

## 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 and Bluetooth.
- 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.

star

wireless

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# LAN TOPOLOGIES (cont'd)

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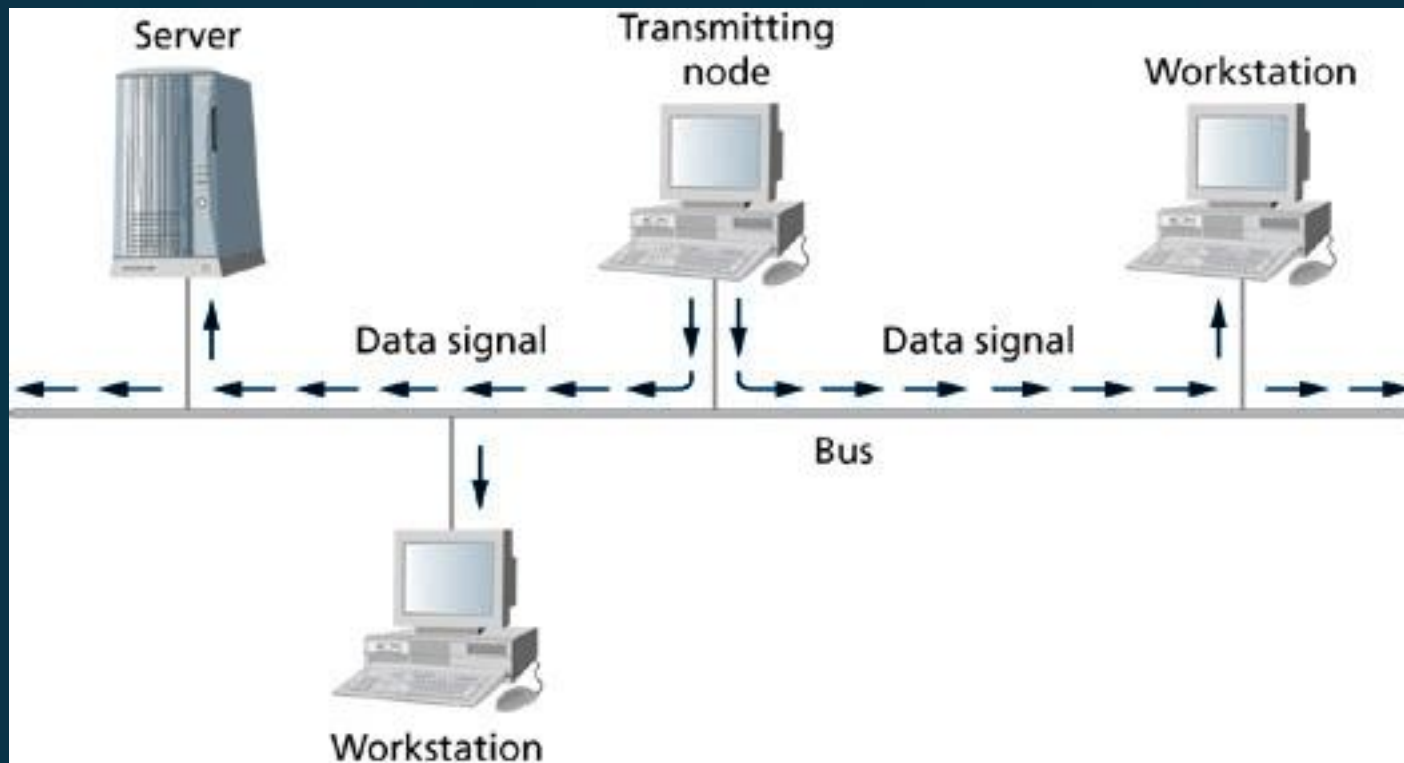
- **Logical topology** defines the conceptual layout of a LAN, or the way in which data flows across the LAN.
- **Physical topology** defines the actual physical layout of the LAN and the configuration of the cabling, computers, printers, and other devices on the LAN.

