Chapter 4:
Network Access

Introduction to Networks v5.1

Chapter Outline

4.0 Introduction

4.1 Physical Layer Protocols

4.2 Network Media

4.3 Data Link Layer Protocols

4.4 Media Access Control

4.5 Summary

Section 4.1:
Physical Layer Protocols

Upon completion of this section, you should be able to:

- Identify device connectivity options.

- Describe the purpose and functions of the physical layer in the network.

- Describe basic principles of the physical layer standards.

Topic 4.1.1:
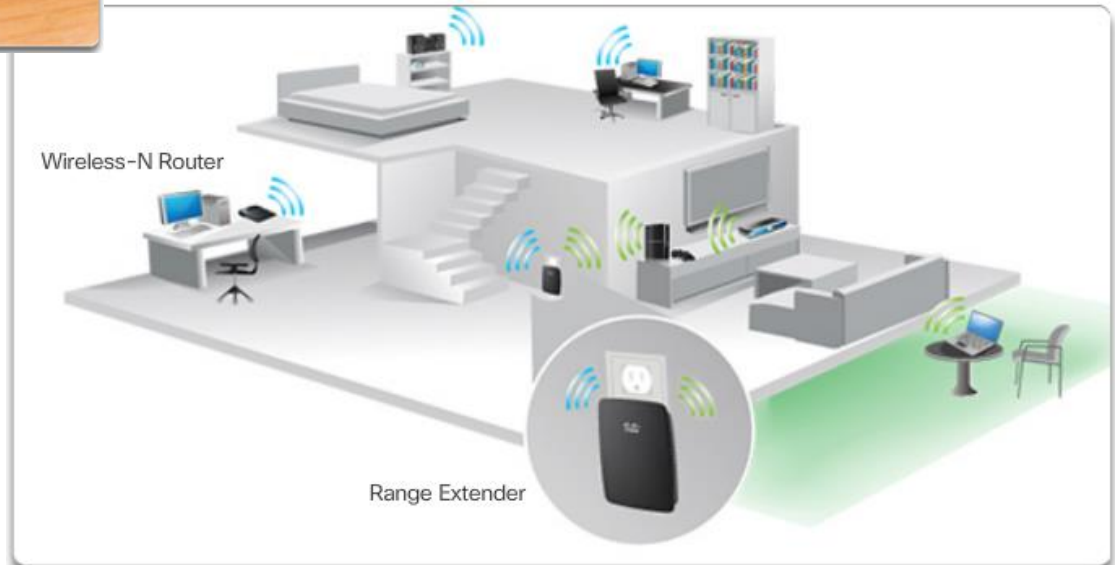# Physical Layer Connection

Types of Connections

Embedded Wireless Antenna

Home Router

Ethernet Switch

Internet Connection

Connecting to the
Wired LAN

Connect your computer to the
Ethernet port (1, 2, 3, or 4).

