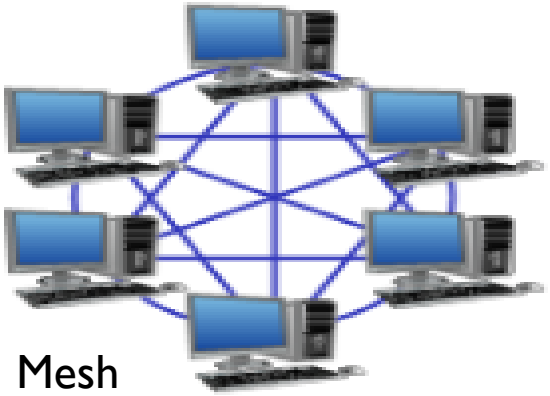


Example of a broadcast network based on satellite communication

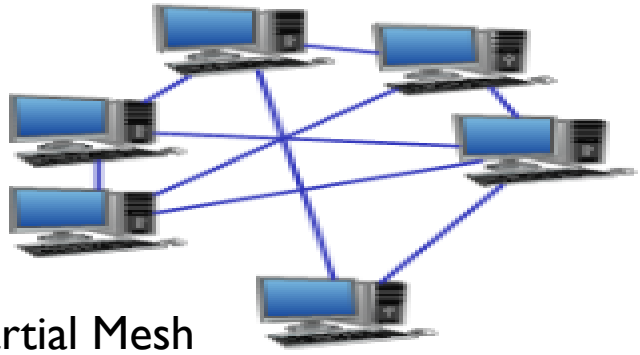
As a general rule (although there are many exceptions), smaller, geographically localized networks tend to use broadcasting, whereas larger networks normally use are point-to-point communication.

Classification based on Topology

- Mesh Topology
  - Every networked node is directly connected to every other networked node(Peer to Peer)
  - This topology features the ultimate reliability and fault tolerance
  - Full Mesh - N Nodes → N(N-1)/2 Links
  - Partial Mesh – N Nodes → < N(N-1)/2 Links



Full Mesh

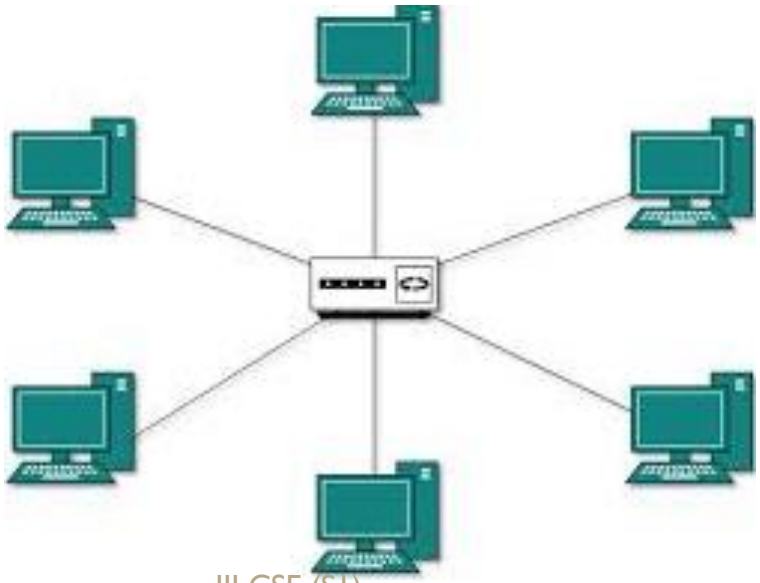


Partial Mesh

- Advantages
  - Minimizes the number of hops between any two network-connected machines
  - Can be built with virtually any transmission technology
- Disadvantages
  - These WANs can be fairly expensive to build
  - A finite (although substantial) limit on the scalability of the network
  - Unlike fully meshed networks, a partial mesh can reduce the startup and operational expenses

Classification based on Topology…

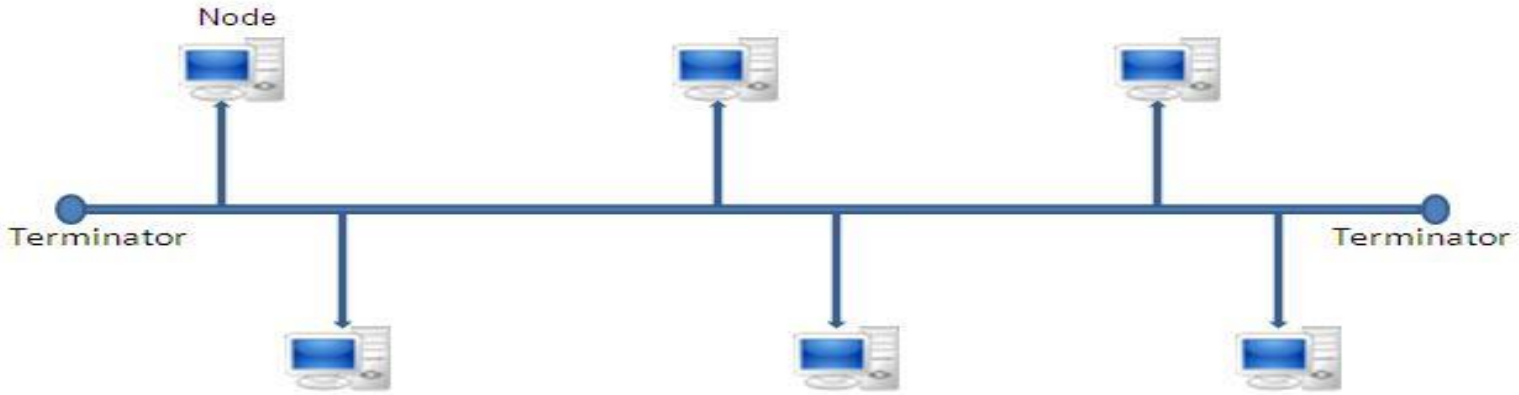
- Star Topology
  - each node is connected to a central hub/switch using a point-to-point connection.
  - it is very popular because the startup costs are low.
  - It is also easy to add new nodes to the network.