# LAN TOPOLOGIES – BUS

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- 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



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: TV , , MBC,SBS 가 B가

# 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.)



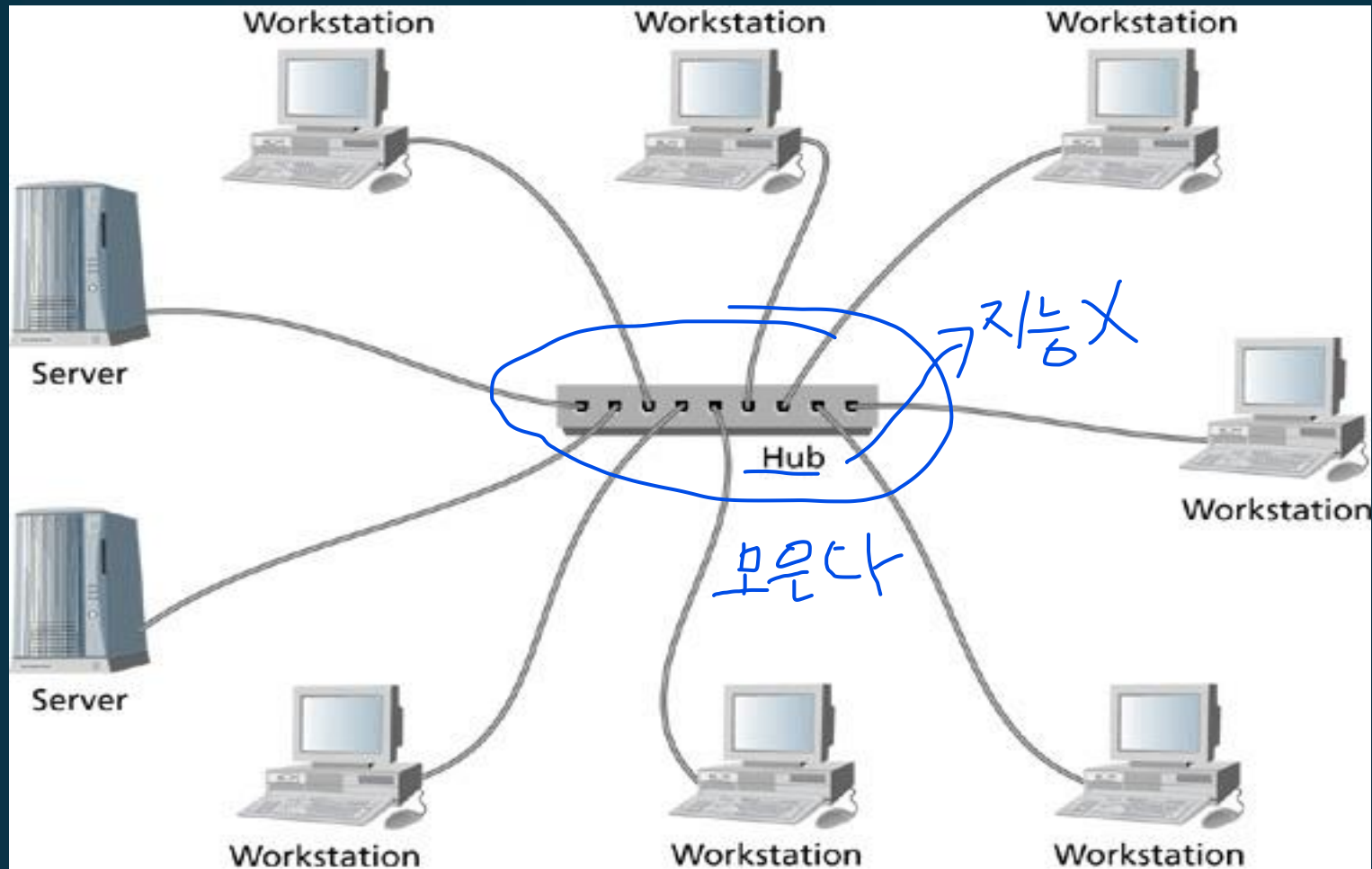
# LAN TOPOLOGIES – STAR

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- 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.

