# SRM
# Institute of Science and Technology

## 21CSC302J-COMPUTER NETWORKS

## Unit- I

# Introduction to Networks

## Data communications

- *The exchange of data between two devices via some form of transmission medium such as a wire cable.*
- *The communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs).*

- The effectiveness of a data communications system **depends on four fundamental characteristics**
  - ***delivery, accuracy, timeliness, and jitter.***

## Delivery

The system ***must deliver data to the correct destination***. Data must be received by the intended device or user and only by that device or user.

## Accuracy

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

- The effectiveness of a data communications system depends on four fundamental characteristics:
  - **delivery, accuracy, timeliness, and jitter.**

## Timeliness

The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and *without significant delay.* This kind of delivery is called real-time transmission.

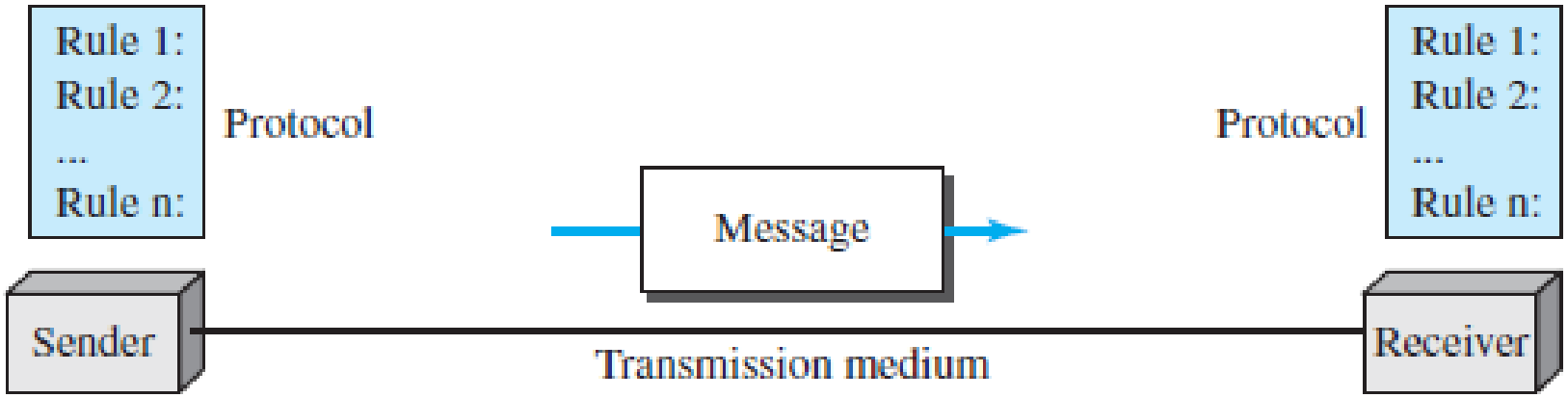
- The effectiveness of a data communications system depends on four fundamental characteristics:
  - **delivery, accuracy, timeliness, and jitter.**

## Jitter

Jitter refers to the *variation in the packet arrival time*. It is the uneven delay in the delivery of audio or video packets.

For example, let us assume that video packets are sent every 30 ms. If some of the packets arrive with 30-ms delay and others with 40-ms delay, an uneven quality in the video is the result.

