chapter 3

Local Area Networks – Topologies and Architectures

CHAPTER OBJECTIVES

- Define the term LAN topology, and identify bus, star, ring, and wireless topologies.
- Describe the differences between physical and logical topologies.
- Define the term LAN architecture.
- Describe the Ethernet LAN architecture and identify common Ethernet standards.
- Describe the Ethernet access method.

CHAPTER OBJECTIVES (cont'd)

- Describe the wireless LAN architecture.
- Discuss wireless LAN and wireless PAN technologies and their histories.
- Identify common standards and access methods for IEEE 802.11, Bluetooth, and HomeRF.
- Discuss technical and business considerations of wireless architectures.
- Identify FDDI and ATM standards, access methods, and technical and business aspects.

LAN TOPOLOGIES

- A LAN topology is the basic map or layout of a local area network.
- Four common types are bus, star, ring, and wireless.
- Logical and physical topologies must be considered in a LAN design.

LAN TOPOLOGIES (cont'd)

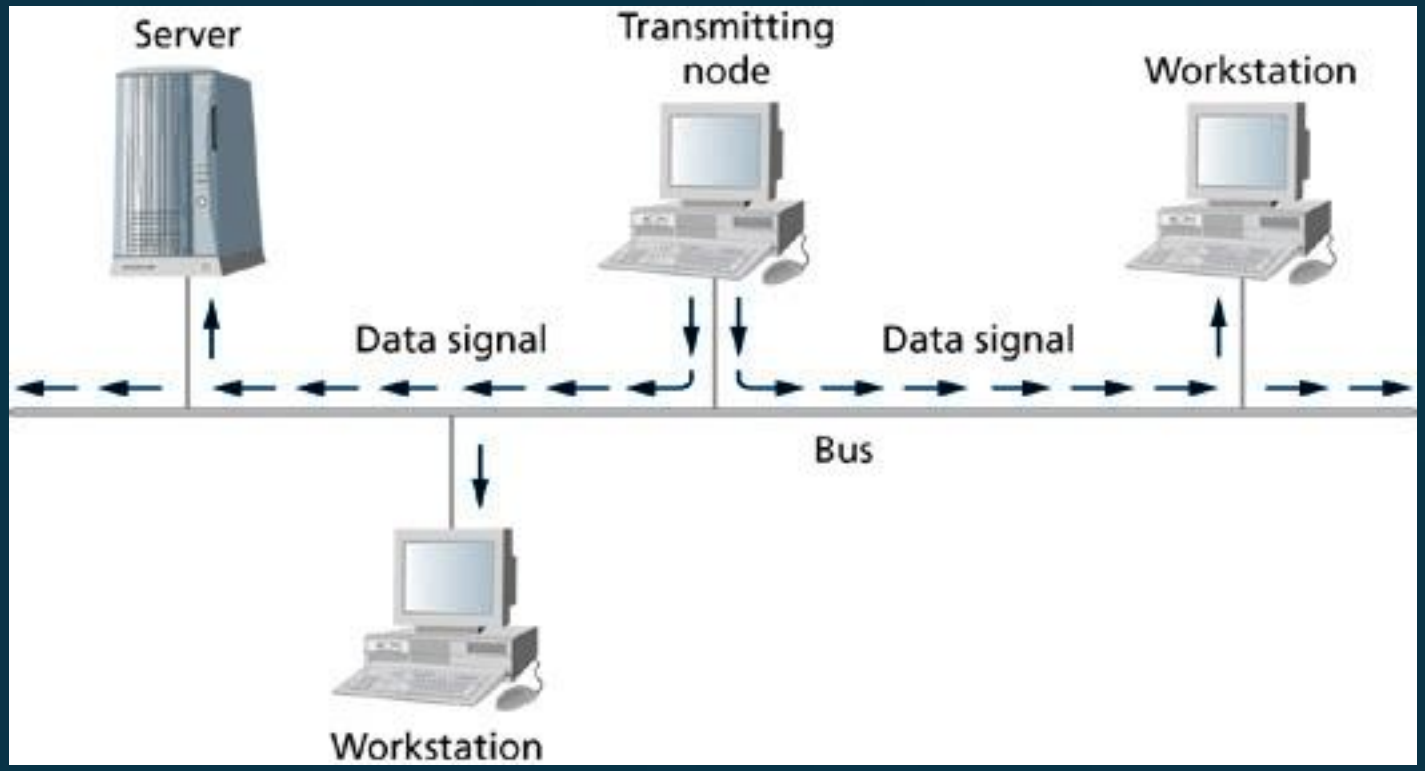
- Logical topology defines the conceptual layout of a LAN, or the way in which data flows across the LAN.

- Physical topology defines the actual physical layout of the LAN and the configuration of the cabling, computers, printers, and other devices on the LAN.

LAN TOPOLOGIES – BUS

- A bus topology is comprised of a shared network medium to which various network devices are attached, and every connected device hears every data transmission on the network.
- A bus topology that is implemented with coax cable is both a physical bus and a logical bus.