Network Interface Cards

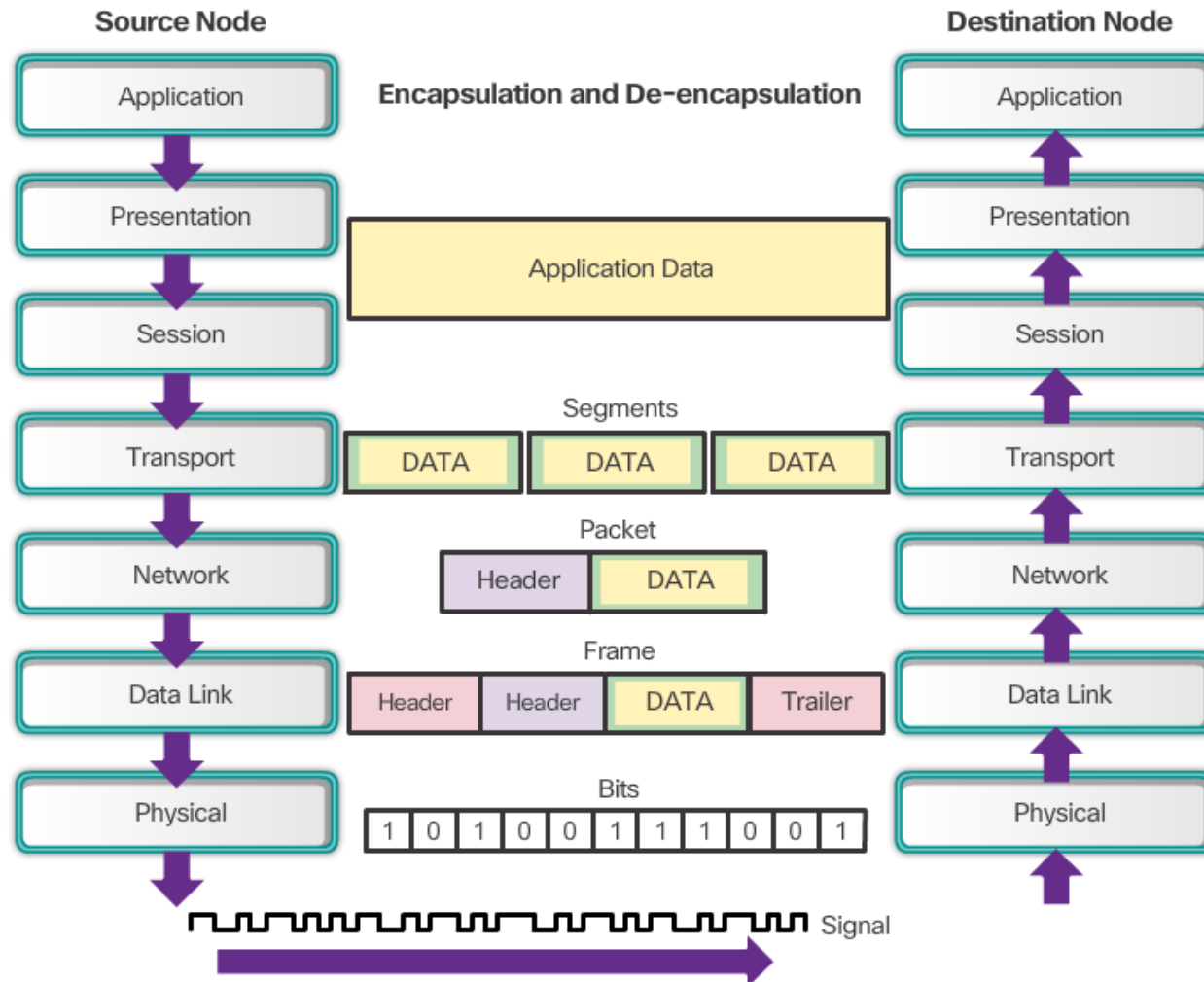Wired Connection Using an Ethernet NIC

Connecting to the Wireless LAN with Range Extender

Wireless-N Router

Range Extender

Topic 4.1.2:
Purpose of the Physical Layer

The Physical Layer

Physical Layer Media

Outbound (Tx) signal

Electrical Signals - Copper cable

Light Pulse - Fiber-optic cable

0 1 0 1 1 0 1 1

Digital Signal

AM

FM

PM
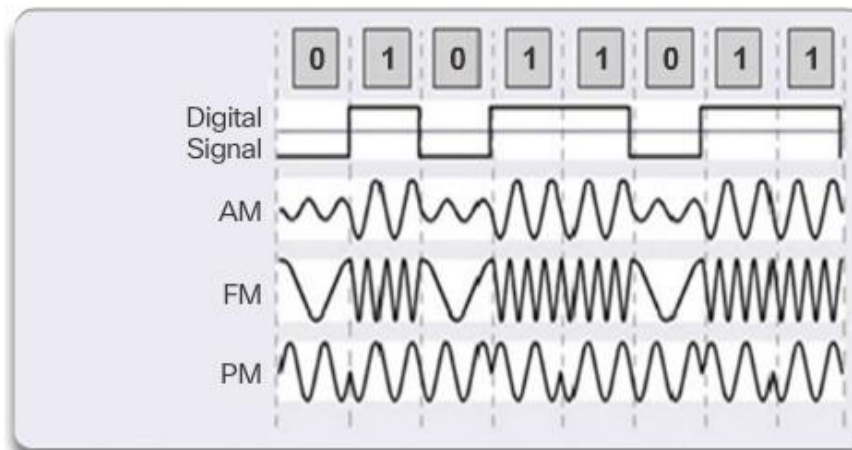
Microwave Signals - Wireless

Physical Layer Standards

Application	
Presentation	
Session	The TCP/IP standards are implemented in software and governed by the IETF.
Transport	
Network	
Data Link	The physical layer standards are implemented in hardware and are governed by many organizations including: · ISO · EIA/TIA · ITU-T · ANSI · IEEE
Physical	
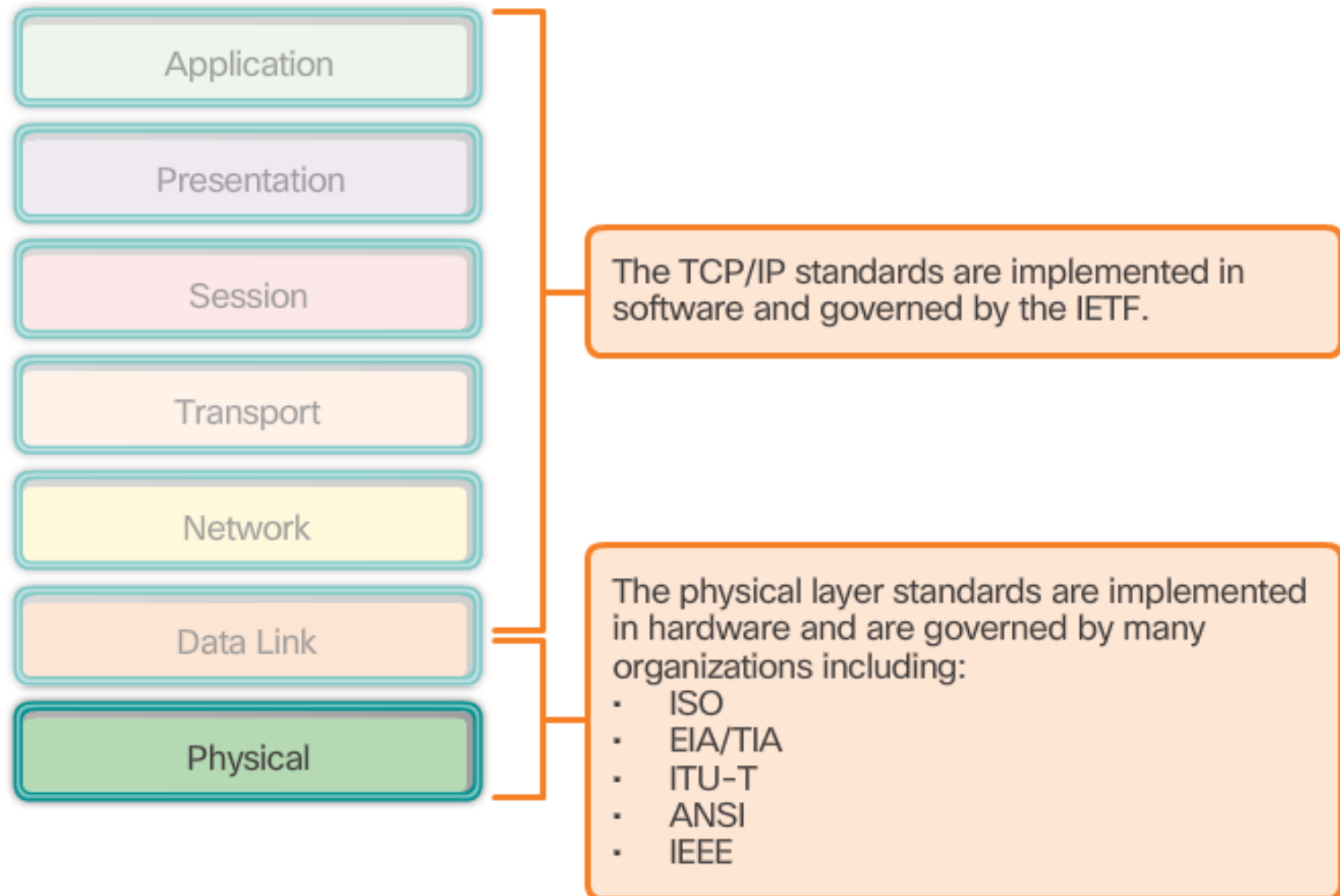
Topic 4.1.3:
Physical Layer Characteristics

Functions

0 1 0 0 1 1 0
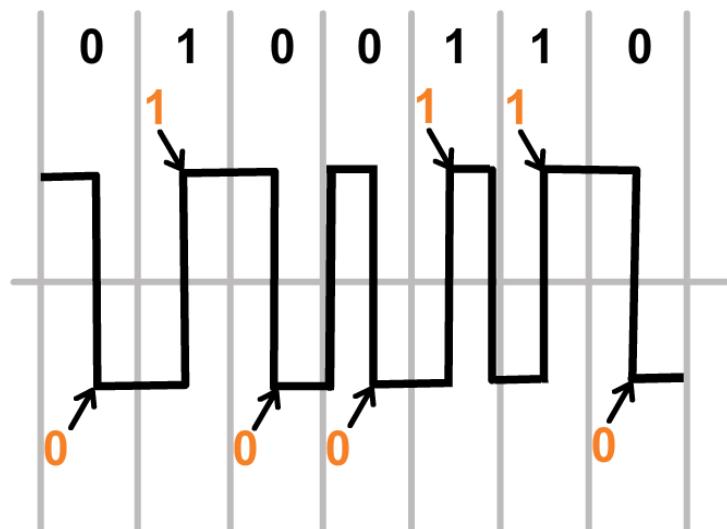
Manchester Encoding

Modulation

Frequency Modulation (FM)