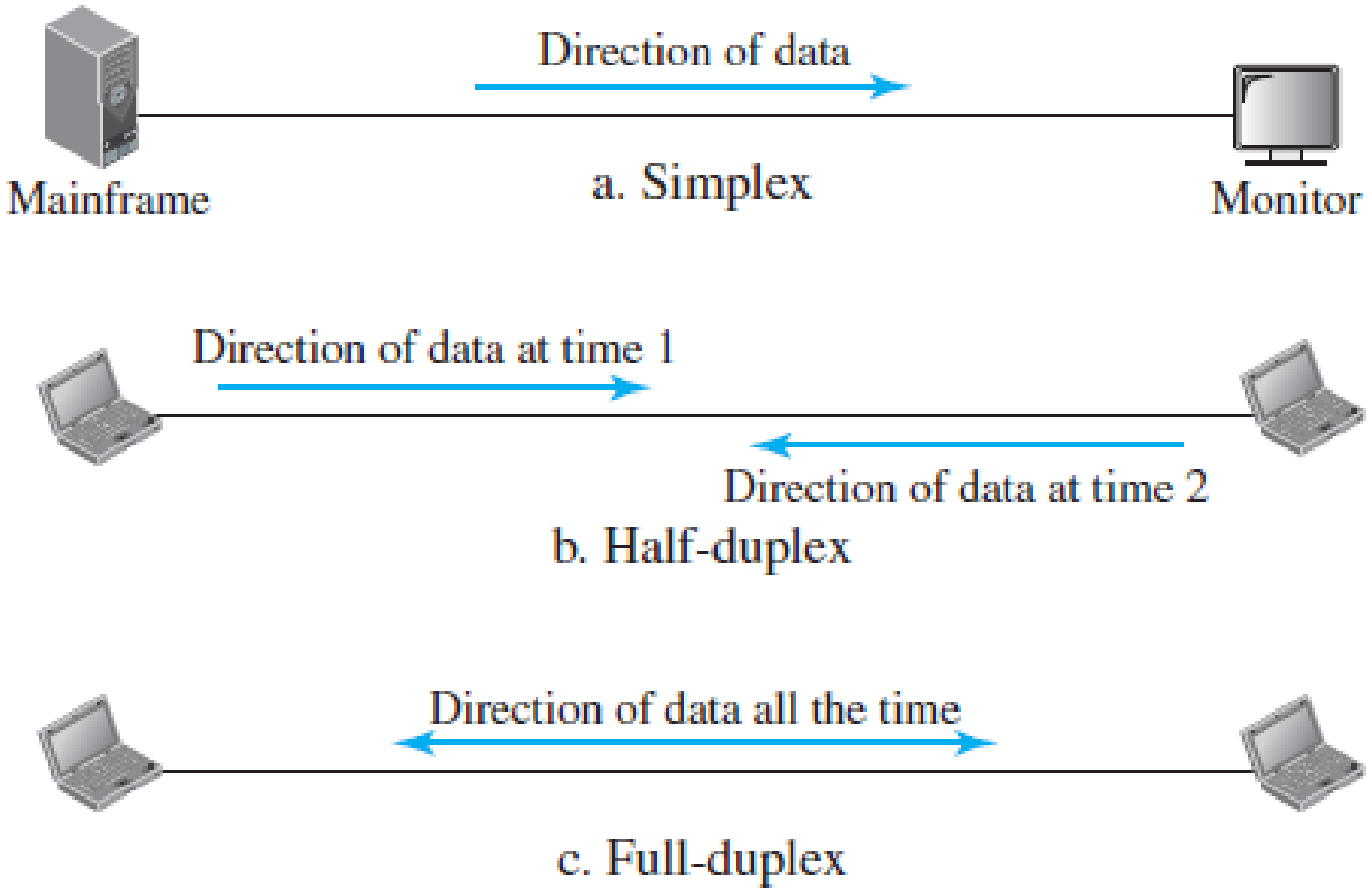
# Components of Data Communication




Five components of data communication

# Protocol

- A protocol is *a set of rules that govern data communications.*
- It *represents an agreement between the communicating devices*. Without a protocol, two devices may be connected but not communicating




Data flow (simplex, half-duplex, and full-duplex)

# NETWORKS

- ***interconnection of a set of devices capable of communication.***

- A device can be
  - ***a host (or an end system as it is sometimes called) such as a large computer, desktop, laptop, workstation, cellular phone, or security system.***
  - ***a connecting device such as a router, which connects the network to other networks,***
  - ***a switch, which connects devices together, a modem (modulator-demodulator), which changes the form of data, and so on.***

- These devices in a network are connected using wired or wireless transmission media such as cable or air.

# Network Criteria

- A network must be able ***to meet a certain number of criteria.***

- The most important of these are ***performance, reliability, and security.***

# Performance

- Performance can be measured - ***transit time and response time.***

- ***Transit time***
  - ***the amount of time required for a message to travel from one device to another.***

- ***Response time***
  - ***the elapsed time between an inquiry and a response***.

# Performance

- The performance of a network ***depends on a number of factors,*** including
  - ***the number of users,***
  - ***the type of transmission medium,***
  - ***the capabilities of the connected hardware, and***
  - ***the efficiency of the software.***

- Performance is often ***evaluated by two networking metrics: throughput and delay.***

- We often need more throughput and less delay.

# Performance

- If we try to send more data to the network,
  - ***we may increase throughput***
  - ***we increase the delay because of traffic congestion in the network.***

# Reliability

- **Measured by**
  - ***the frequency of failure,***
  - ***the time it takes a link to recover from a failure, and***
  - ***the network's robustness in a catastrophe.***

# Security

- Network security issues include
  - ***protecting data from unauthorized access,***
  - ***protecting data from damage and development, and***
  - ***implementing policies and procedures for recovery from breaches and data losses.***

# Type of connection

- **A network is *two or more devices connected through links.***
- **A link is *a communications pathway that transfers data from one device to another.***
- For communication to occur, two devices must be connected in some way to the same link at the same time.
- There are two possible types of connections:
  - ***point-to-point and multipoint.***

# Point-to-Point

- ***Provides a dedicated link between two devices.***

- The entire capacity of the link is reserved for transmission between those two devices.

- Use an actual length of wire or cable to connect the two ends, but other options, such as microwave or satellite links, are also possible.