Simple Bus Topology



LAN TOPOLOGIES – BUS (cont'd)

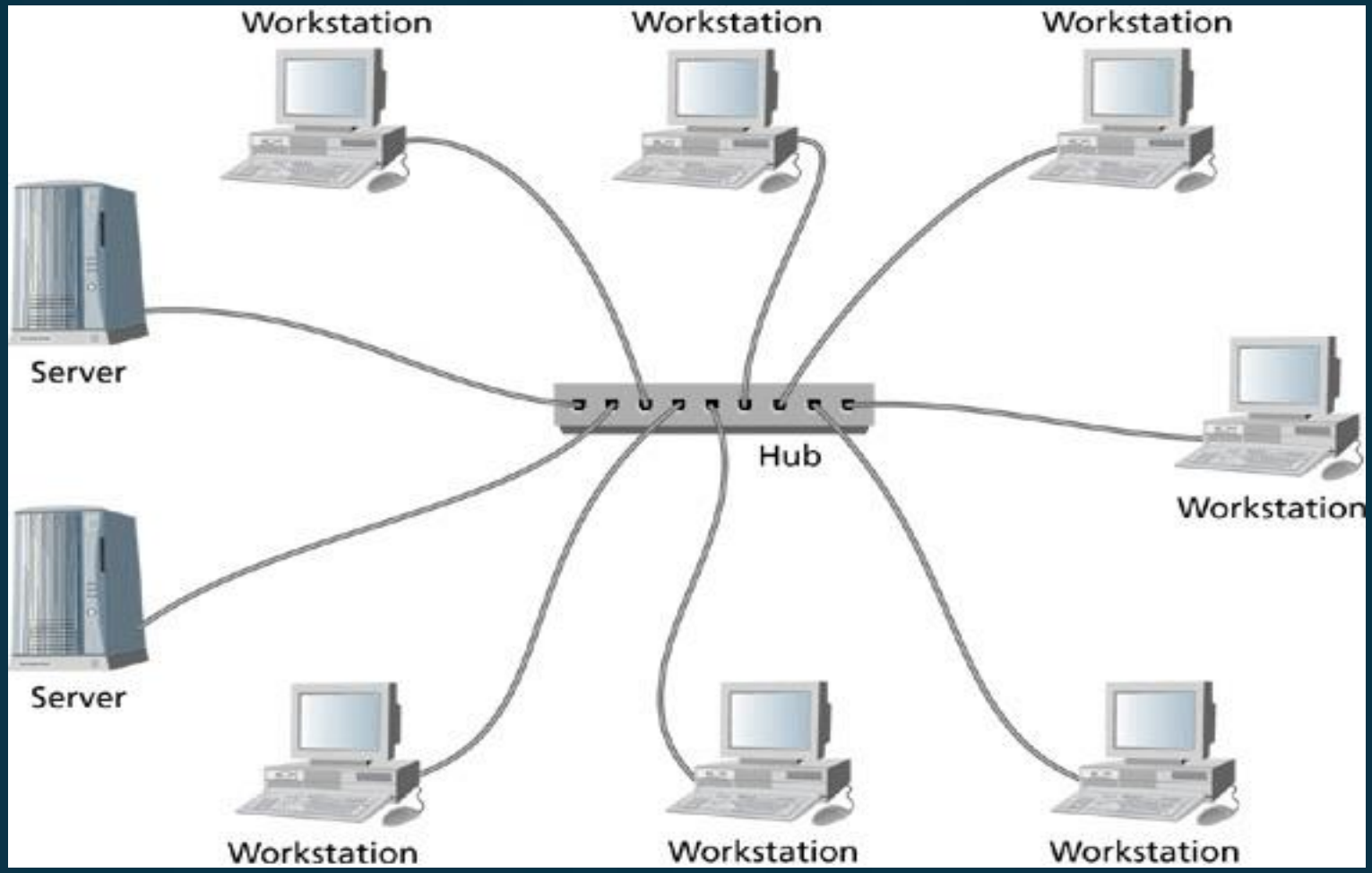
- Bus topology advantages/disadvantages:
  - Easy and inexpensive to implement. (Adv.)
  - If a cable segment is disconnected or damaged, the entire network becomes unavailable. (Disadv.)
  - Difficult to troubleshoot because if a cable segment fails, it is not readily apparent which cable segment has failed. (Disadv.)

LAN TOPOLOGIES – STAR

- A star topology is comprised of network devices, data transmission media, and a centralized device that provides connectivity among all attached devices.

- Common implementations include UTP cabling connected to a hub or a switch.