Modulating Wave   Carrier Signal   FM Signal

+ =
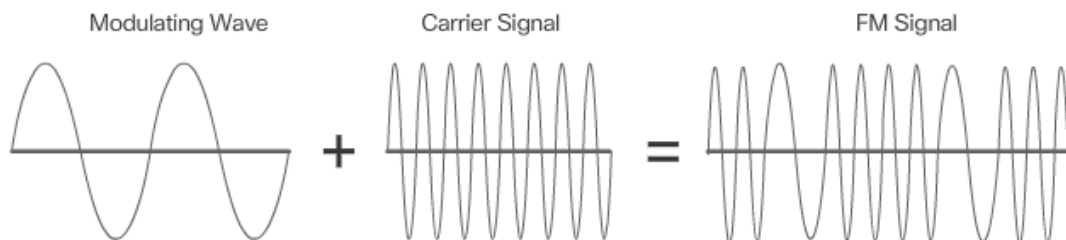
Amplitude Modulation (AM)

Modulating Wave   Carrier Signal   AM Signal

+ =
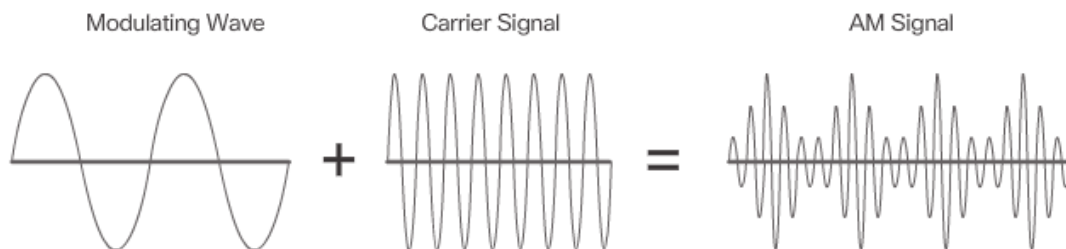
Bandwidth

Unit of Bandwidth	Abbreviation	Equivalence
Bits per second	bps	1 bps = fundamental unit of bandwidth
Kilobits per second	kbps	1 kbps = 1,000 bps = 10^3 bps
Megabits per second	Mbps	1 Mbps = 1,000,000 bps = 10^6 bps
Gigabits per second	Gbps	1 Gbps = 1,000,000,000 bps = 10^9 bps
Terabits per second	Tbps	1 Tbps = 1,000,000,000,000 bps = 10^12 bps