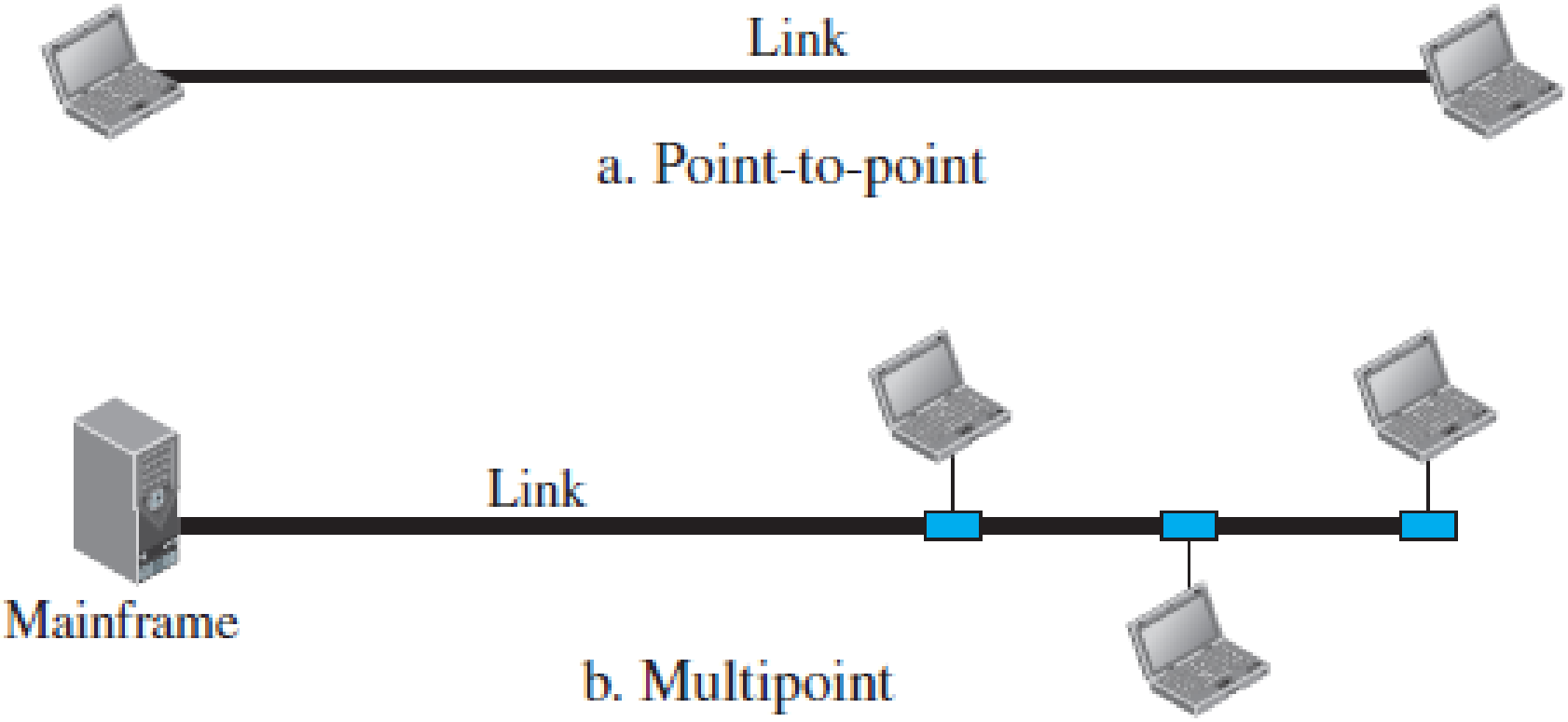
- When we change television channels by infrared remote control, we are establishing a point-to-point connection between the remote control and the television's control system.

# Multipoint

- A multipoint (also called multidrop) connection is one in which more than two specific devices share a single link in a multipoint environment, the capacity of the channel is shared, either spatially or temporally.

- **If several devices can use the link simultaneously, *it is a spatially shared connection.***

- **If users must take turns, *it is a timeshared connection.***




Types of connections: point-to-point and multipoint

# Physical Topology

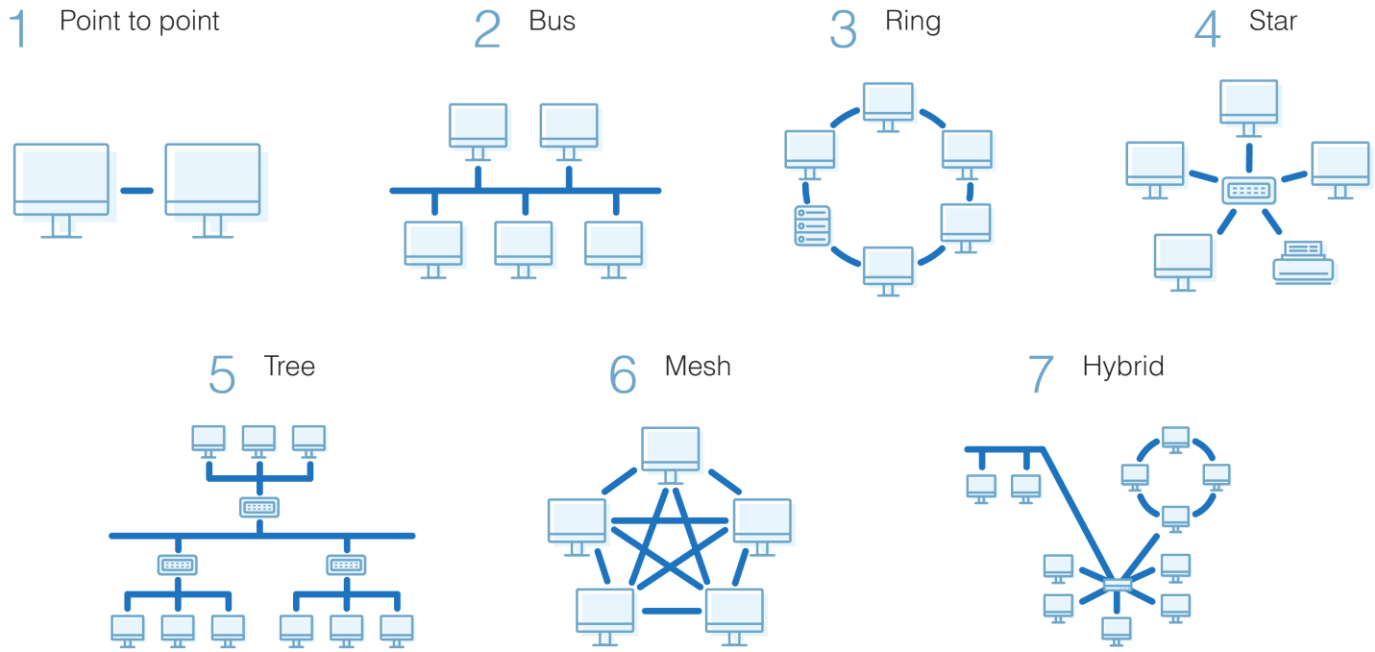
- The term physical topology refers ***to the way in which a network is laid out physically.***

- Two or more devices connect to a link; two or more links form a topology.