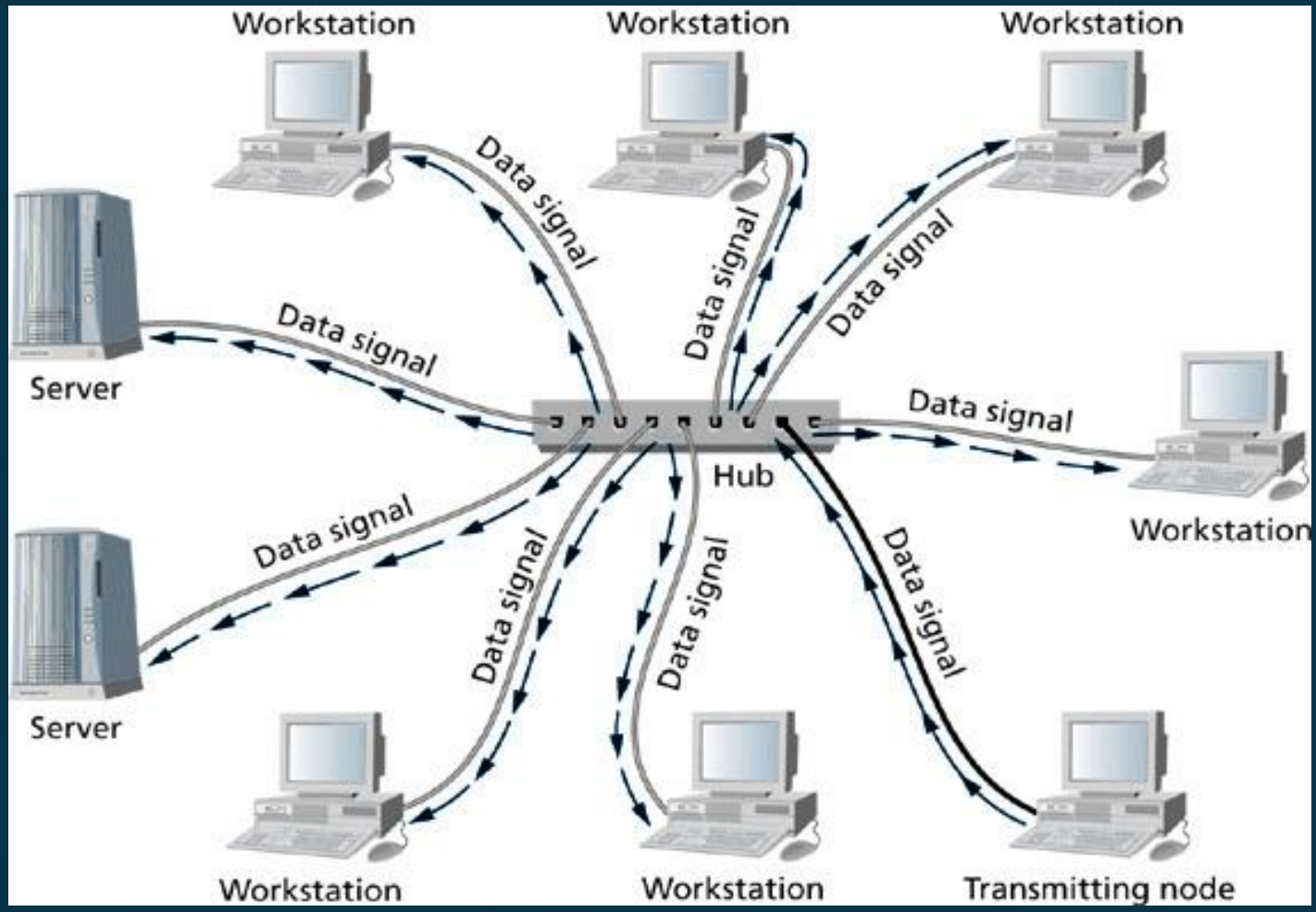
Star Topology



LAN TOPOLOGIES – STAR (cont'd)

- Physical star/logical bus
  - A physical star/logical bus topology uses twisted pair cabling and a hub.
  - All computing devices that are connected to the hub immediately hear the data, which makes the configuration a logical bus.
  - The actual physical layout that links devices to the hub via twisted pair cabling is a physical star.