- Advantages
  - Centralized management. It helps in monitoring the network
  - Failure of one node or link doesn't affect the rest of network
- Disadvantages
  - If central device fails whole network goes down
  - Performance and as well number of nodes which can be added in such topology is depended on capacity of central device

Classification based on Topology…

- Bus Topology
  - All networked nodes are interconnected, peer to peer, using a single, open-ended cable
  - Both ends of the bus must be terminated with a terminating resistor to prevent signal bounce

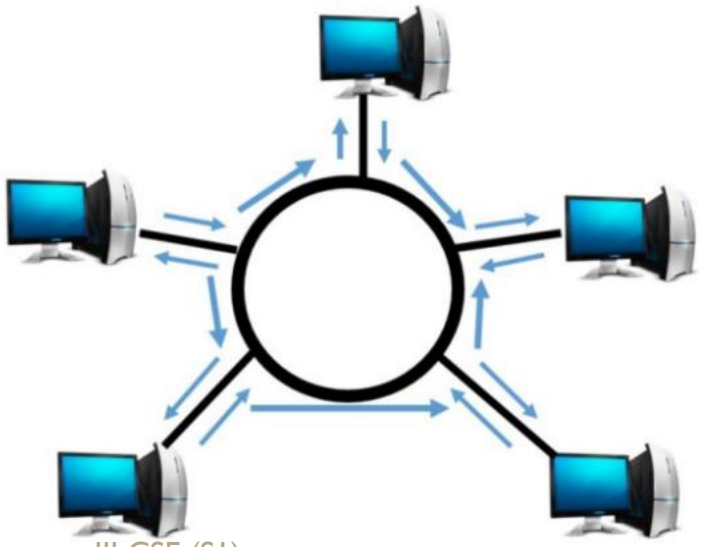


- Advantages
  - Easy to implement and extend
  - Well suited for temporary networks that must be set up in a hurry
  - Typically the least cheapest topology to implement
  - Failure of one station does not affect others

- Disadvantages
  - Difficult to administer/troubleshoot
  - Limited cable length and number of stations
  - A cable break can disable the entire network; no redundancy
  - Performance degrades as additional computers are added

Classification based on Topology…

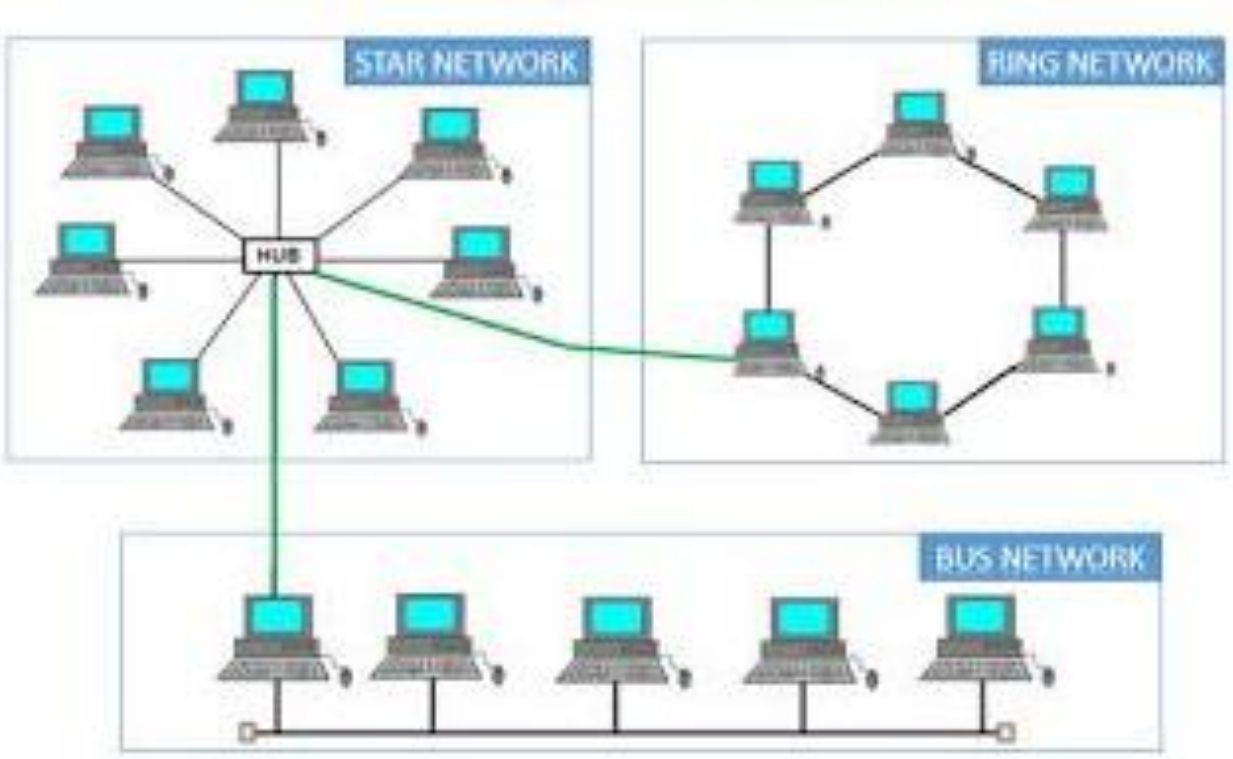
- Ring Topology
  - Each networked workstation had two connections: one to each of its nearest neighbors
  - Data was transmitted unidirectionally around the ring. Sending and receiving of data takes place by the help of TOKEN



- Advantages
  - It provides alternative routes
  - It is less expensive than all
  - It is also good for handling high-volume traffic over long distances since every computer can act as a booster of the signal.
- Disadvantages
  - Depending on the geographic dispersion of the locations, adding an extra transmission facility to complete the ring may be cost prohibitive
  - Rings are not very scalable

Classification based on Topology…

- Hybrid Topology
  - A combination of two or more topology is known as hybrid topology.



- Advantages
  - We can choose the topology based on the requirement
  - Scalable as we can further connect other computer networks with the existing networks
- Disadvantages
  - Fault detection is difficult.
  - Installation is difficult.
  - Design is complex so maintenance is high thus expensive.