- **The geometric representation** ***of the relationship of all the links and linking devices (usually called nodes) to one another.***

- ***There are four basic topologies*** possible: **mesh, star, bus, and ring.**

# Network Topology Types




https://www.heavy.ai/technical-glossary/network-topology

# Mesh Topology

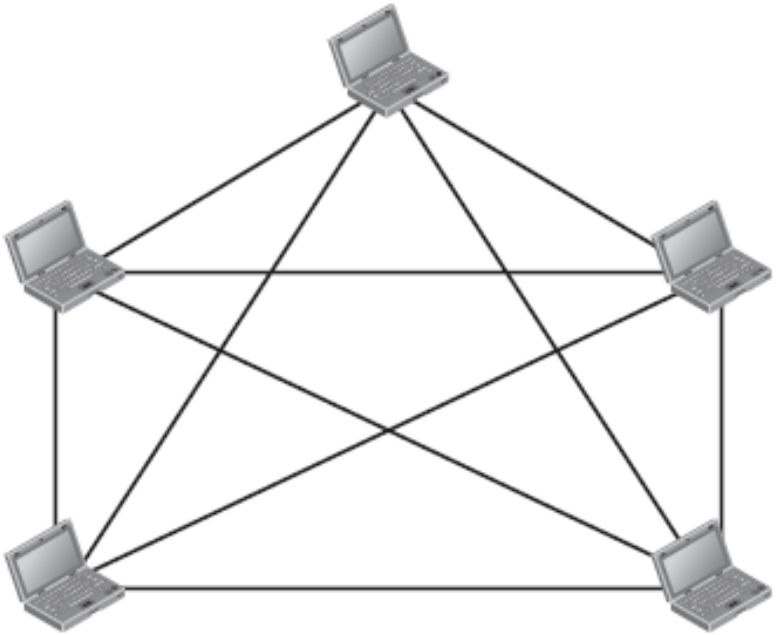
- Every device has ***a dedicated point-to-point link to every other device.***
  - ***The link carries traffic only between the two devices it connects.***

- **To find the number of physical links with n nodes**, we first consider that each node must be connected to every other node.
  - ***We need n (n – 1) physical links.***

- If each physical link allows communication in both directions (duplex mode), we can divide the number of links by 2.
  - ***we need n (n – 1) / 2 duplex-mode links.***

# Mesh Topology

$n = 5$
10 links.



# Mesh Topology

- A mesh offers several advantages over other network topologies.
  - ***The use of dedicated links guarantees that each connection can carry its own data load, thus eliminating the traffic problems that can occur when links must be shared by multiple devices.***
  - ***A mesh topology is robust. If one link becomes unusable, it does not incapacitate the entire system.***

# Mesh Topology

- A mesh offers several advantages over other network topologies.
  - ***There is the advantage of privacy or security. When every message travels along a dedicated line, only the intended recipient sees it. Physical boundaries prevent other users from gaining access to messages.***
  - ***Point-to-point links make fault identification and fault isolation easy. Traffic can be routed to avoid links with suspected problems. This facility enables the network manager to discover the precise location of the fault and aids in finding its cause and solution.***

# Mesh Topology

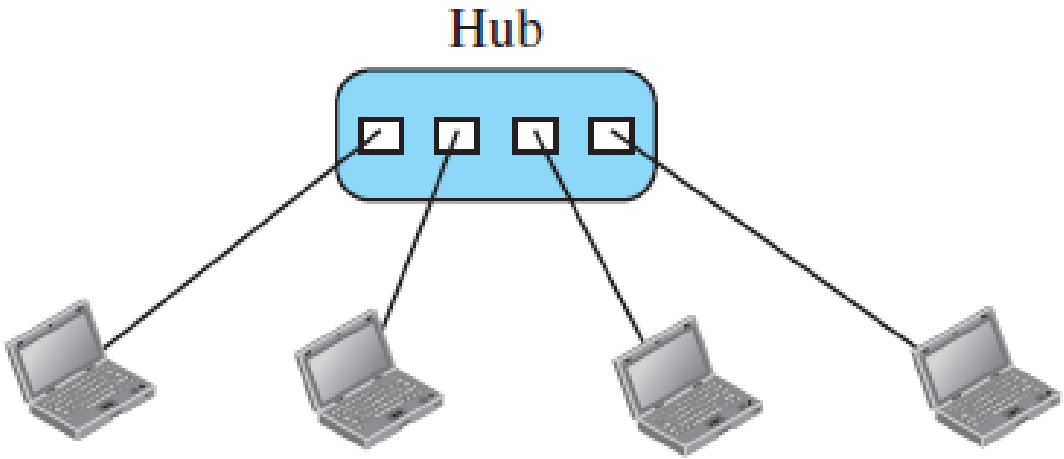
- The **main disadvantages** - **the amount of cabling and the number of I/O ports required**.
  - ***Every device must be connected to every other device, installation and reconnections are difficult.***
  - ***The sheer bulk of the wiring can be greater than the available space (in walls, ceilings, or floors) can accommodate.***
  - ***The hardware required to connect each link (I/O ports and cable) can be prohibitively expensive.***

- For these reasons a mesh topology is usually implemented in a limited fashion

# Star Topology

- Each device has a dedicated point-to-point link only to a central controller, usually called a hub.
- The devices are not directly linked to one another.
- Unlike a mesh topology, a star topology does not allow direct traffic between devices.
- The controller acts as an exchange
  - ***If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device***

# Star Topology



# Star Topology

- A star topology is less expensive than a mesh topology.
- In a star, each device needs only one link and one I/O port to connect it to any number of others.
- This factor also makes it easy to install and reconfigure.
- Far less cabling needs to be housed, and additions, moves, and deletions involve only one connection: between that device and the hub.