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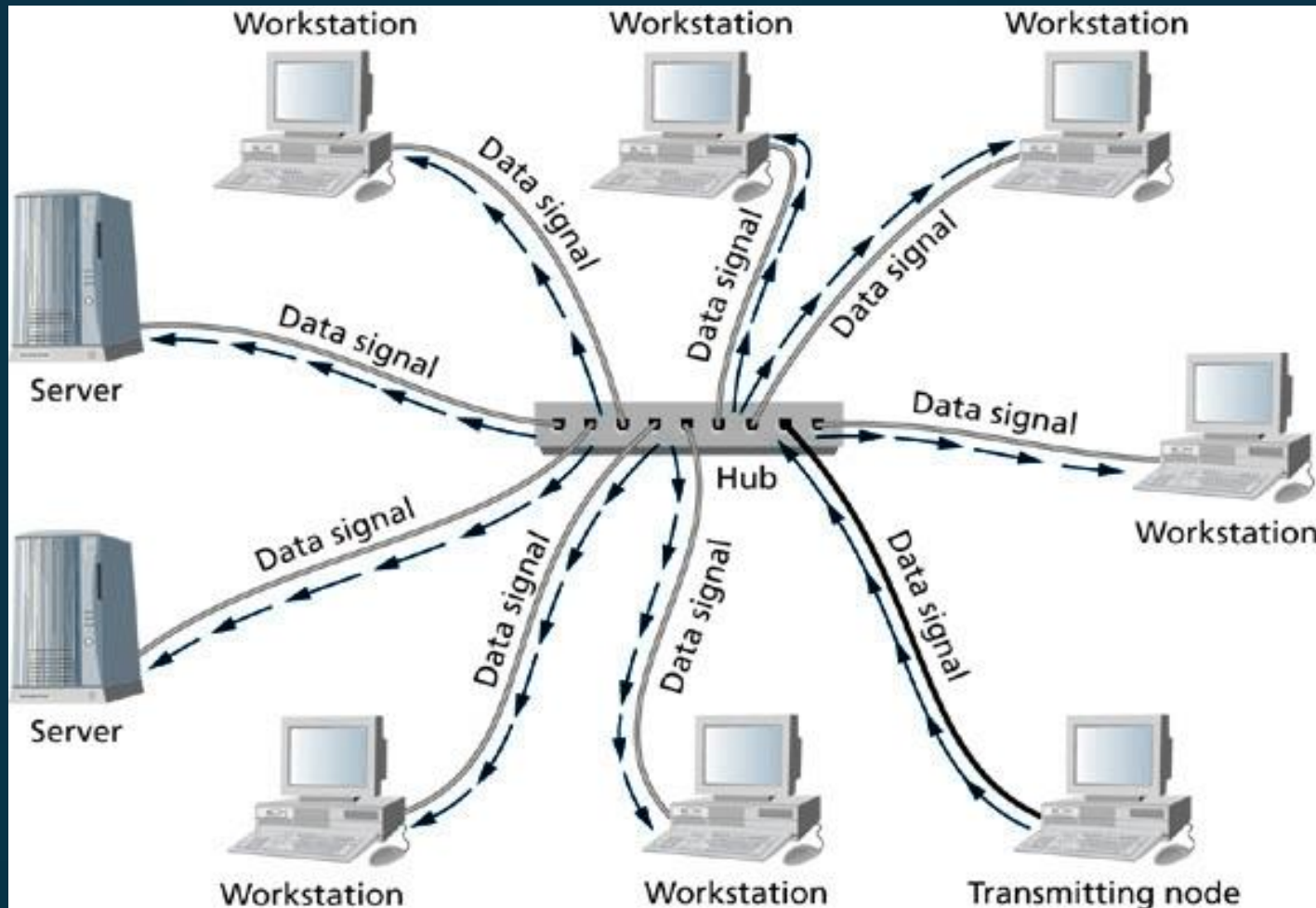
# Star Topology