Throughput
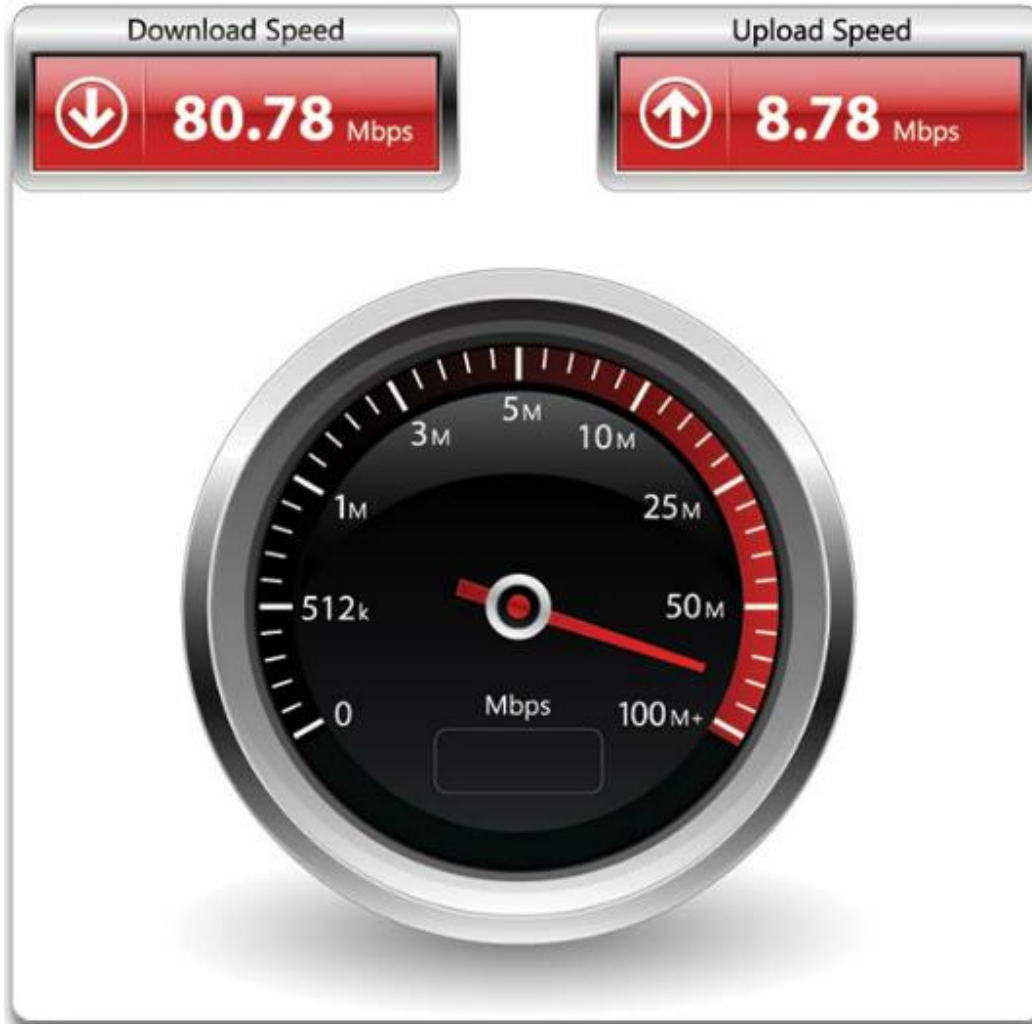
Types of Physical Media

SHDSL Interface

Management Ports

Gigabit Ethernet Interfaces

FastEthernet Switch Ports

USB Type A Connector
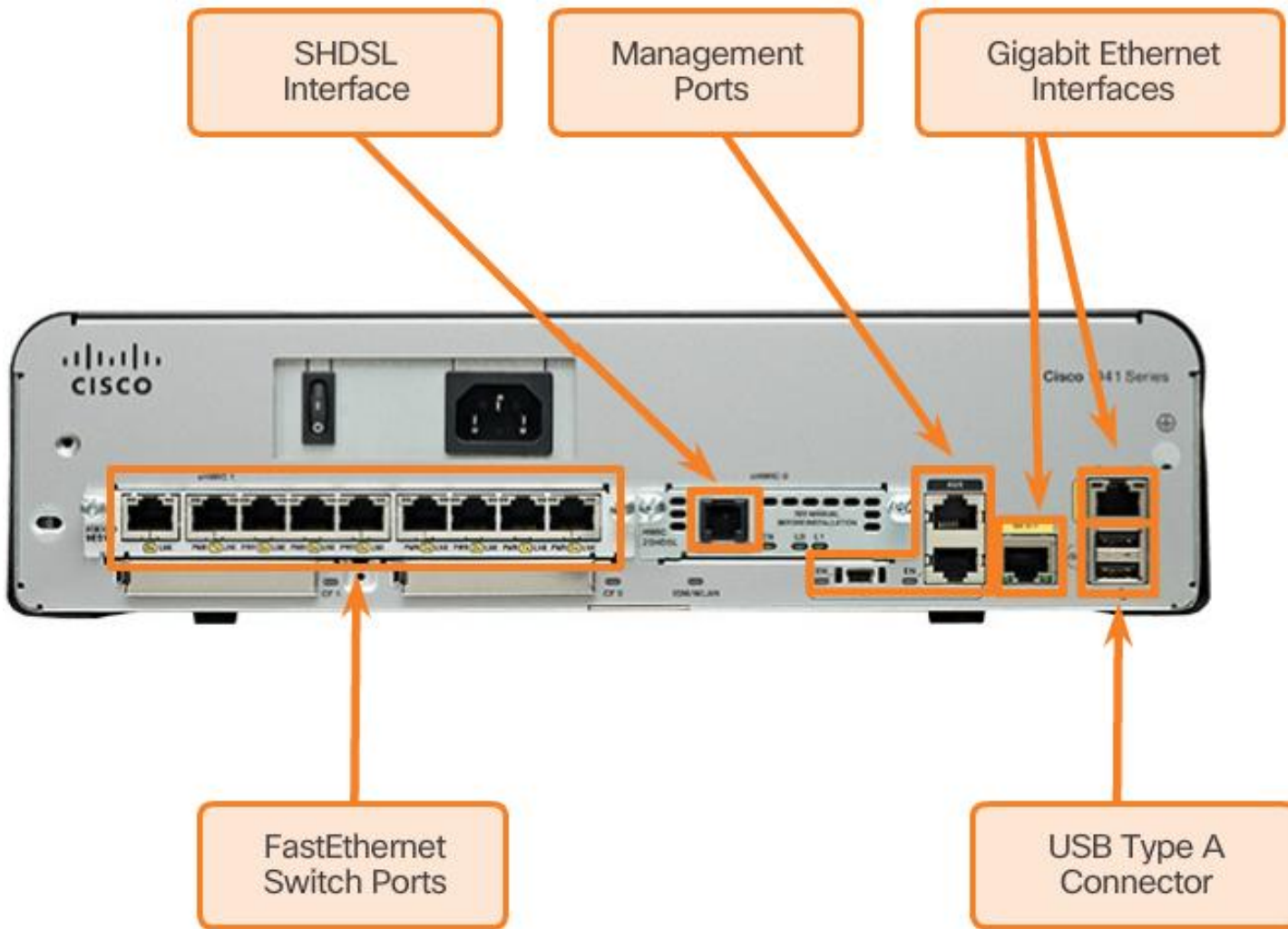
Section 4.2:
Network Media

Upon completion of this section, you should be able to:

- Identify the basic characteristics of copper cabling.

- Build a UTP cable used in Ethernet networks (scope – does not include cabling area discussion).

- Describe fiber-optic cabling and its main advantages over other media.

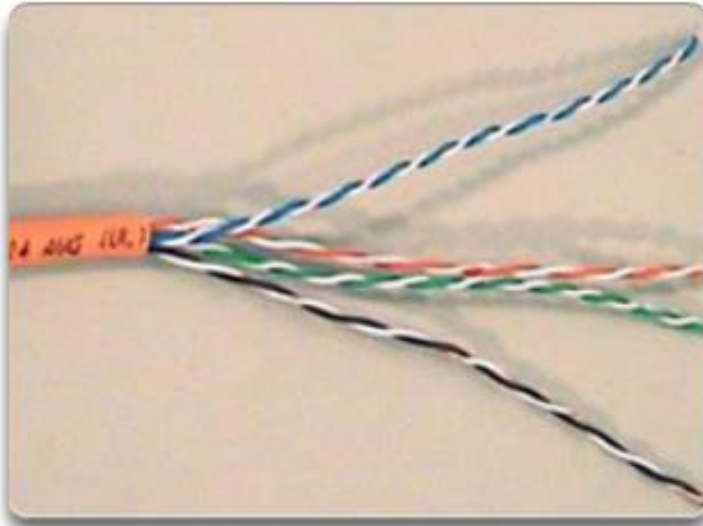- Connect devices using wired and wireless media.