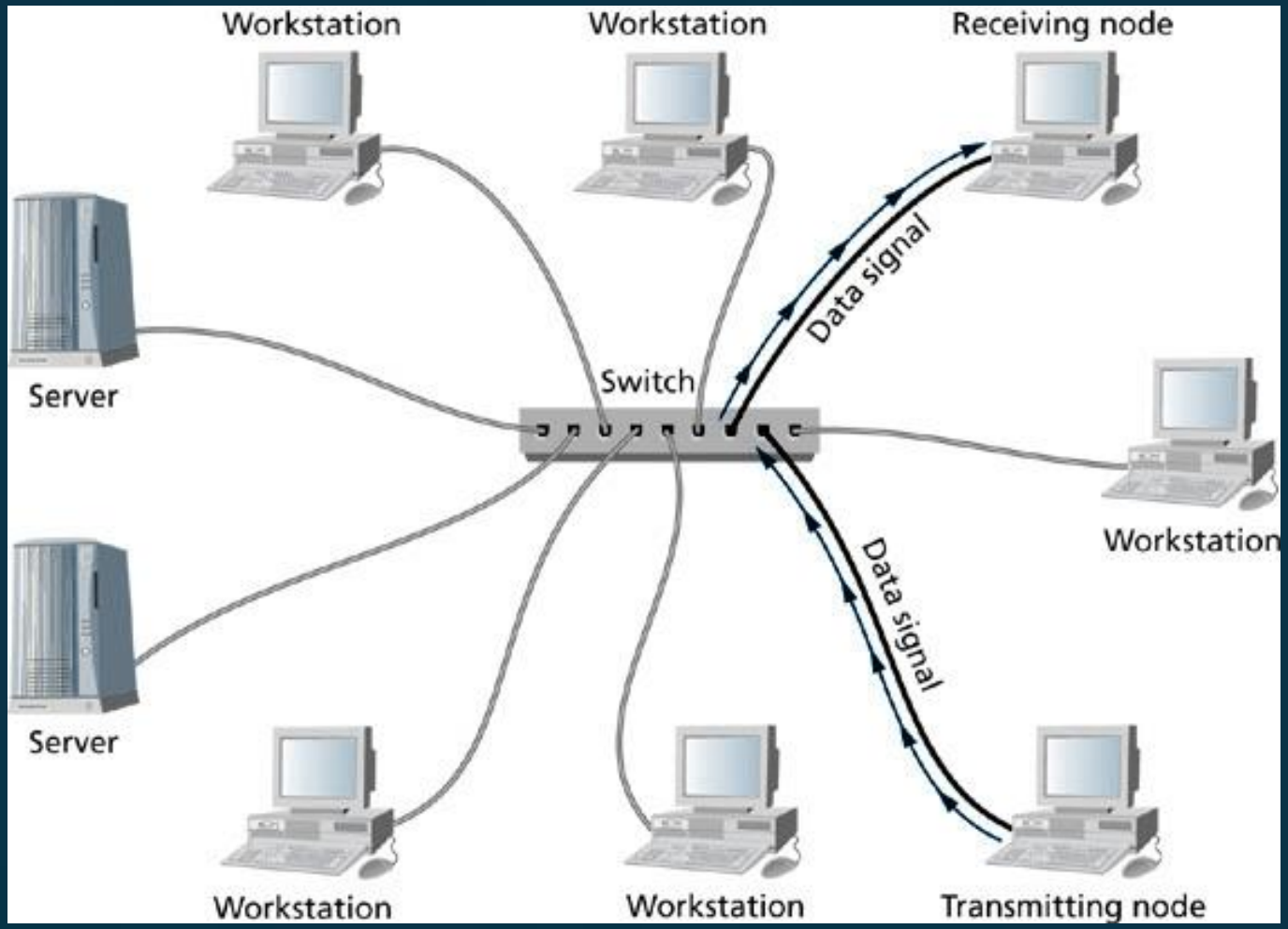
Physical Star/Logical Bus



LAN TOPOLOGIES – STAR (cont'd)

- Physical star/logical star
  - Uses twisted pair cabling and a switch.
  - Has the physical configuration of a star.
  - The flow of data emanates only to the intended recipients, which makes the configuration a logical star as well.

Physical Star/Logical Star



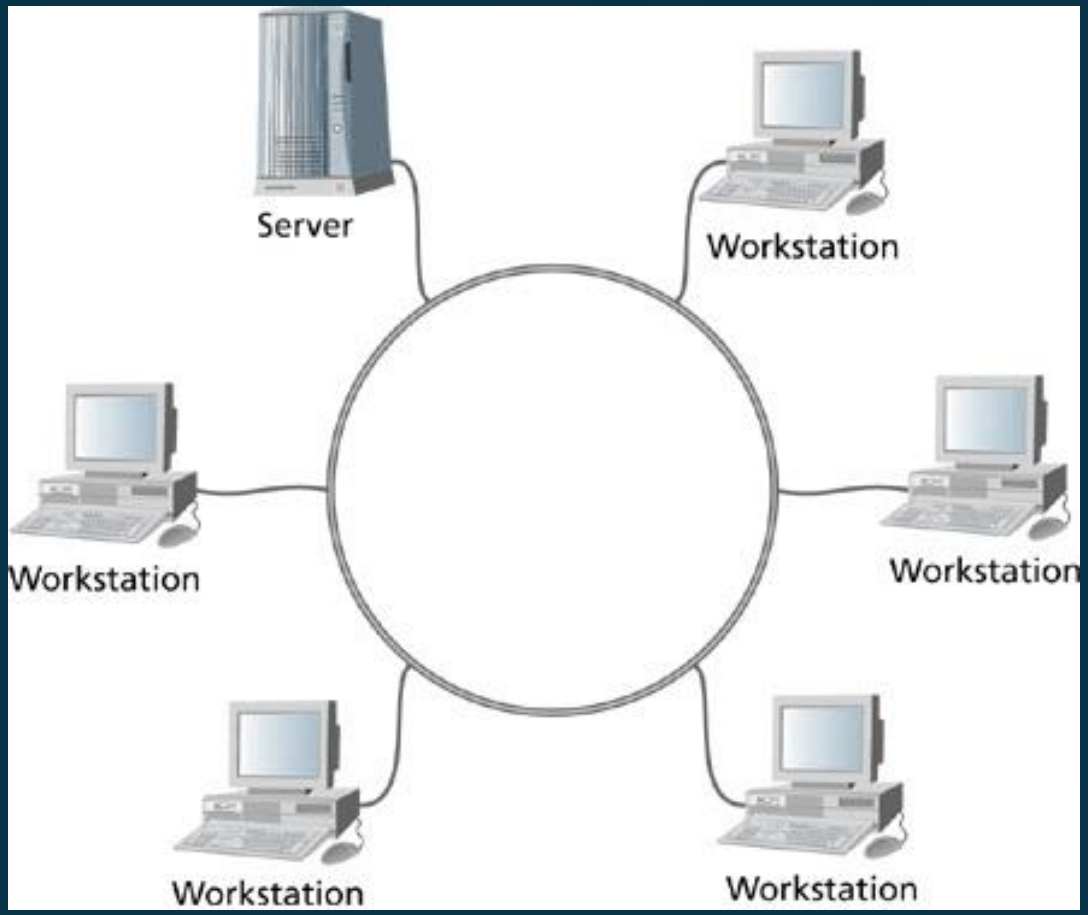
LAN TOPOLOGIES – STAR (cont'd)

- Physical star advantages/disadvantages:
  - Connectivity to the LAN is through a centralized device. (Adv.)
  - Centralized device is a potential single point of failure. (Disadv.)
  - The loss of one cable segment does not bring down the entire network. (Adv.)

LAN TOPOLOGIES – RING

- In a ring topology, all network devices are connected in a closed loop, and the data flows from device to device in a unidirectional fashion, around the ring.