Classification based on Kind of Network Media connectivity

- Wired Networks
  - can be defined as the connection of nodes through physical media connection such as Twisted pair, Coaxial Cable, Optical Fiber

Advantages:

- it has high bandwidth and low interference
- security in the wired network is better

Disadvantages:

- more expensive
- Mobility of devices is not possible

Classification based on Kind of Network Media connectivity

- Wireless Networks
  - the network where the connections are made without the physical wired connection i.e. using electromagnetic radiation, satellite communication

Advantages:

- low cost and mobility
- easy to install

Disadvantages:

- need a high security because the data is transmitted in air
- high interference/noise due to external factors

Classification based on Kind of Network Media connectivity

- Adhoc Networks
  - the network which continuously changes i.e. nodes change
  - generally such networks are wireless
  - If mobility is also involved they are called Mobile Adhoc Networks(MANETS)

Advantages:

- Self-configuring & Flexible

Disadvantages:

- more connection failures
- performance considerations
- network connection costs

Classification based on Kind of Network Media connectivity

- Heterogeneous Networks
  - the network which is combination of wired / wireless / adhoc networks
  - mostly used in real time networks

Advantages:

  - High scalability

Disadvantages:

  - Integration of technologies
  - Installation & trouble shooting
  - maintenance costs

Classification based on Service Offered

- Connection Oriented Service
  - The **Connection oriented services** establish a **connection** prior to sending the packets belonging to the same message from source to the destination.
  - It includes three stages
    1) Connection Establishment.
    2) Data Transmission.
    3) Connection Release.
  - In connection-oriented service, Handshake method is used to establish the connection between sender and receiver.

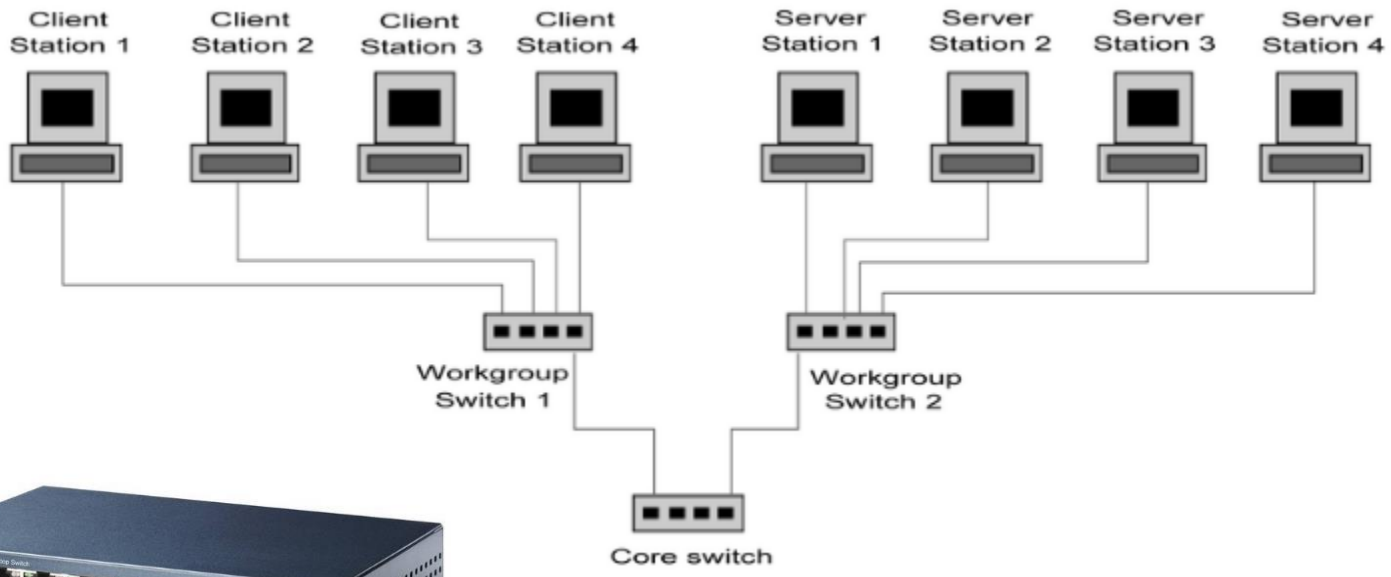
Classification based on Service Offered

- Connectionless Service
  - It does not include any connection establishment and connection termination.
  - Connectionless Service does not give the guarantee of delivery of data.
  - Authentication is not needed.

Switching

- End devices need not be directly connected to each other
- In such cases the end devices are connected by means of set of intermediary devices
- The mechanism of forwarding data between devices of such network is called network switching.