Topic 4.2.1:
Copper Cabling

Characteristics of Copper Cabling
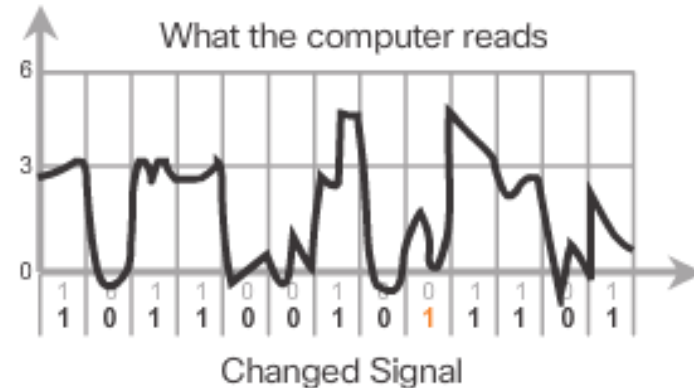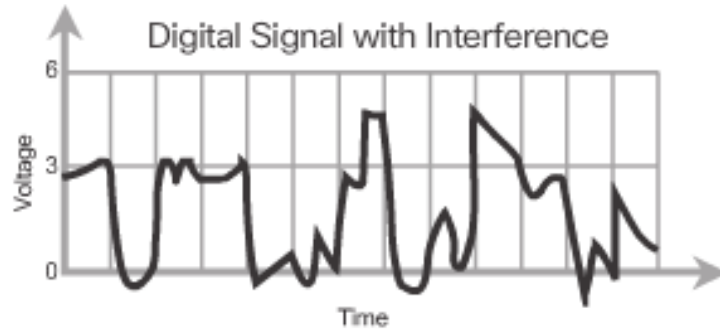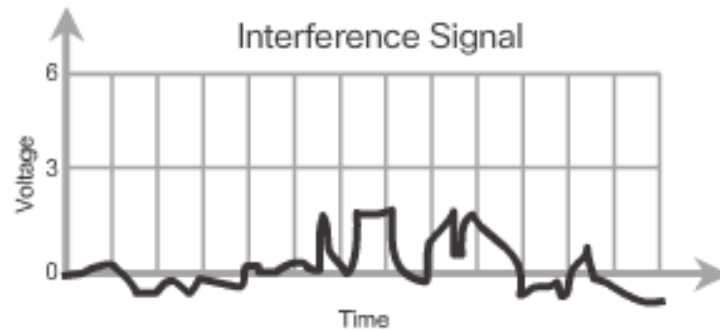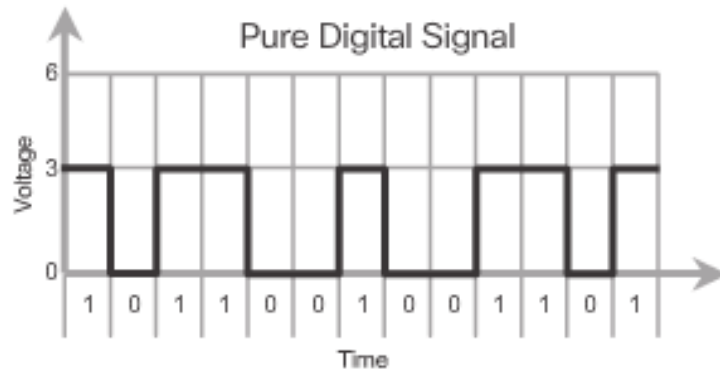
Copper Media
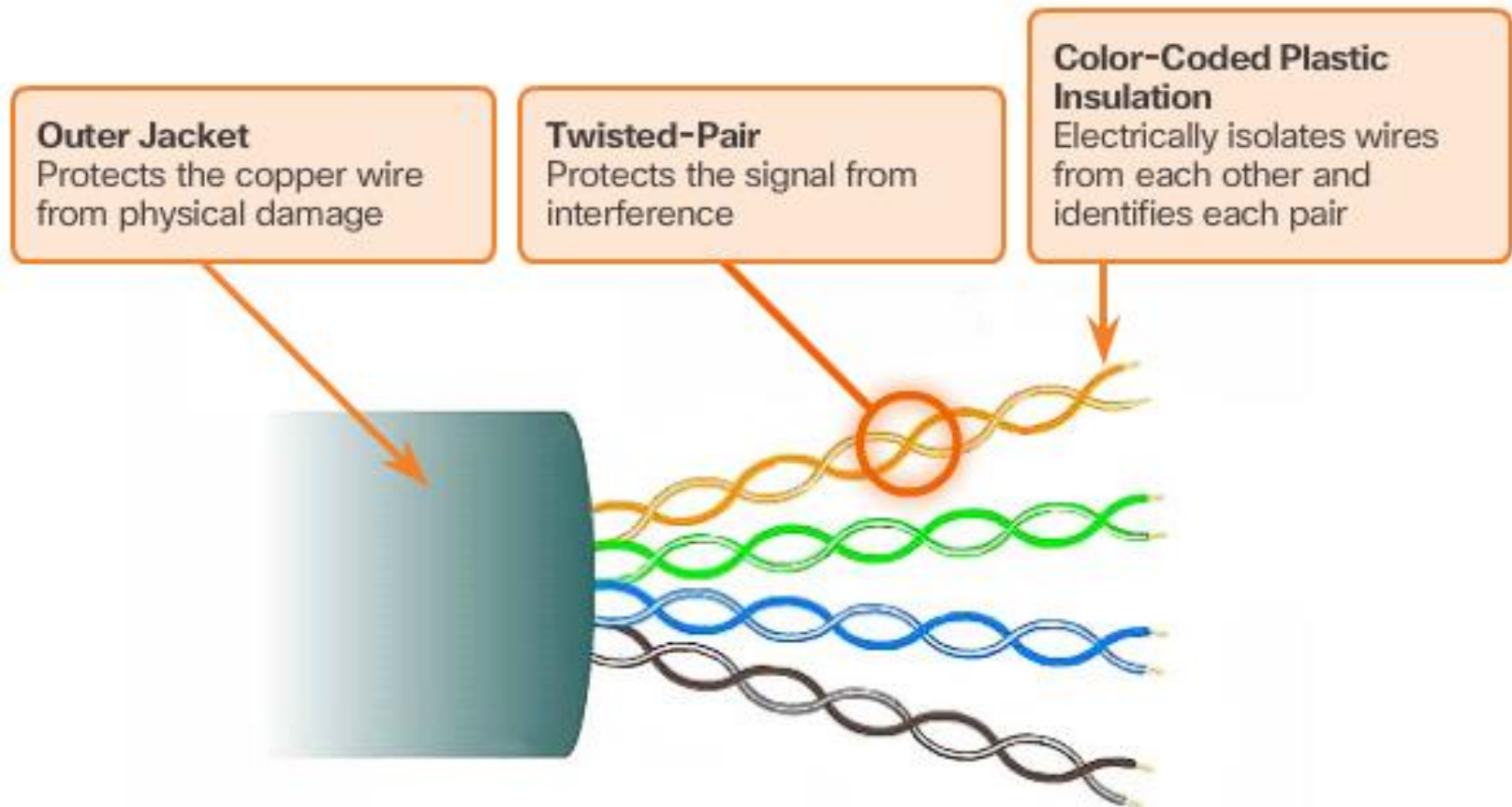