Ring Topology



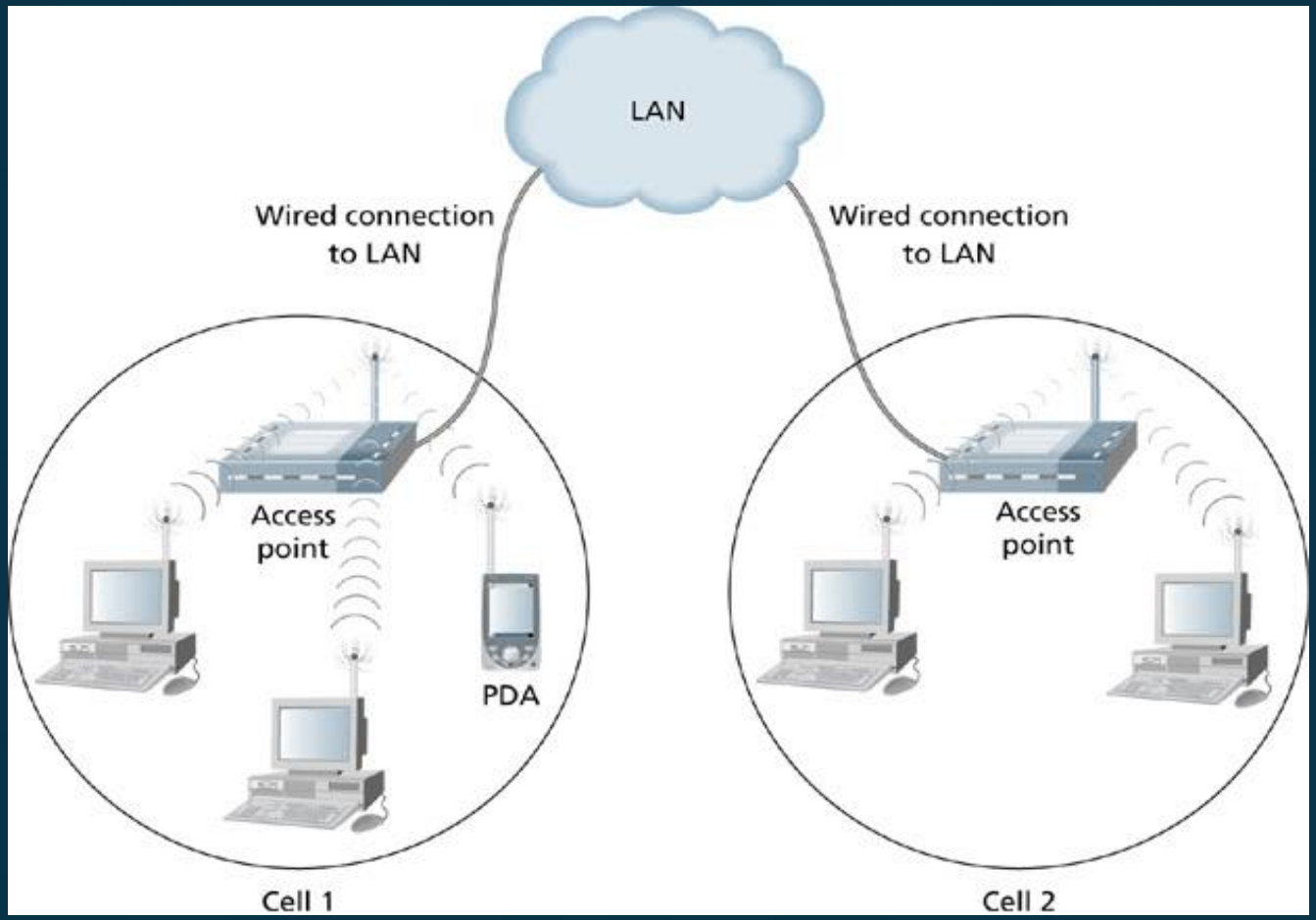
LAN TOPOLOGIES – RING (cont'd)

- Advantages/disadvantages:
  - Without a star configuration, any break in the cable between devices can crash the entire ring. (Disadv.)
  - Dual rings can provide failover protection if the first ring fails or is damaged.

LAN TOPOLOGIES - WIRELESS

- Wireless topologies use radio frequencies instead of cables as the transmission medium.
- Wireless topologies use access points instead of hubs for connecting wireless devices to a LAN.
- Geographic areas are divided into cells, and each cell contains an access point.

Wireless Topology



LAN TOPOLOGIES – WIRELESS (cont'd)

- The physical topology of a wireless LAN can be compared to a physical star.
- The logical topology can be compared to a logical bus.
- BUT – wireless devices on a wireless LAN do not always hear each other. This is different from a logical bus topology in which all devices hear every other device on the LAN.

LAN TOPOLOGIES – WIRELESS (cont'd)

- Advantages/disadvantages to wireless:
  - Wireless LANs are easy to install. (Adv.)
  - No cables to install or holes to drill. (Adv.)
  - Network devices can move from cell to cell. (Adv.)
  - Network devices must be located within a few hundred feet of an access point. (Disadv.)
  - Security requires more attention. (Disadv.)

Topology Comparison

TABLE 3.1
Topology Comparison

Topology Type	Where Commonly Used	Business Considerations
Physical bus/logical bus	10Base5 and 10Base2 Ethernet LANs	Old technology that is no longer implemented. Provided 10 Mbps bandwidth in its day
Physical star/logical bus	10/100Base-T Ethernet LANs	Uses UTP cabling and hubs to link computers in 10Base-T or 100Base-T LANs
Physical star/logical star	10/100Base-T switched Ethernet LANs	Uses UTP cabling and Ethernet switches to link computers
Physical star/logical ring	Token Ring LANs and FDDI backbones	Uses STP or UTP cabling to link Token Ring devices through a MSAU. Uses fiber-optic or UTP cabling to link FDDI backbones through an FDDI hub
Physical ring/logical ring	Token Ring LANs and FDDI backbones	Uses STP or UTP cabling to link Token Ring devices in a ring. Uses fiber-optic or UTP cabling to link FDDI devices in either a single or dual ring

LAN ARCHITECTURES

- LAN architecture is the way in which data accesses network media and the structure of the data frames that are placed on the media.