# Star Topology

- Other advantages include robustness.
  - ***If one link fails, only that link is affected.***
  - ***All other links remain active.***

- This factor also lends itself to easy fault identification and fault isolation.

- As long as the hub is working, it can be used to monitor link problems and bypass defective links.

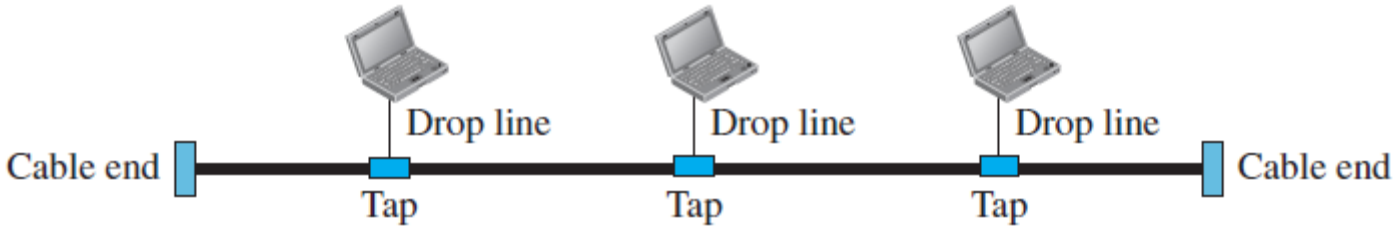
# Star Topology

- One big disadvantage of a star topology is the dependency of the whole topology on one single point, the hub.
- If the hub goes down, the whole system is dead.
- Although a star requires far less cable than a mesh, each node must be linked to a central hub.
- For this reason, often more cabling is required in a star than in some other topologies (such as ring or bus).

# Bus Topology

- A bus topology, is multipoint.

- One long cable acts as a backbone to link all the devices in a network




- Nodes are connected to the bus cable by drop lines and taps.

- A drop line is a connection running between the device and the main cable.

# Bus Topology

- **A tap is a connector**
  - ***either splices into the main cable or***
  - ***punctures the sheathing of a cable to create a contact with the metallic core.***

- **A signal travels along the backbone, *some of its energy is transformed into heat.***

- It becomes weaker and weaker as it travels farther and farther.

- For this reason there is a limit on the number of taps a bus can support and on the distance between those taps.

# Bus Topology

- Advantages of a bus topology include ease of installation.
- Backbone cable can be laid along the most efficient path, then connected to the nodes by drop lines of various lengths.
- A bus ***uses less cabling*** **than mesh or star topologies.**
- In a bus, this redundancy is eliminated.
- Only the backbone cable stretches through the entire facility.

# Bus Topology

- Disadvantages - ***difficult reconnection and fault isolation.***

- A bus is usually designed to be optimally efficient at installation.

- It can therefore be difficult to add new devices.

- Signal reflection at the taps can cause degradation in quality.

- This degradation can be controlled by limiting the number and spacing of devices connected to a given length of cable.