Unshielded Twisted-Pair (UTP) cable
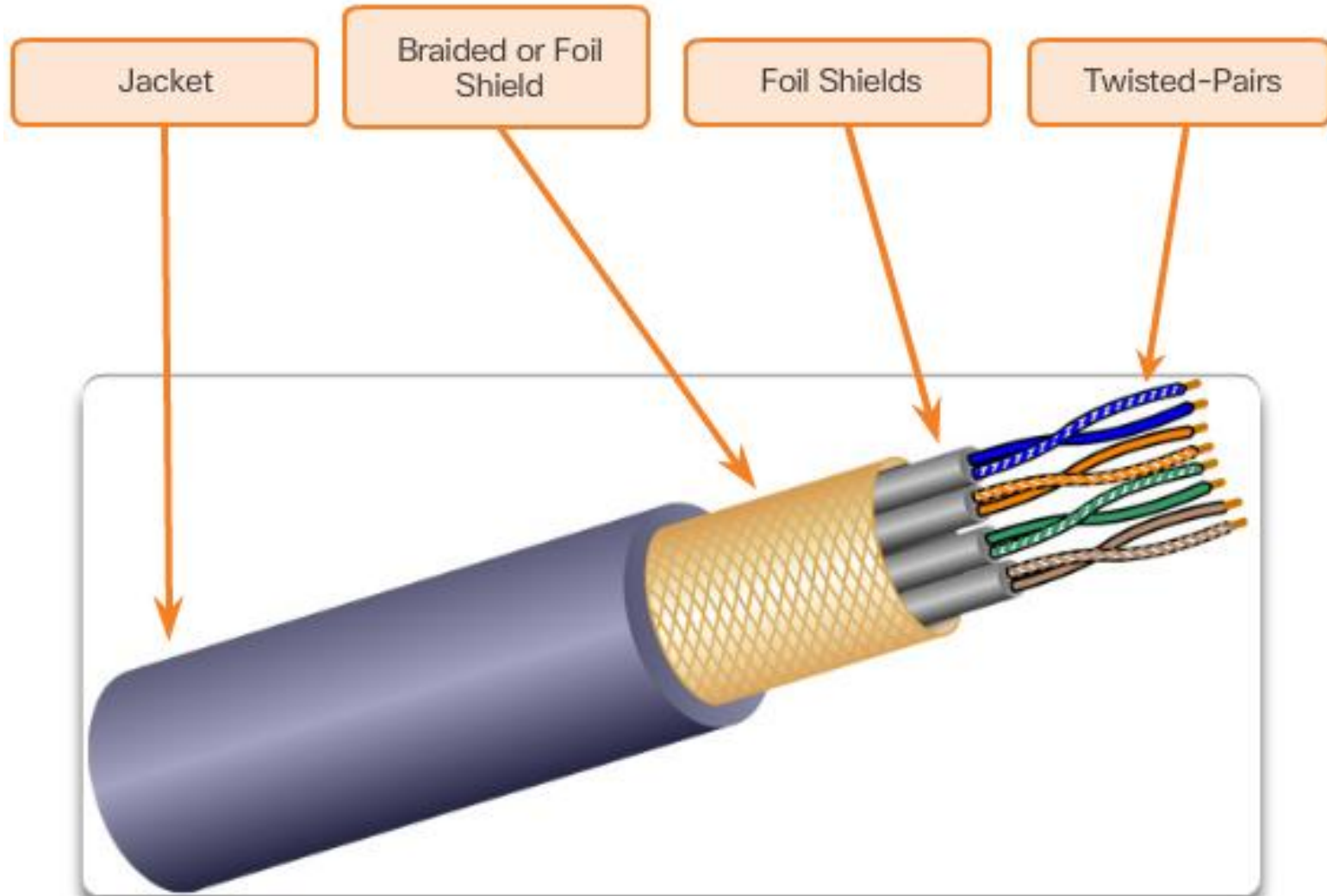

Shielded Twisted-Pair
(STP) cable

Coaxial cable

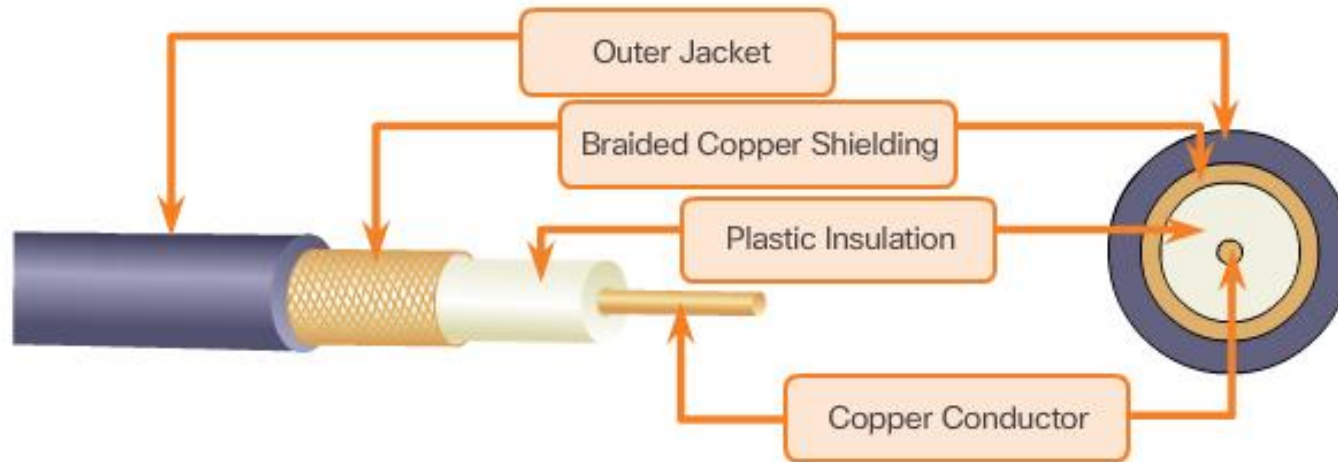# Unshielded Twisted-Pair Cable

Outer Jacket
Protects the copper wire from physical damage

Twisted-Pair
Protects the signal from interference

Color-Coded Plastic Insulation
Electrically isolates wires from each other and identifies each pair

Shielded Twisted-Pair Cable

Jacket

Braided or Foil Shield

Foil Shields

Twisted-Pairs

Coaxial Cable

Outer Jacket

Braided Copper Shielding

Plastic Insulation

Copper Conductor

Coaxial Connectors

BNC   N type   F type

Copper Media Safety

The separation of data and electrical power cabling must comply with safety codes.

Cables must be connected correctly.
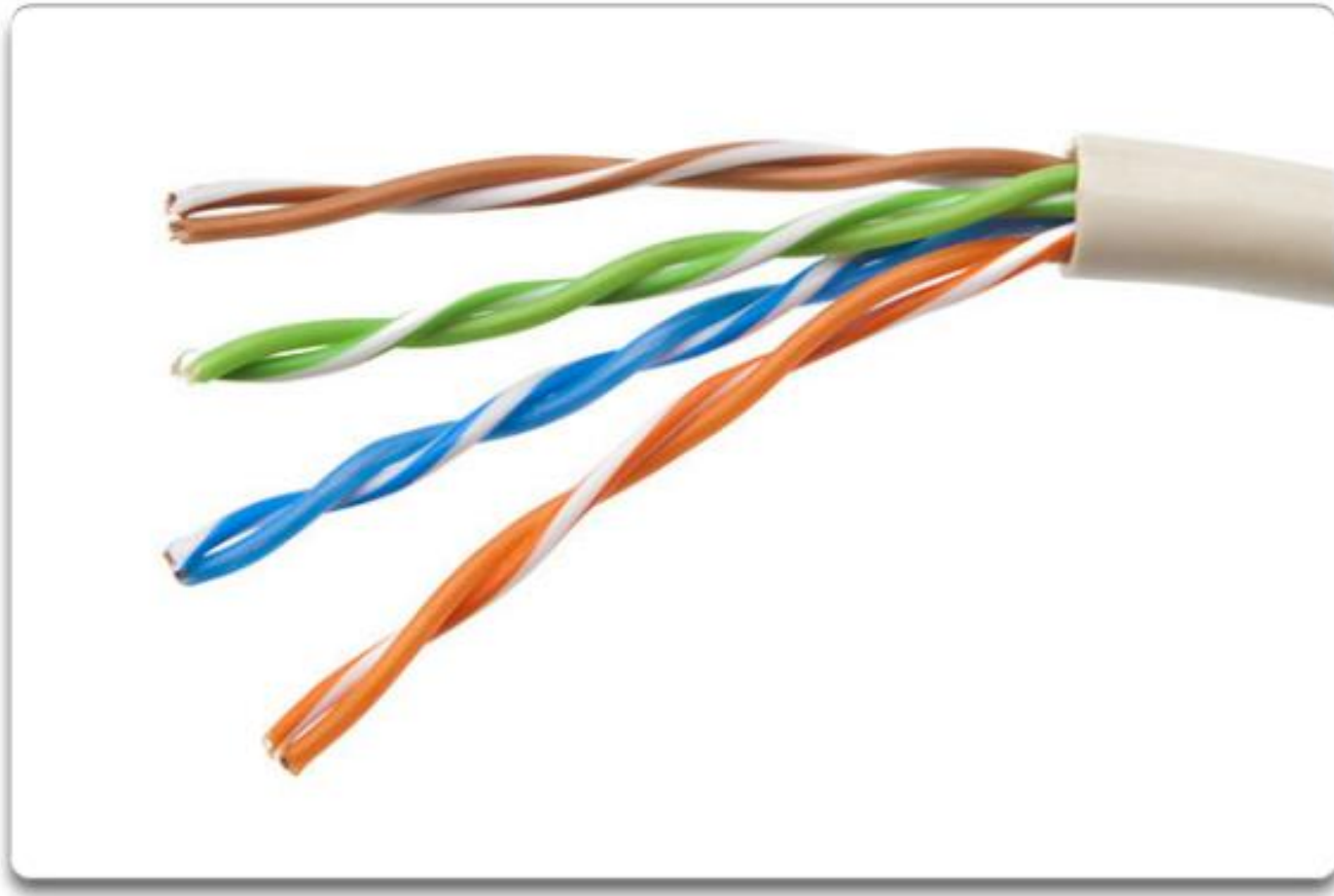
Installations must be inspected for damage.