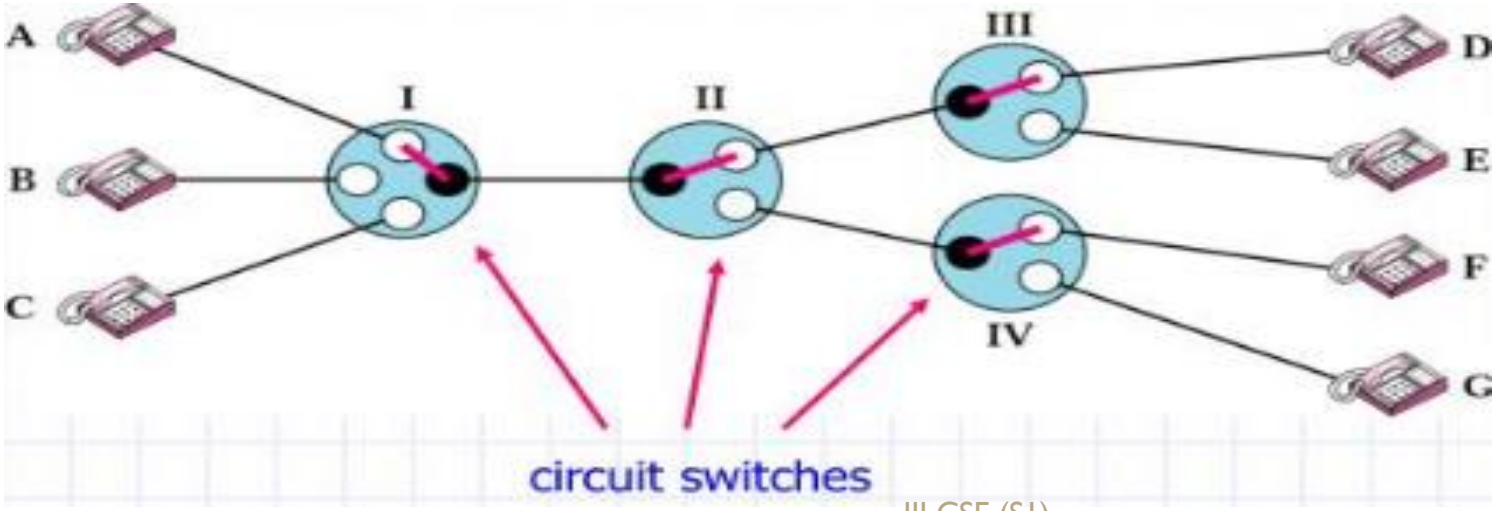
Switching

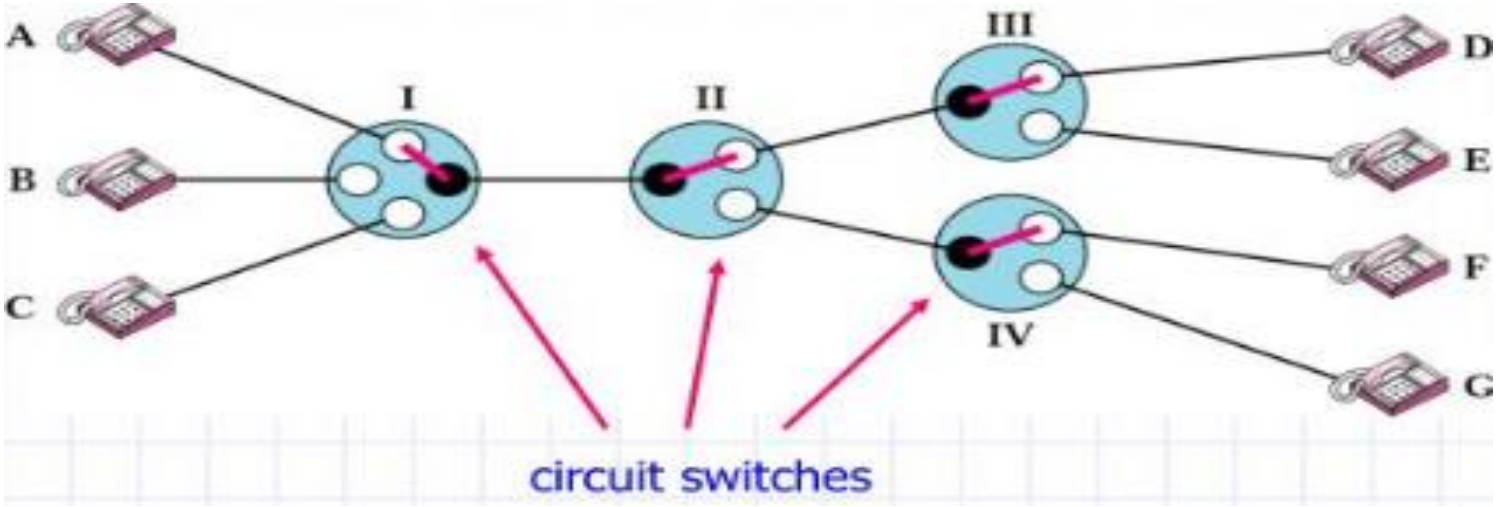


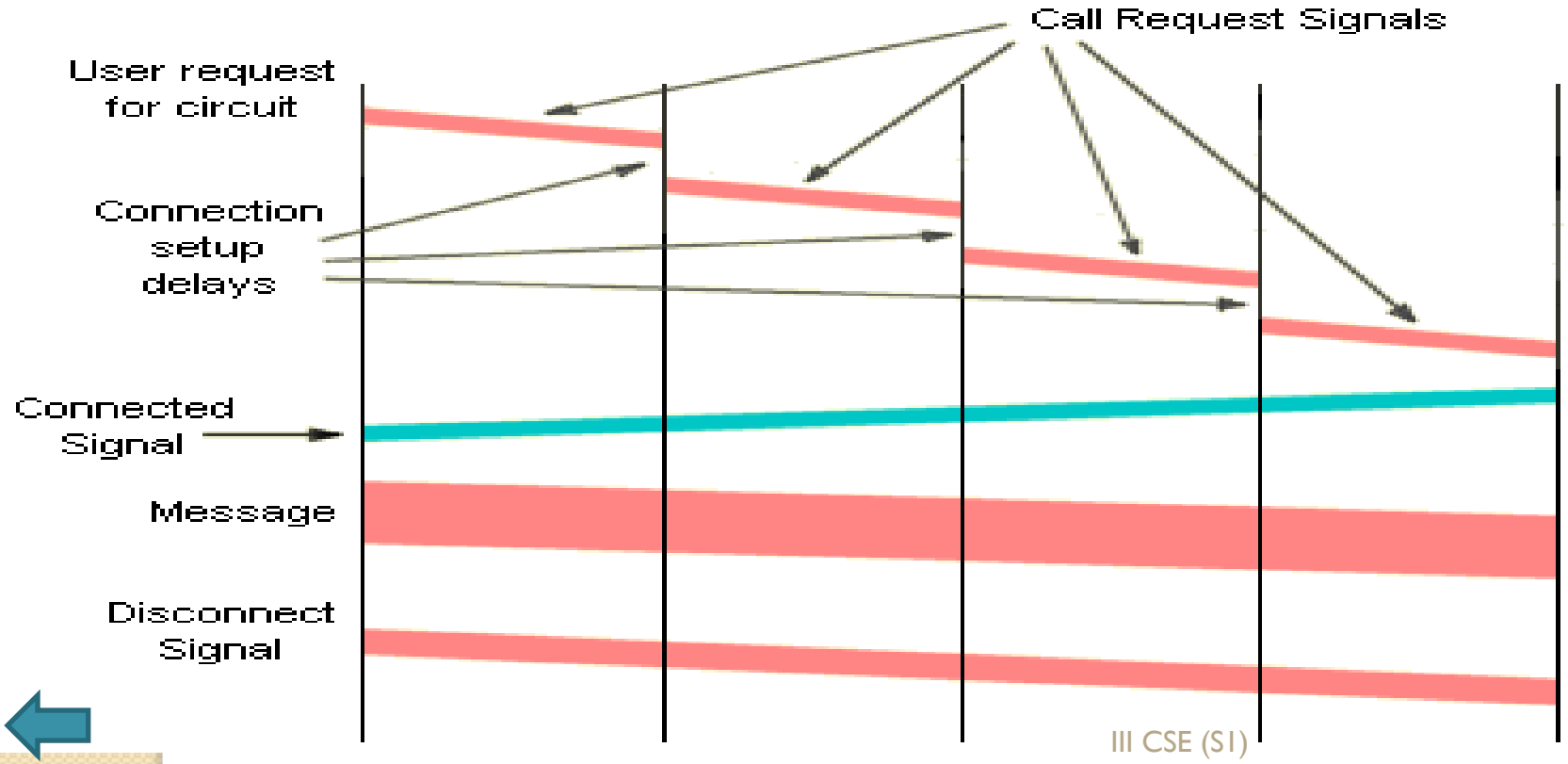
- Data entering through a incoming line/port is referred to as **ingress**, while data leaving through outgoing line/port is referred to as **egress**.