# 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)

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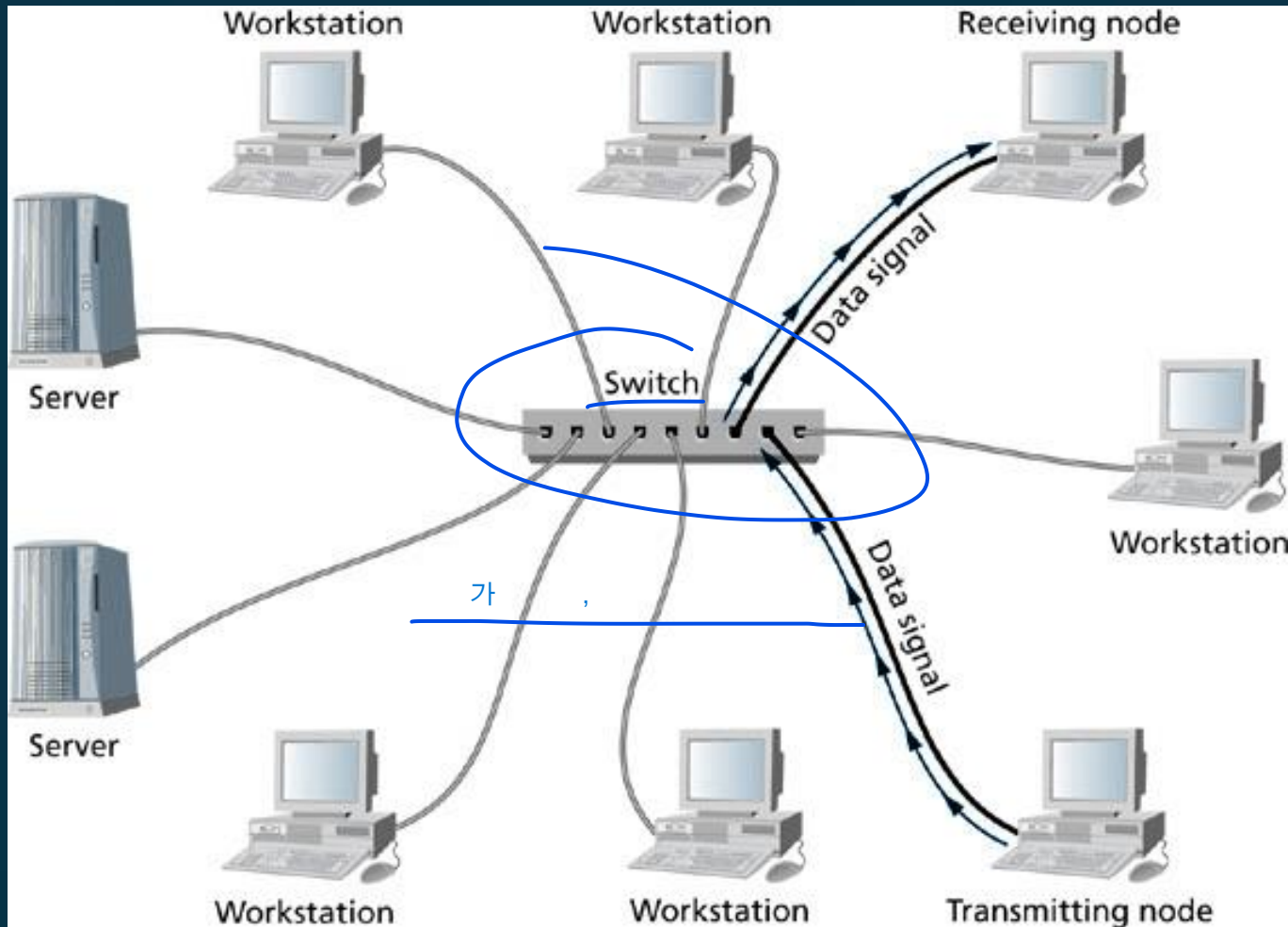
- Physical star/logical star
  - Uses twisted pair cabling and a switch.
  - Has the physical configuration of a star.
  - The flow of data emanates only to the intended recipients, which makes the configuration a logical star as well.

# Physical Star/Logical Star

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# LAN TOPOLOGIES – STAR

## (cont'd)

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- 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.)