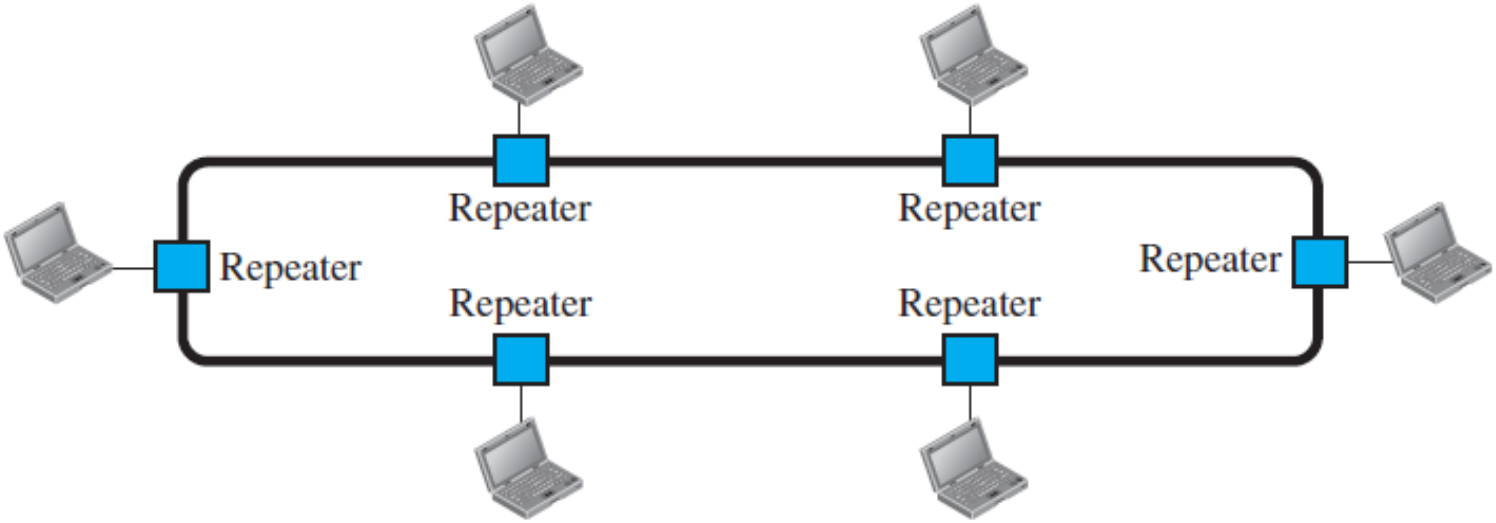
# Bus Topology

- Adding new devices require modification or replacement of the backbone.
- A fault or break in the bus cable stops all transmission, even between devices on the same side of the problem.
- The damaged area reflects signals back in the direction of origin, creating noise in both directions.
- Bus topology was the one of the first topologies used in the design of early local area networks.

# Ring Topology

- Each device has ***a dedicated point-to-point connection*** with only the two devices on either side of it.
- A signal is passed along the ring in one direction, from device to device, until it reaches its destination.
- Each device in the ring incorporates a repeater.
- When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along

# Bus Topology



# Ring Topology

- A ring is relatively ***easy to install and reconfigure***.
- Each device is linked to only its immediate neighbors (either physically or logically).
- To add or delete a device requires changing only two connections.
- The only constraints are media and traffic considerations (maximum ring length and number of devices).
- fault isolation is simplified.

# Ring Topology

- Generally, in a ring a signal is circulating at all times.
- If one device does not receive a signal within a specified period, it can issue an alarm.
- The alarm alerts the network operator to the problem and its location.
- However, unidirectional traffic can be a disadvantage.
- In a simple ring, a break in the ring (such as a disabled station) can disable the entire network.

# Ring Topology

- This weakness can be solved by using a dual ring or a switch capable of closing off the break.

- Ring topology was prevalent when IBM introduced its local-area network, Token Ring.

- The need for higher-speed LANs has made this topology less popular.

# NETWORK TYPES

*size, geographical coverage, and ownership*

# Local Area Network

- Usually ***privately owned and connects some hosts*** **in a single office, building, or campus.**

- Depending on the needs of an organization, a LAN can be
  - ***as simple as two PCs and a printer in someone's home office, or***
  - ***it can extend throughout a company and include audio and video devices.***

- Each host in a LAN has ***an identifier, an address,*** that uniquely defines the host in the LAN.

- A packet sent by a host to another host carries both the source host's and the destination host's addresses.

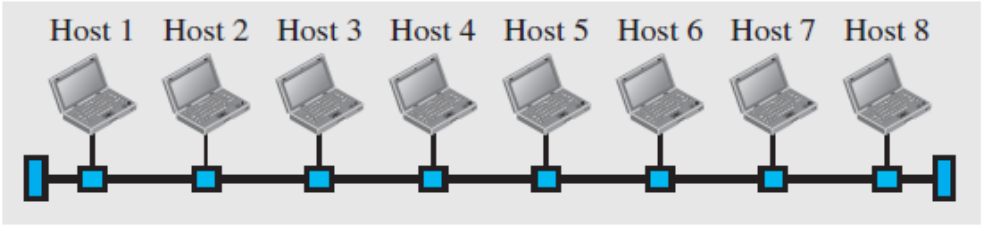
# Local Area Network

- In the past, **all hosts in a network were connected through a common cable**,
  - ***a packet sent from one host to another was received by all hosts.***
  - ***The intended recipient kept the packet;***
  - ***The others dropped the packet.***

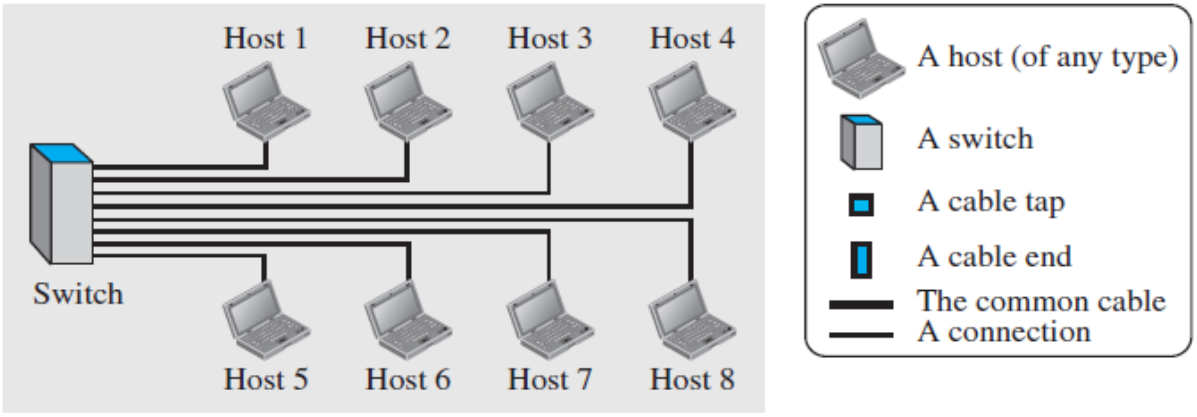
- Today, **most LANs use a smart connecting switch**,
  - ***Able to recognize the destination address of the packet and***
  - ***Guide the packet to its destination without sending it to all other hosts.***