LAN ARCHITECTURES - ETHERNET

- Originated in the early 1970s.
- It's based on the data transmission method used by a network known as Alohanet.
- Bob Metcalfe is credited with its invention.
- First Ethernet standard was known as DIX.
- First IEEE Ethernet standard is known as IEEE 802.3
- Popular in modern LANs.
- It's reliable, easy to implement, and cost effective.
- It's a widely accepted industry standard.

LAN ARCHITECTURES – ETHERNET (cont'd)

- Ethernet was originally deployed across thicknet (10Base5) and later thinnet (10Base2).
- 10Base-T is 10 Mbps baseband Ethernet over UTP cable.
- 100Base-T is 100 Mbps baseband Ethernet over UTP cable.
- Other Ethernet standards fall under the IEEE 802.3x set of standards.

IEEE 802.3 Ethernet Standards

TABLE 3.2
IEEE 802.3 Ethernet Standards

Ethernet Standard	Media Type(s) Supported	Description
10BASE5	Thicknet or thick Ethernet	10 Mbps Ethernet over thicknet with a maximum cable segment length of 500 meters
10BASE2	Thinnet or thin Ethernet	10 Mbps Ethernet over thinnet with a maximum cable segment length of 185 meters[a]
10BASE-T	Categories 3-6 UTP	10 Mbps Ethernet over UTP cabling, usually cat5. Uses two of the twisted pairs
100BASE-TX	Categories 3-6 UTP	100 Mbps Ethernet over UTP cabling, usually cat5 or cat5e. Uses two of the twisted pairs
100BASE-FX	Fiber-optic cable	100 Mbps Ethernet over fiber-optic cable
100BASE-T4	Category 3 UTP	Obsolete. Was designed to use all four of the twisted pairs of cat3 UTP cabling
1000BASE-T	Category 5-6 UTP	1 Gbps over cat 5 or greater. Uses all four of the cabling's twisted pairs. Generally implemented on cat5e or greater
10GBase-LX4	SMF or MMF	10 Gbps over SMF or MMF

[a]The 2 in 10Base2 is a representation of 200 meters, which is 185 meters rounded up.

LAN ARCHITECTURES - ETHERNET ACCESS METHOD

- Ethernet uses CSMA/CD.
- Carrier sense refers to a network device listening for or sensing a neutral electrical signal on the network media.
- Multiple access specifies that all network devices have equal access to the network media.

LAN ARCHITECTURES - ETHERNET ACCESS METHOD (cont'd)

- Collision detection ensures that the sending device that detects the collision sends out a signal to all other devices to indicate that a collision has taken place.
- When a collision occurs, network devices wait a random amount of time before attempting to retransmit.

LAN ARCHITECTURES - ETHERNET ACCESS METHOD (cont'd)

- Advantages and disadvantages of CSMA/CD:
  - It's easy to configure and has widespread standardization and implementation. (Adv.)
  - Increasing numbers of collisions as more devices are added to the network. (Disadv.)

ETHERNET: TECHNICAL AND BUSINESS CONSIDERATIONS

- Ethernet has distance limitations.
  - For example, 100 Mbps Ethernet has a maximum segment length of 100 meters and a network span of 205 meters.
- Ethernet is an industry standard.
  - Vendors continue to develop new products.
  - Newer versions of Ethernet are backward compatible with older versions.
  - Plentiful technical support.

LAN ARCHITECTURES – WIRELESS

- Wireless architectures are comprised of IEEE 802.11, Bluetooth, and HomeRF.
- IEEE supports the IEEE 802.11 series of standards and the IEEE 802.15 (Bluetooth) series of standards.
- HomeRF Working Group supports HomeRF.

Wireless IEEE 802.11 Data Communications Standards

TABLE 3.4
Wireless IEEE 802.11 Data Communications Standards

IEEE 802.11 Standard	Description
802.11	The basic standard with transmission rates up to 2 Mbps in the 2.4 GHz frequency range
802.11a	Extension to the basic standard with transmission rates up to 54 Mbps in the 5 GHz frequency range
802.11b	Extension to the basic 802.11 standard with transmission rates up to 11 Mbps in the 2.4 GHz frequency range
802.11e	Provides Quality of Service (QoS) functionality to allow voice, video, and data transmission over wireless
802.11g	Defines data transmission rates up to 54 Mbps in the 2.4 GHz frequency range
802.11h	Allows compatibility with European regulations in the 5 GHz frequency range
802.11i	Defines security protocols for 802.11 WLAN security
IEEE 802.15 (Bluetooth) Standard	
802.15.1	The basic standard for wireless personal area networks (WPANs) based on the Bluetooth v1.1 SIG specification, which includes data rate at up to 1 Mbps operating in the 2.4 GHz frequency range and at distances spanning less than 10 meters
802.15.1a	Update to the original standard to include the Bluetooth SIG v1.2 specs
802.15.2	Defines the coexistence of 802.11 WLANs and 802.15 WPANs within the 2.4 GHz frequency range so that the signals do not interfere with each other
802.15.3	Defines high-speed WPANs up to 55 Mbps for distances under 10 meters
802.15.4	Defines WPANs with data transmission rates between 2 Kbps and 200 Kbps in the 2.4 GHz and 915 MHz frequency ranges

LAN ARCHITECTURES – WIRELESS ACCESS METHODS

- IEEE 802.11 uses a method of collision avoidance known as distributed coordination function (DCF).
- DCF reduces the need for a full-duplex channel to communicate collision detection.