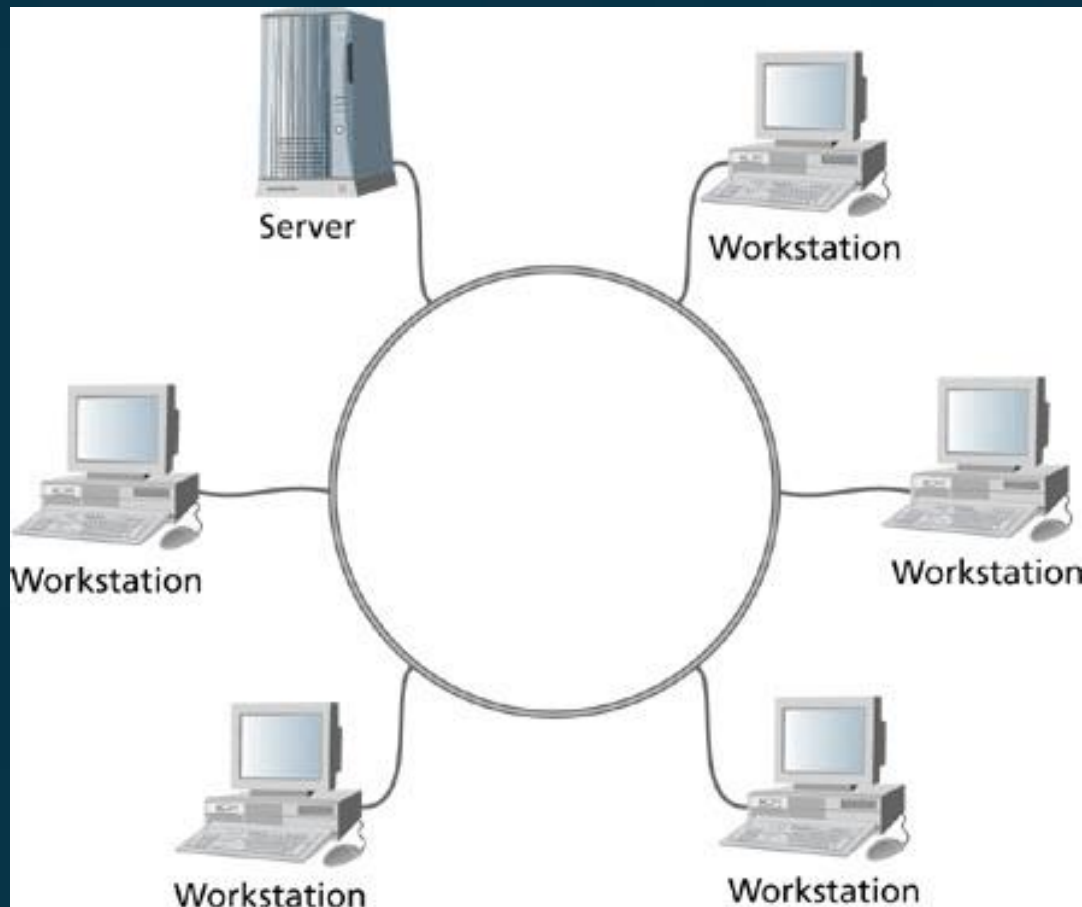
# LAN TOPOLOGIES – RING

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- 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.

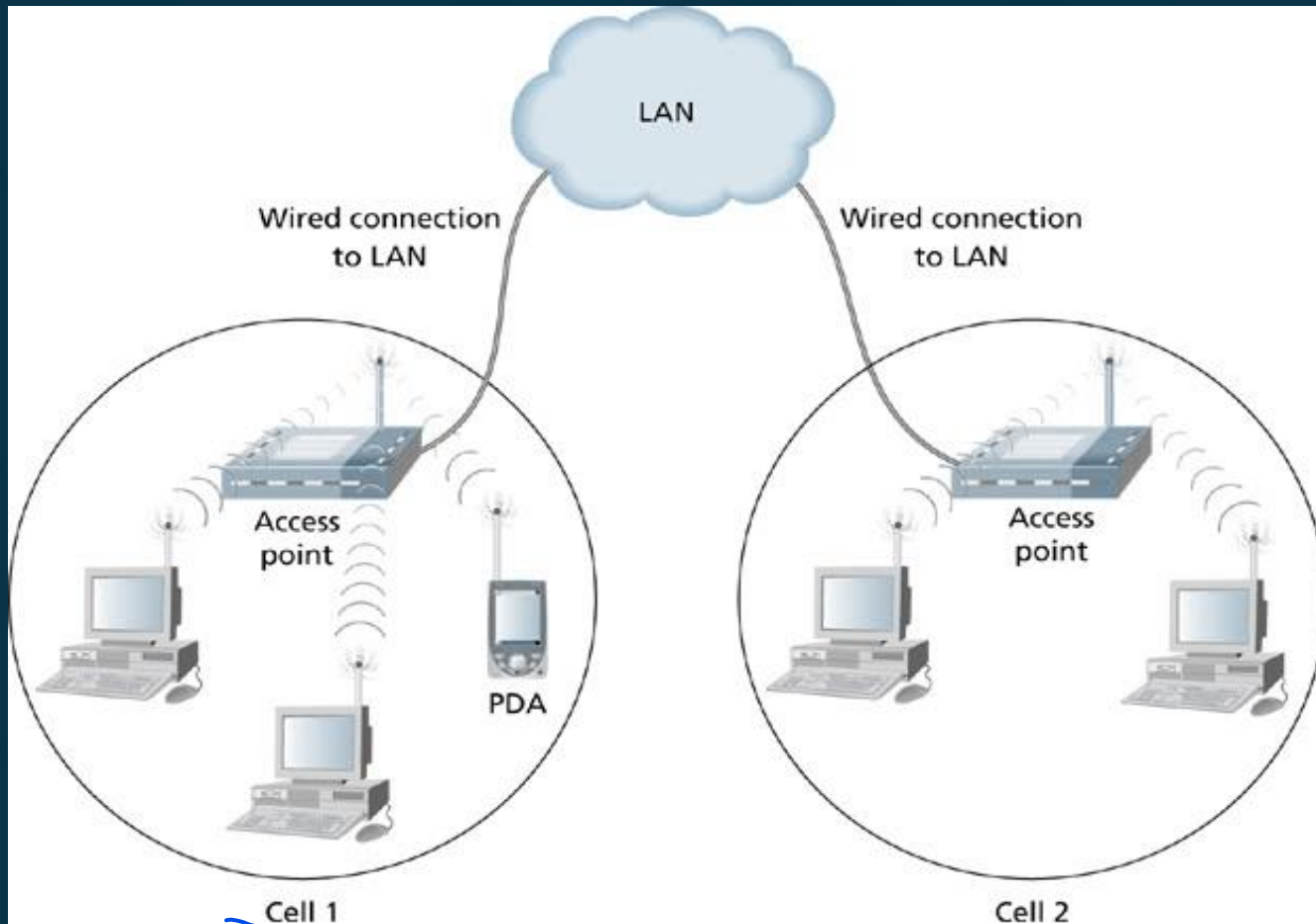
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# LAN TOPOLOGIES - WIRELESS