Equipment must be grounded correctly.

RESET
OFF
GROUNDED
PROTECTED

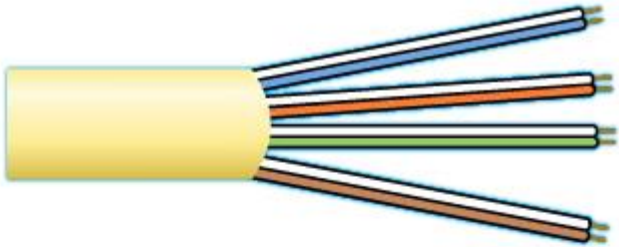# Topic 4.2.2:
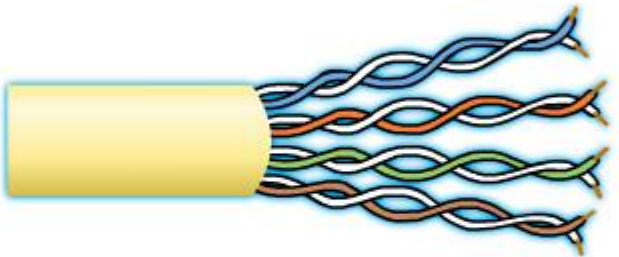# UTP Cabling

Properties of UTP Cabling

UTP Cabling Standards
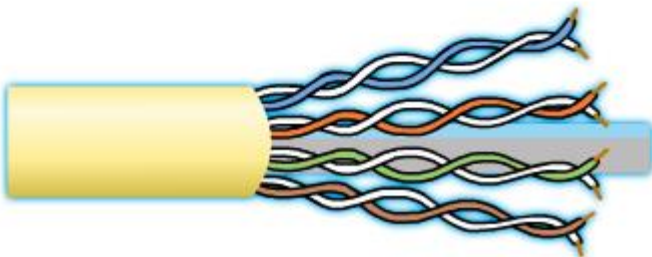
Category 3 Cable (UTP)

Category 3 Cable (UTP)

- Used for voice communication
- Most often used for phone lines

Category 5 and 5e Cable (UTP)

Category 5 and 5e Cable (UTP)

- Used for data transmission
- Cat5 supports 100 Mb/s and can support 1000 Mb/s, but it is not recommended
- Cat5e supports 1000 Mb/s

Category 6 Cable (UTP)

Category 6 Cable (UTP)

- Used for data transmission
- An added separator is between each pair of wires allowing it to function at higher speeds
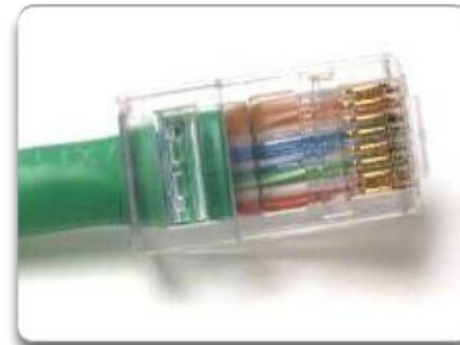- Supports 1000 Mb/s – 10 Gb/s, though 10 Gb/s is not recommended

UTP Connectors
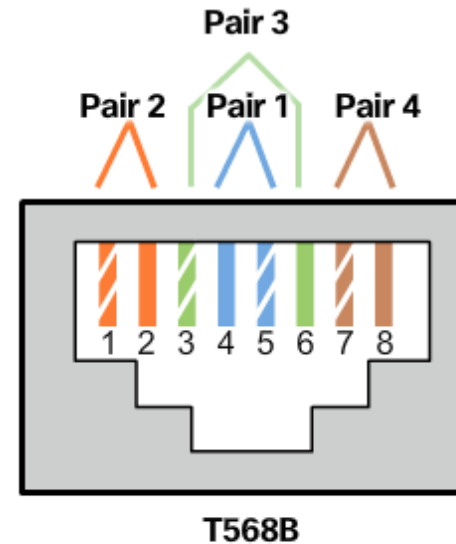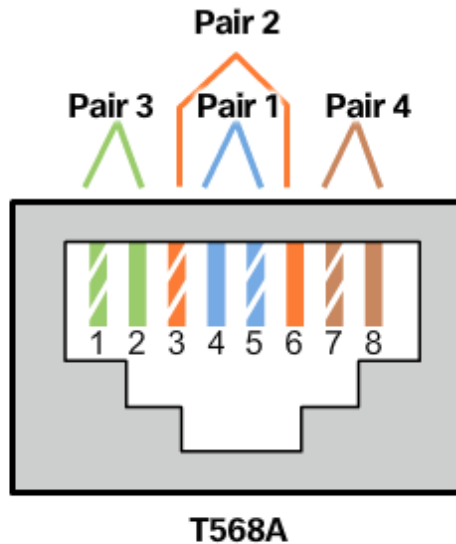
RJ-45 UTP Plugs

RJ-45 UTP Socket

Bad connector – Wires are exposed, untwisted, and not entirely covered by the sheath.

Good connector – Wires are untwisted to the extent necessary to attach the connector.

Types of UTP Cable

Pair 2 / Pair 3 / Pair 1 / Pair 4 — 1 2 3 4 5 6 7 8 — **T568A**

Pair 3 / Pair 2 / Pair 1 / Pair 4 — 1 2 3 4 5 6 7 8 — **T568B**

Cable Type	Standard	Application
Ethernet Straight-through	Both ends T568A or both ends T568B	Connects a network host to a network device such as a switch or hub.
Ethernet Crossover	One end T568A, other end T568B	• Connects two network hosts • Connects two network intermediary devices (switch to switch, or router to router)
Rollover	Cisco proprietary	Connects a workstation serial port to a router console port, using an adapter.