LAN ARCHITECTURES – WIRELESS ACCESS METHODS (cont'd)

- Bluetooth uses a polling mechanism with controlled access.
- Devices establish themselves as either Master or Slave devices on a Bluetooth piconet, and communication between any two devices is controlled by the Master device.
- This method prevents data collisions and ensures efficient use of the communications channel.

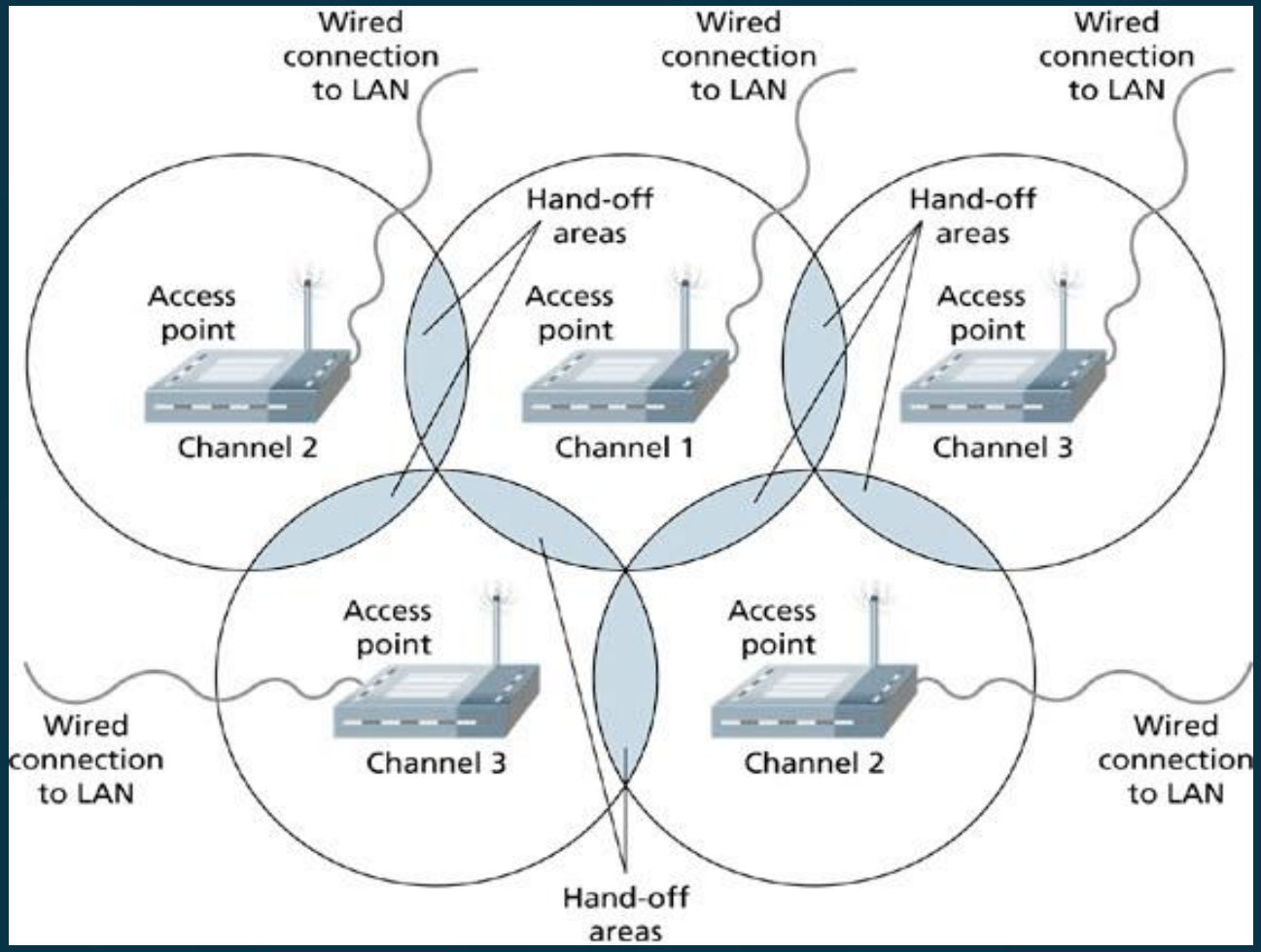
LAN ARCHITECTURES – WIRELESS ACCESS METHODS (cont'd)

- HomeRF uses different media access methods depending on the types of data being transmitted.
  - TDMA is used where timing is critical as in multimedia transmissions.
  - CSMA/CA is used for data transmissions that are not critically dependent upon the timing of the delivery.

WIRELESS TECHNICAL CONSIDERATIONS

- Frequency overlap between competing standards.
- Access point location should provide optimal coverage for users and not overlap with adjacent access points.

Locating Access Points with No Channel Overlap



WIRELESS BUSINESS CONSIDERATIONS

- Cost.
- Which wireless architecture to choose.
- Standards are important for longevity and interoperability with existing “wired” technologies.
- Distance and speed requirements to meet business needs.