- **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.

Access point 가 1 1

# 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.)

# LAN ARCHITECTURES

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

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# 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).  
10mb 5thicknet ( )
- 10Base-T is 10 Mbps baseband Ethernet over UTP cable. UTP
- 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
<b>10BASE5</b>	Thicknet or thick Ethernet	10 Mbps Ethernet over thicknet with a maximum cable segment length of 500 meters
<b>10BASE2</b>	Thinnet or thin Ethernet	10 Mbps Ethernet over thinnet with a maximum cable segment length of 185 meters <sup>a</sup>
<b>10BASE-T</b>	Categories 3-6 UTP	10 Mbps Ethernet over UTP cabling, usually cat5. Uses two of the twisted pairs
<b>100BASE-TX</b>	Categories 3-6 UTP	100 Mbps Ethernet over UTP cabling, usually cat5 or cat5e. Uses two of the twisted pairs
<b>100BASE-FX</b>	Fiber-optic cable	100 Mbps Ethernet over fiber-optic cable
<b>100BASE-T4</b>	Category 3 UTP	Obsolete. Was designed to use all four of the twisted pairs of cat3 UTP cabling
<b>1000BASE-T</b>	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
<b>10GBase-LX4</b>	SMF or MMF	10 Gbps over SMF or MMF

<sup>a</sup>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)

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- **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.)

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# ETHERNET: TECHNICAL AND BUSINESS CONSIDERATIONS

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- Ethernet has distance limitations.
  - For example, 100 Mbps Ethernet has a maximum segment length of 100 meters and a network span of 205 meters. 가 100
- 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

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- 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.

# Wireless IEEE 802.11 Data Communications Standards

**TABLE 3.4**  
**Wireless IEEE 802.11**  
**Data**  
**Communications**  
**Standards**

IEEE 802.11 Standard	Description
<b>802.11</b>	The basic standard with transmission rates up to 2 Mbps in the 2.4 GHz frequency range
<b>802.11a</b>	Extension to the basic standard with transmission rates up to 54 Mbps in the 5 GHz frequency range
<b>802.11b</b>	Extension to the basic 802.11 standard with transmission rates up to 11 Mbps in the 2.4 GHz frequency range
<b>802.11e</b>	Provides Quality of Service (QoS) functionality to allow voice, video, and data transmission over wireless
<b>802.11g</b>	Defines data transmission rates up to 54 Mbps in the 2.4 GHz frequency range
<b>802.11h</b>	Allows compatibility with European regulations in the 5 GHz frequency range
<b>802.11i</b>	Defines security protocols for 802.11 WLAN security
<b>IEEE 802.15 (Bluetooth)</b>	
<b>802.15.1</b>	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
<b>802.15.1a</b>	Update to the original standard to include the Bluetooth SIG v1.2 specs
<b>802.15.2</b>	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
<b>802.15.3</b>	Defines high-speed WPANs up to 55 Mbps for distances under 10 meters
<b>802.15.4</b>	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