# Local Area Network

- The switch **alleviates the traffic in the LAN** and ***allows more than one pair to communicate with each other at the same time***




a. LAN with a common cable (past)




b. LAN with a switch (today)

# Wide Area Network

- There are some differences between a LAN and a WAN.
- ***A LAN is normally limited in size***, spanning an office, a building, or a campus;
- ***A WAN has a wider geographical span***, spanning a town, a state, a country, or even the world.
- ***A LAN interconnects hosts;***
- ***A WAN interconnects connecting devices such as switches, routers, or modems.***

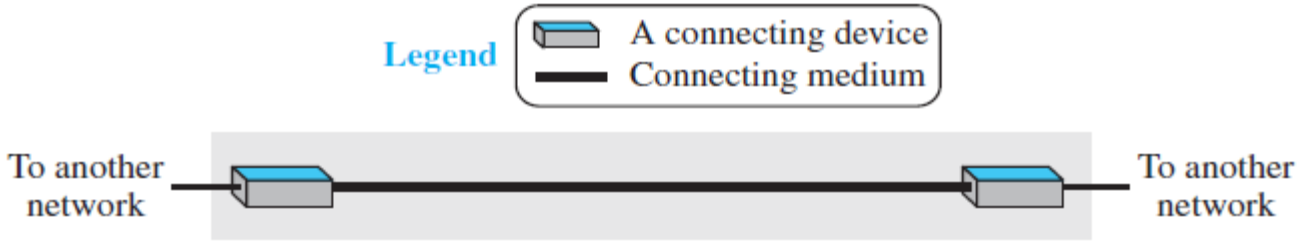
# Wide Area Network

- A LAN is normally privately owned by the organization that uses it;
- A WAN is normally created and run by communication companies and leased by an organization that uses it.
- Two distinct examples of WANs today: point-to-point WANs and switched WANs.

# Point-to-Point WAN

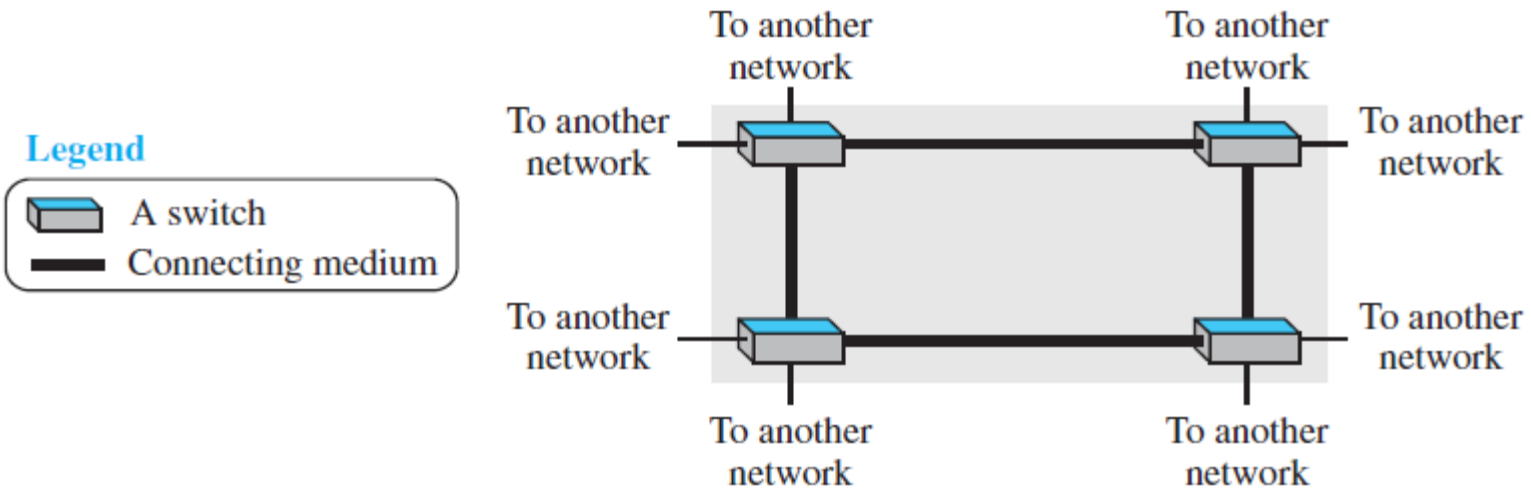
- A point-to-point WAN is a network that connects two communicating devices through a transmission media (cable or air).

- Figure shows an example of a point-to-point WAN.



# Switched WAN

- **A network with more than two ends.**
- ***Used in the backbone of global communication today.***
- ***A combination of several point-to-point WANs*** **that are connected by switches.**
- Figure 1.10 shows an example of a switched WAN.