Wireless Technologies Compared

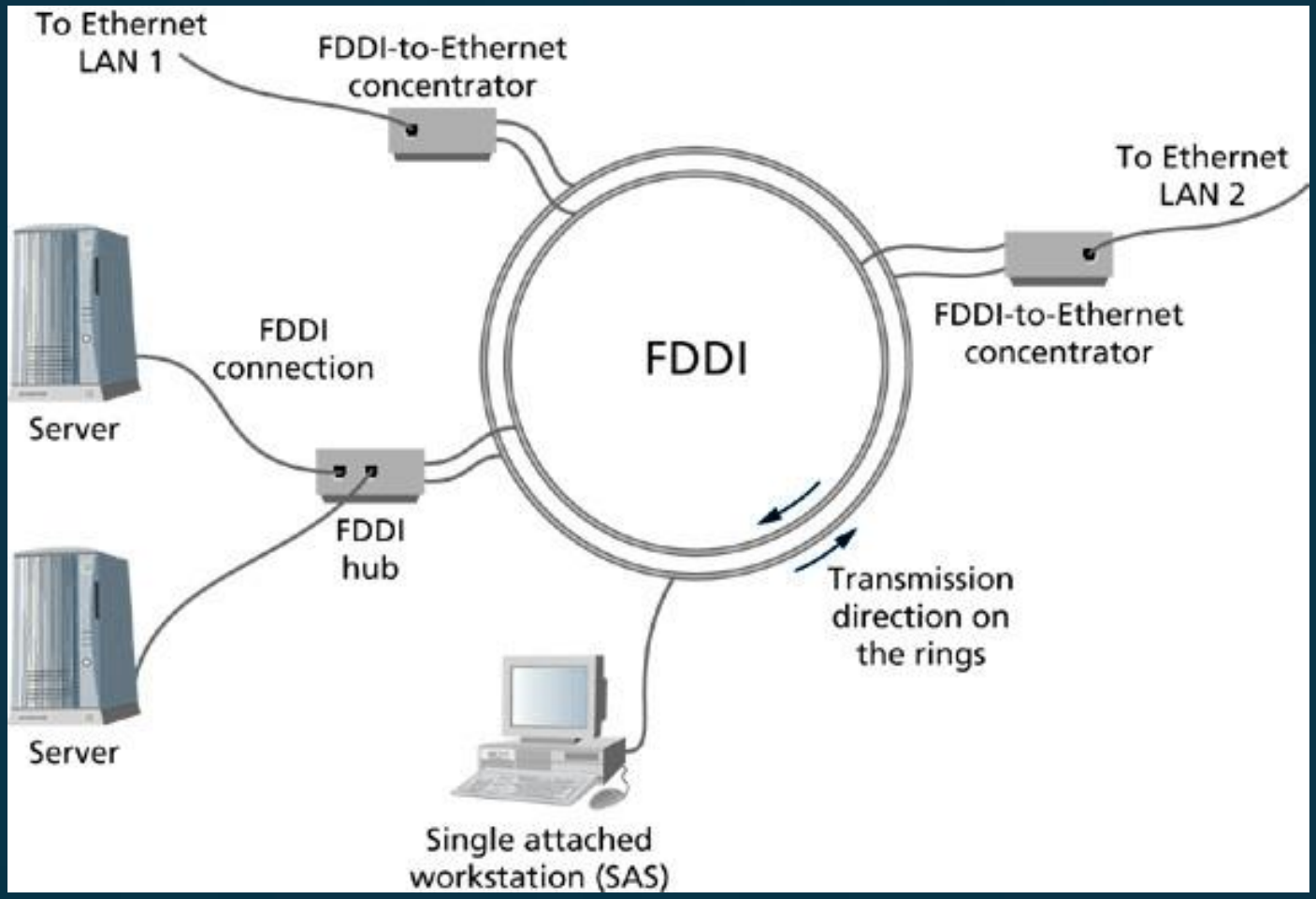
TABLE 3.5

Wireless Technology	WPAN or WLAN	Frequency Ranges	Data Rate (Mbps)	Common Operating Range
802.11	WLAN	2.4 GHz and 5 GHz	2 to 54	Up to 150 feet
Bluetooth	WPAN	2.4 GHz	Up to 55	Up to 10 meters
HiperLAN2	WLAN	5 GHz	Up to 54	30 to 150 meters
HomeRF	WPAN	2.4 GHz	Up to 10	Up to 150 feet

LAN ARCHITECTURES – FDDI

- FDDI – Fiber Distributed Data Interface
- It's an older data transmission technology.
- It's roots date back to the early 1980s.
- It's still supported in various network environments.
- At one time it was a common choice for high-speed connectivity between remote LANs in a campus environment.

FDDI Dual-ring Configuration and Network Interconnectivity



LAN ARCHITECTURES – FDDI (cont'd)

- FDDI can be maintained in existing installations, but as higher data rates are required, it is generally replaced by Gigabit (or faster) Ethernet.

LAN ARCHITECTURES – ATM

- ATM is a technology that dates back to the late 1960s at Bell Labs.
- ATM provides high-speed and low-latency data transfer on networks that require reliable and timely delivery of data, voice, and video transmissions.
- Is generally reserved for network backbones, wide area networks, and carrier service networks.

LAN ARCHITECTURES – ATM (cont'd)

- Business Considerations for ATM:
  - Not widely used in LANs due to cost and efficient competitors such as Ethernet.
  - Can be used for backbone connectivity in LAN settings, but Gigabit (and faster forms of) Ethernet are efficient competitors here as well.
  - ATM is used extensively in carrier service networks for the transmission of data, voice, and video.

LAN Architectures Summary

TABLE 3.6
LAN Architectures Summary

LAN Architecture	Data Rates Supported	Topologies Supported	Common Usage
Ethernet	10, 100 Mbps, 1, 10 Gbps	Bus, Star	LANs, LAN Backbones
Token ring	4, 16, 100 Mbps	Ring, Star	Legacy LANs
Wireless LANs and WPANs	Up to 55 Mbps	Wireless	Short-range LAN connectivity
FDDI	100 Mbps	Ring, Star	Legacy LAN backbones
ATM	25, 155 Mbps	Star	LAN backbones