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- **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)

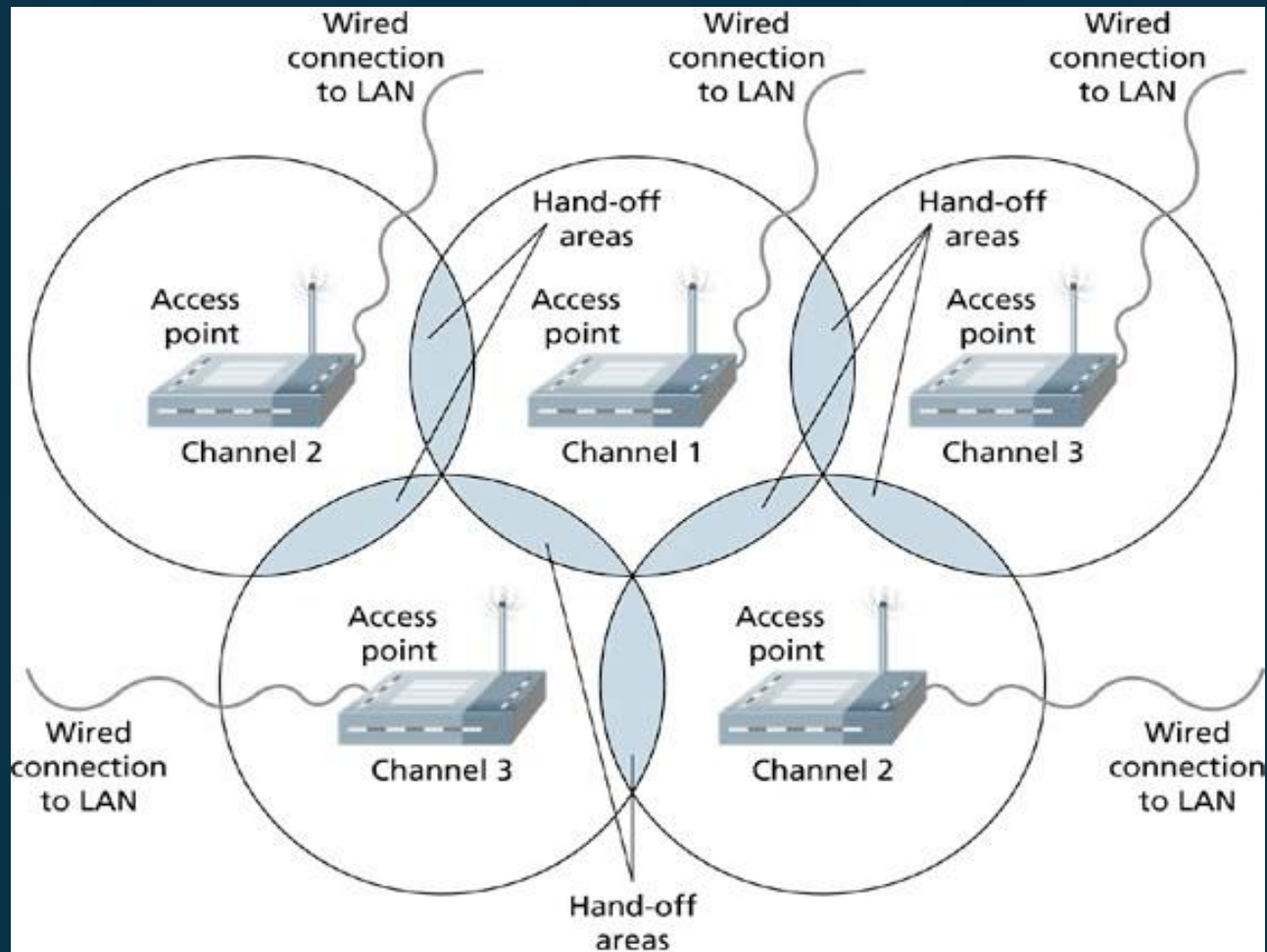
- **Bluetooth** uses a polling mechanism with controlled access.
- Devices establish themselves as either Master or Slave devices on a Bluetooth **piconet**, and communication between any two devices is controlled by the Master device.
- This method prevents data collisions and ensures efficient use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