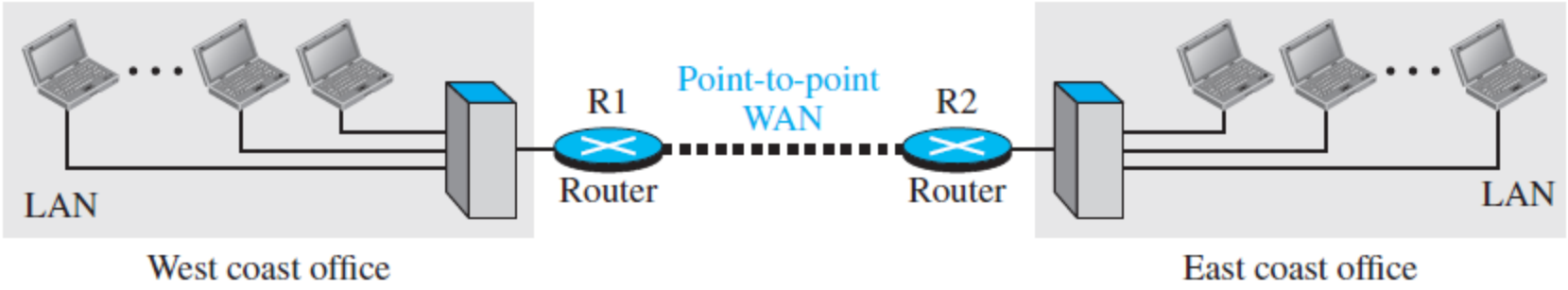


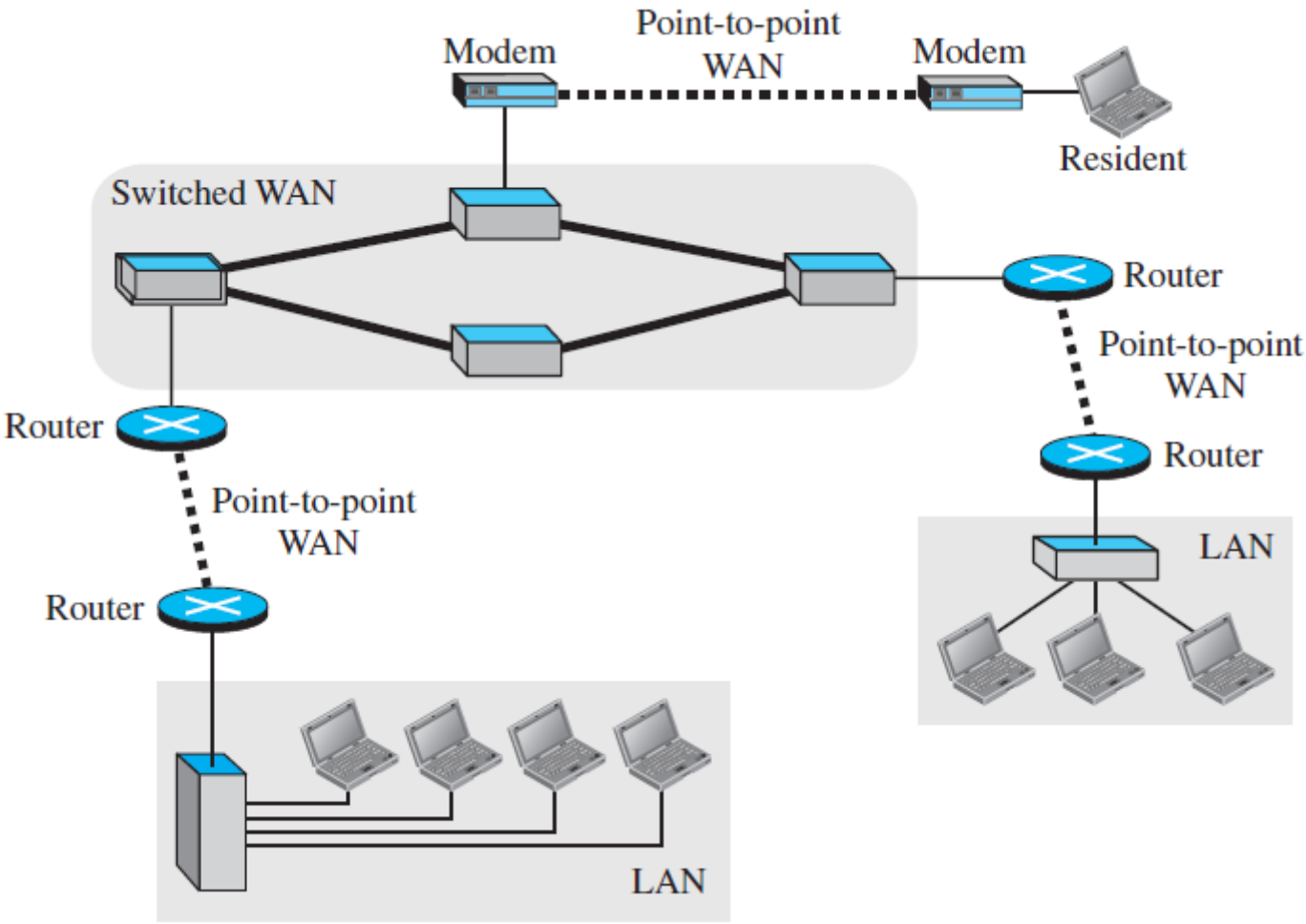
# Internetwork

- It is very rare to see a LAN or a WAN in isolation; they are connected to one another.
- When two or more networks are connected, they make an internetwork, or internet.
- Assume that an organization has two offices, one on the east coast and the other on the west coast.
- Each office has a LAN that allows all employees in the office to communicate with each other.

# Internetwork

- To make the communication between employees at different offices possible,
- the management leases a point-to-point dedicated WAN from a service provider, such as a telephone company, and connects the two LANs.
- Communication between offices is now possible.






A heterogeneous network made of four WANs and three LANs

# Thank You