Classification based on Switching

- Circuit Switching
  - A dedicated connection, called a circuit, is always available between the two end systems; the switch can only make it active or inactive.
  - the delay is observed in establishing a physical connection.




A
B
C
I
II
III
IV
D
E
F
G
circuit switches

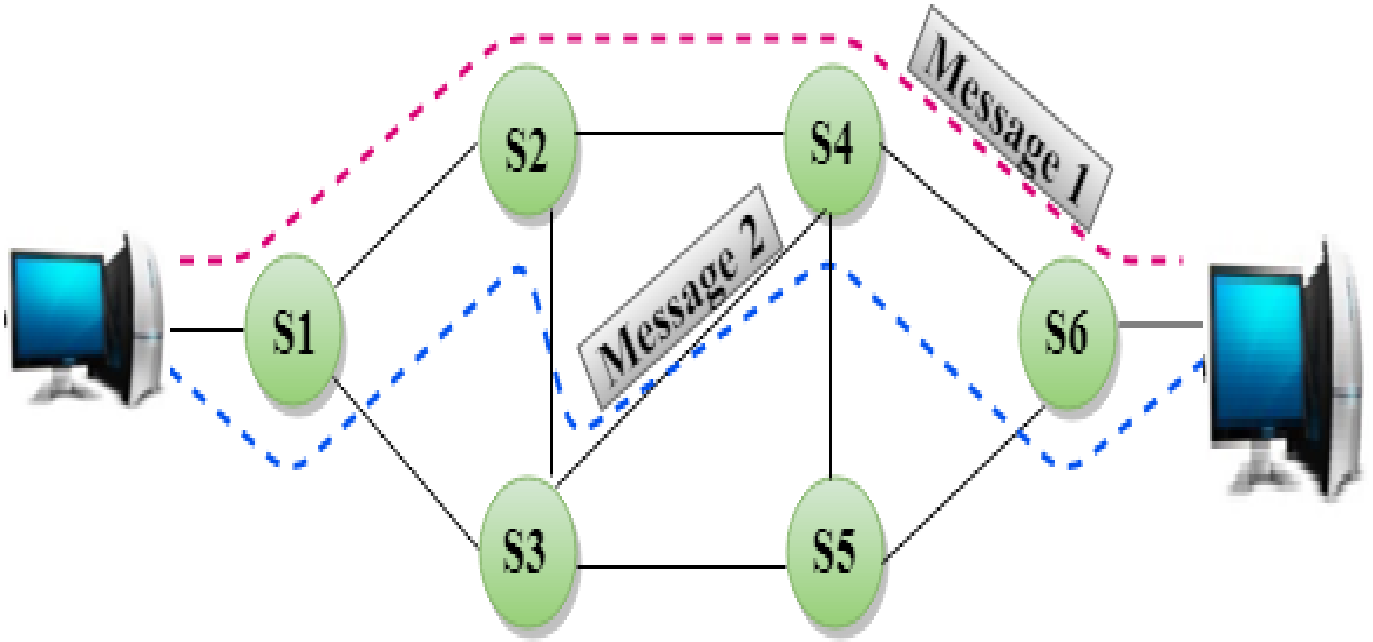

Call Request Signals
User request for circuit
Connection setup delays
Connected Signal
Message
Disconnect Signal

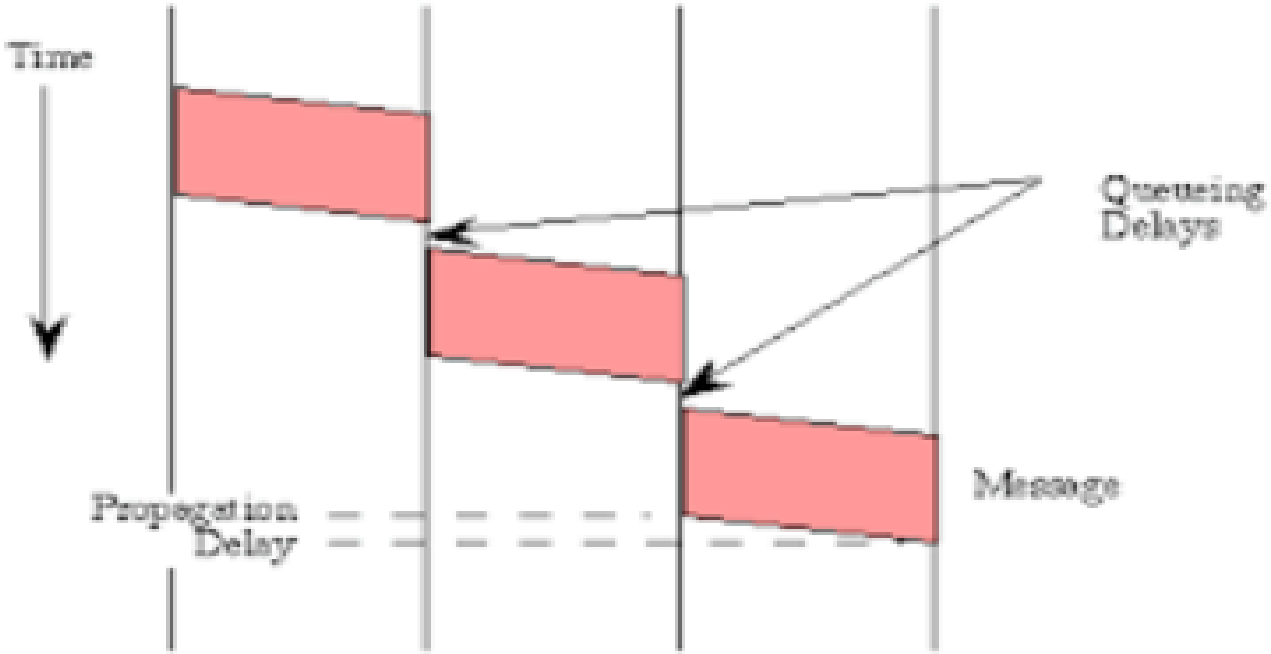
- Advantages
  - The quality of communication is increased as a dedicated communication channel is used.
  - The rate at which the data is transmitted is fixed.
  - It is preferred when the communication is long and continuous.