# WIRELESS TECHNICAL CONSIDERATIONS

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- 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

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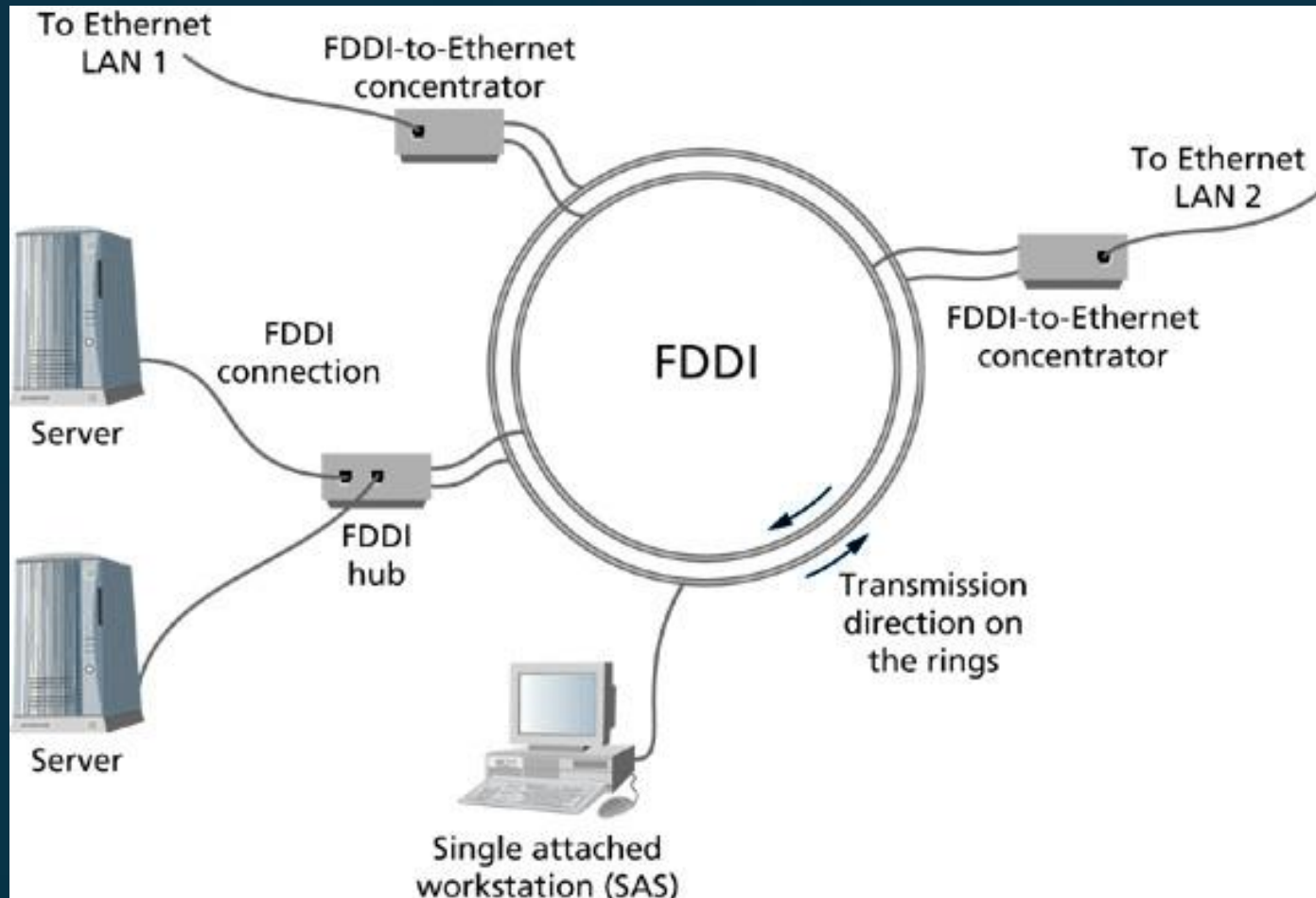
- Cost.
- Which wireless architecture to choose.
- Standards are important for longevity and interoperability with existing “wired” technologies.
- Distance and speed requirements to meet business needs.

# LAN ARCHITECTURES – FDDI

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- 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)

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

FDDI



# LAN ARCHITECTURES – ATM

Asynchronous Transfer Mode

- 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)

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- 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.