- Disadvantages
  - Since a dedicated channel is been used, the transmission of other data becomes impossible.
  - The time taken by the two stations for the establishment of the physical link is too long.
  - Circuit switching is expensive because every connection uses a dedicated path establishment.

Classification based on Switching

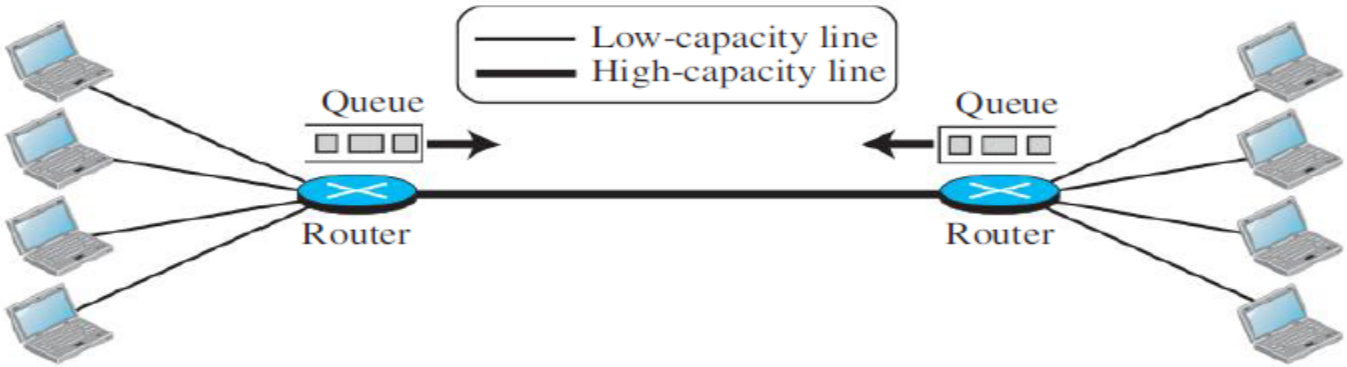
- Message Switching
  - it is not necessary to established a dedicated path in between any two communication devices.
  - Each complete message is then transmitted from one device to another through internetwork.
  - Each intermediate device receive the message and store it until the nest device is ready to receive it and then this message is forwarded to the next device. (Store & Forward Switching)

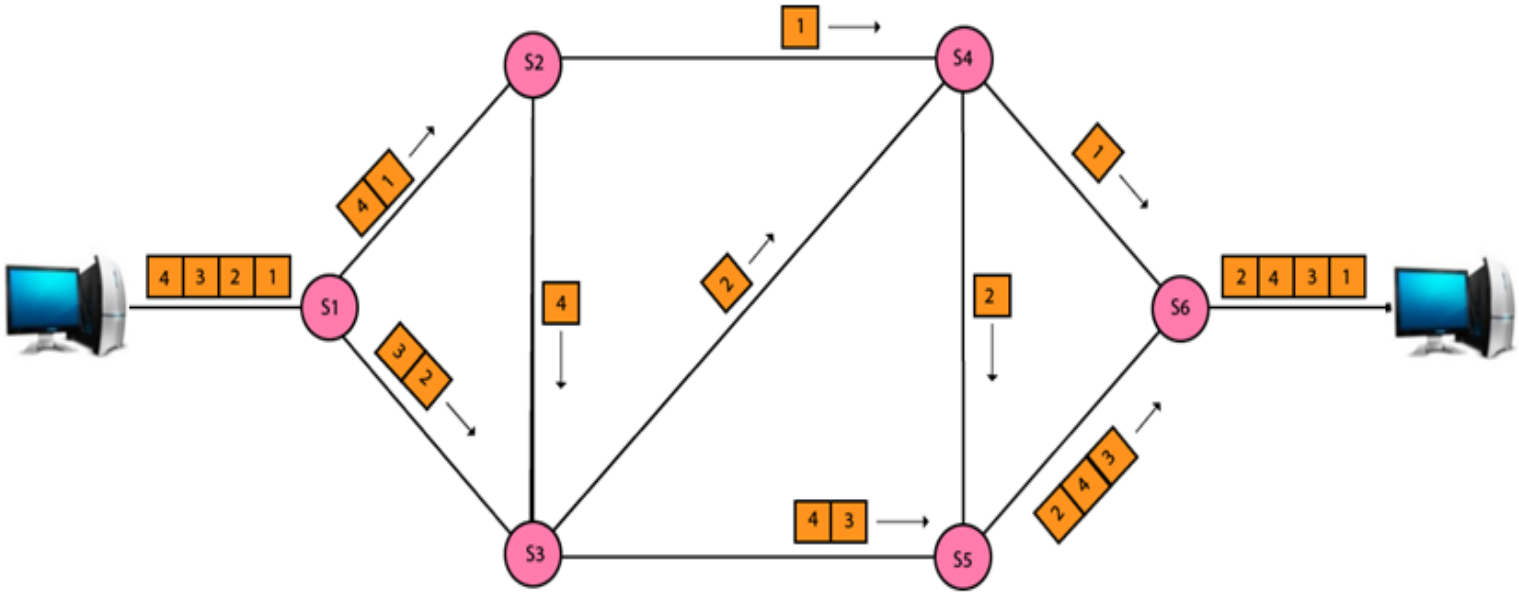

Message 1
Message 2
S1
S2
S3
S4
S5
S6

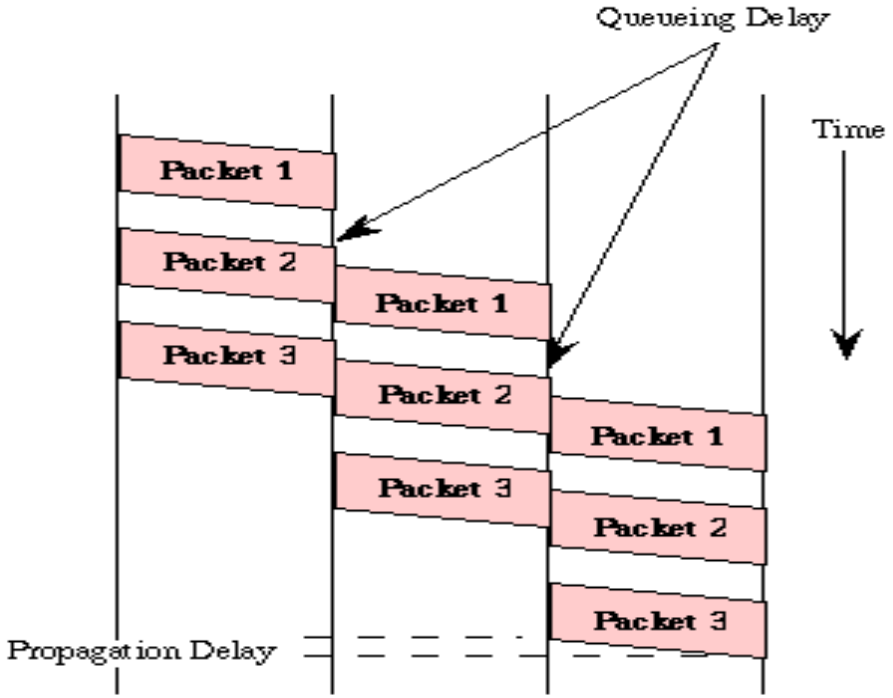

Time
Queueing Delays
Message
Propegation Delay

Classification based on Switching

- Packet Switching
  - It is a connectionless network where the messages are divided into small units of data known as a packet.
  - Each packet is routed from the source to the destination as individually.
  - it is the responsibility of the destination to put these packets in the right order.

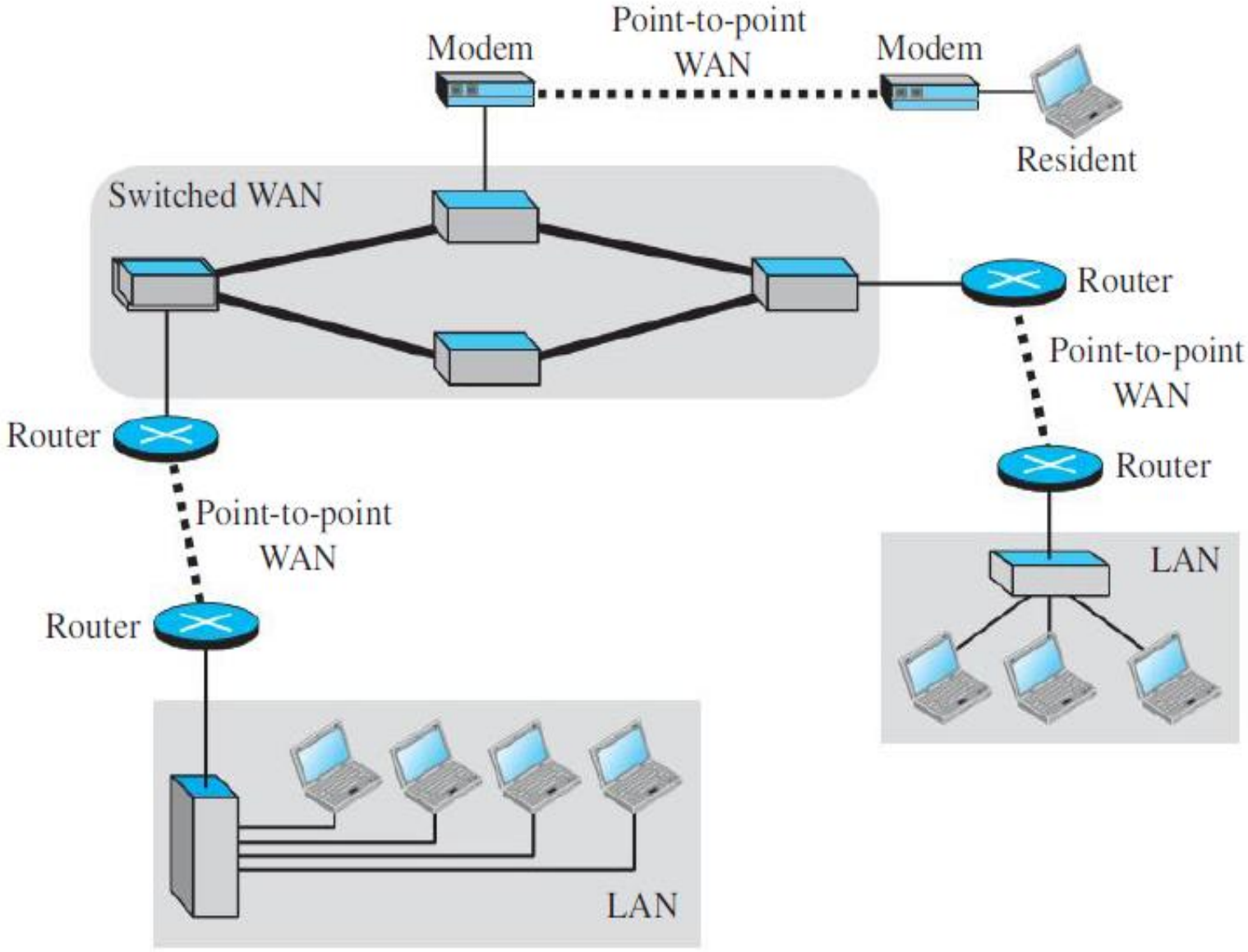



S1
S2
S3
S4
S5
S6
4 3 2 1
4 1
3 2
4
2
1
2
1
2 4 3 1
4 3
2 4 3


Queueing Delay
Time
Packet 1
Packet 2
Packet 3
Packet 1
Packet 2
Packet 3
Packet 1
Packet 2
Packet 3
Propagation Delay

- Advantages
  - There is no requirement for massive storage space as the information is passed on to the destination as soon as they are received.
  - Failure in the links does not stop the delivery of the data as these packets can be routed from other paths too.
  - Multiple users can use the same channel while transferring their packets.
  - The usage of bandwidth is better in case of packet switching as multiple sources can transfer packets from the same source link.

- Disadvantages
  - Installation/maintenance costs of packet switching are expensive.
  - Connectivity issues may lead to loss of information and delay in the delivery of the information.
  - Live communication cannot use packet switching as there is a out of order delivery of packets (if routed through different paths).

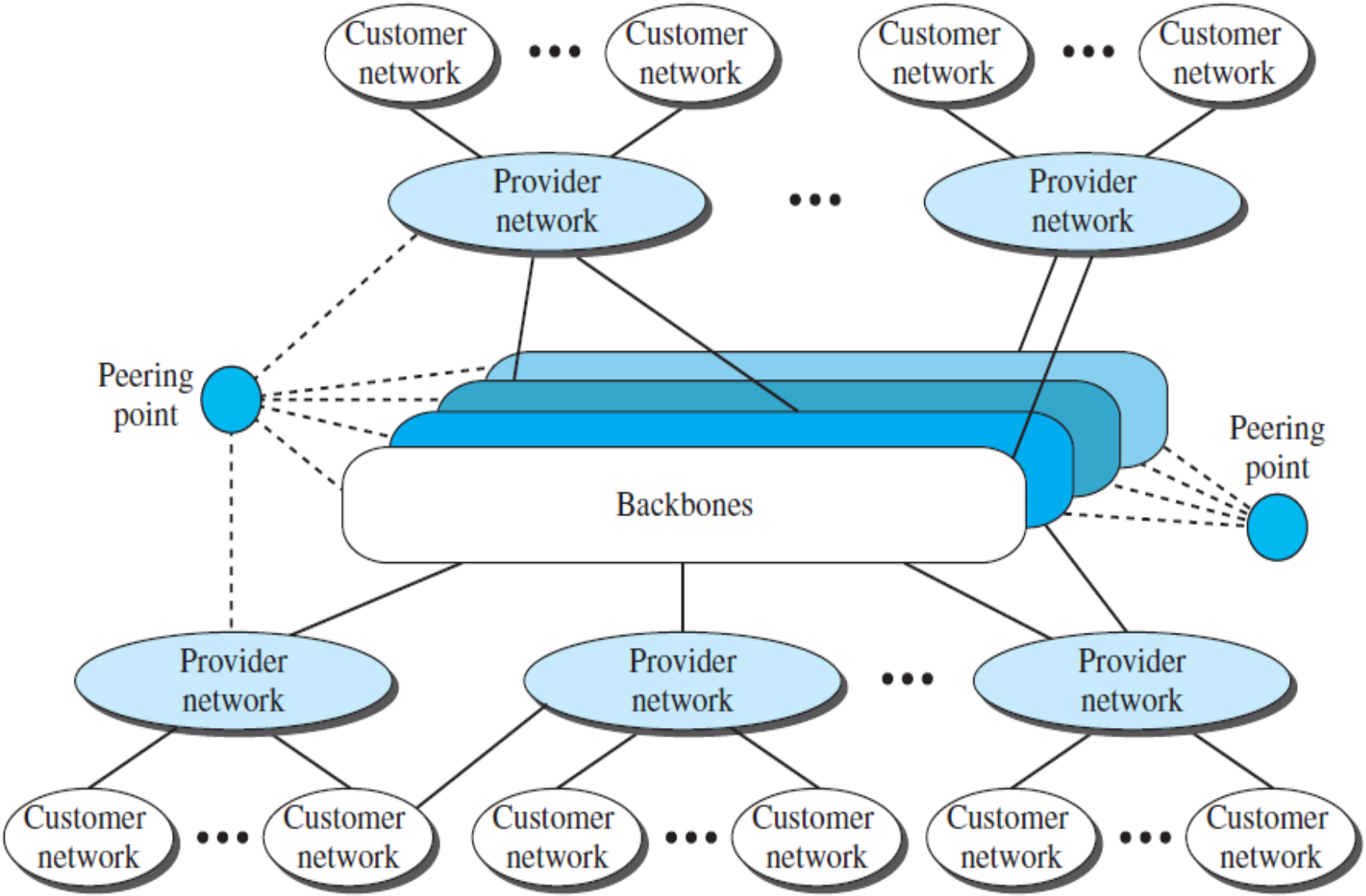


A heterogeneous network made of four WANs and three LANs

Internet

- It is a heterogeneous wide area network composed of thousands of interconnected networks.
- Internet as several backbones, provider networks, and customer networks.
- At the top level, the ***backbones*** are large networks owned by some communication companies such as Sprint, Verizon (MCI), AT&T, and NTT. The backbone networks are connected through some complex switching systems, called ***peering points***.
- At the second level, there are smaller networks, called ***provider networks***, that use the services of the backbones for a fee. The provider networks are connected to backbones and sometimes to other provider networks.

- The ***customer networks*** are networks at the edge of the Internet that actually use the services provided by the Internet. They pay fees to provider networks for receiving services.
- Backbones and provider networks are also called **Internet Service Providers (ISPs).** The backbones are often referred to as *International ISPs;* the provider networks are often referred to as N*ational* or *Regional ISPs*.



The Internet today