Testing UTP Cables

UTP Testing Parameters:

- Wire map

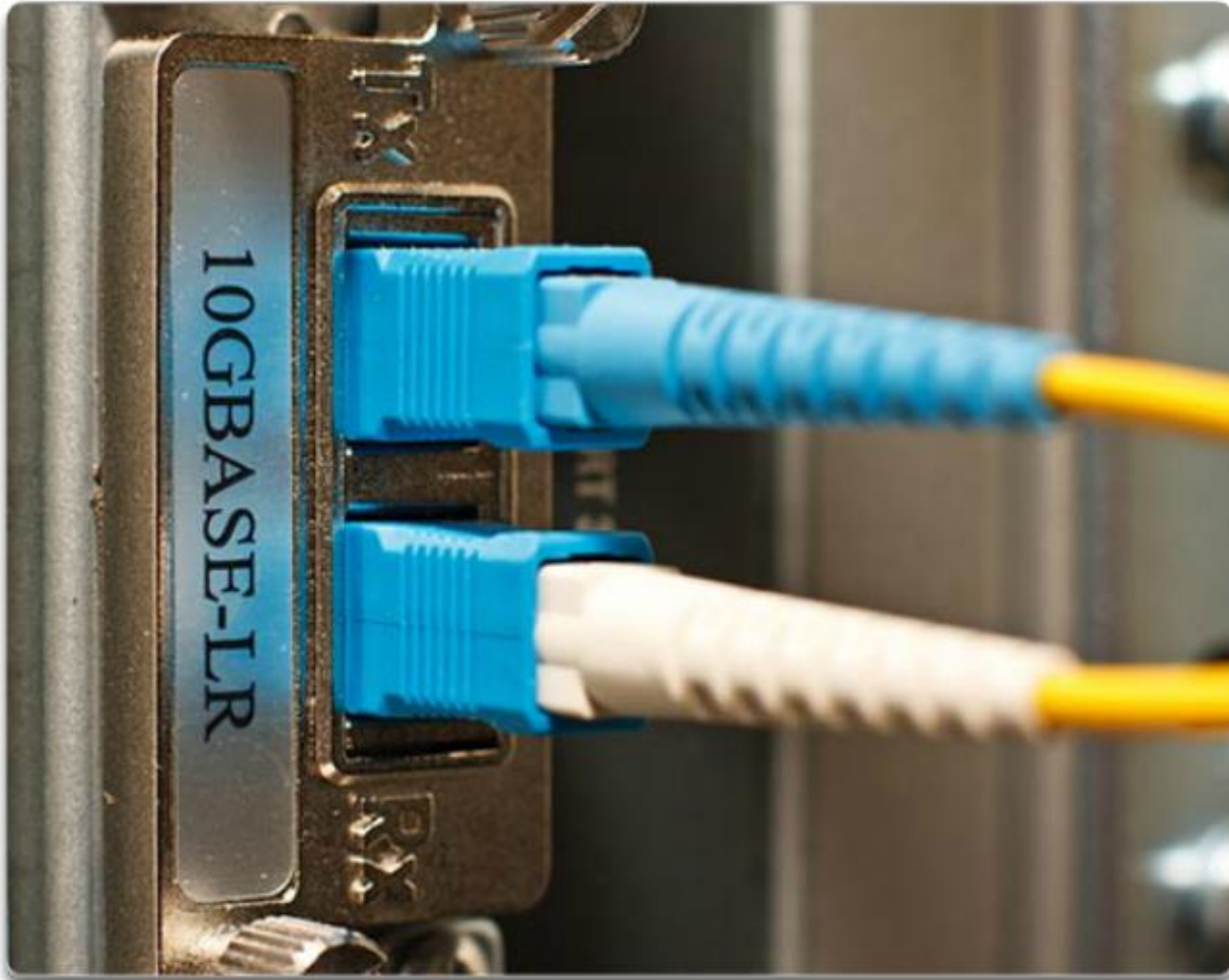- Cable length

- Signal loss due to attenuation

- Crosstalk

Topic 4.2.3:
Fiber Optic Cabling

Properties of Fiber Optic Cabling

Fiber Media Cable Design

Jacket

Typically a PVC jacket that protects the fiber against abrasion, moisture, and other contaminants. This outer jacket composition can vary depending on the cable usage.

Core

The core is actually the light transmission element at the center of the optical fiber. This core is typically silica or glass. Light pulses travel through the fiber core.

Buffer

Used to help shield the core and cladding from damage.
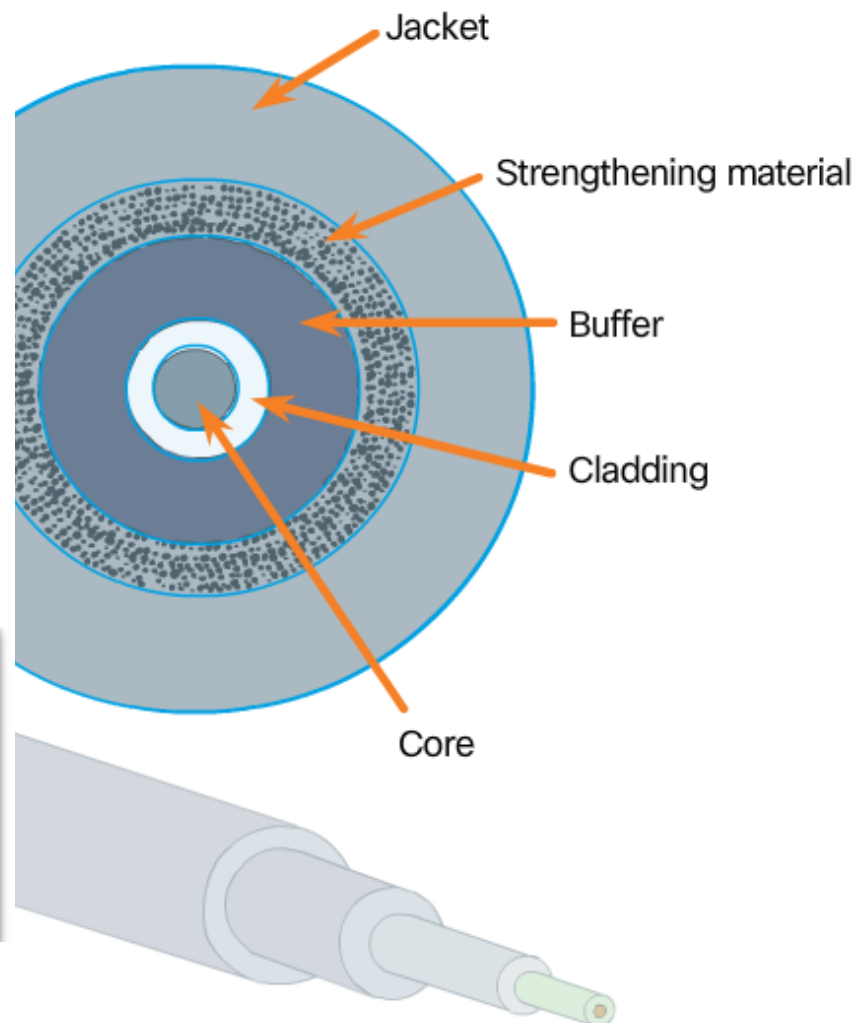
Cladding

Made from slightly different chemicals than those used to create the core. It tends to act like a mirror by reflecting light back into the core of the fiber. This keeps light in the core as it travels down the fiber.
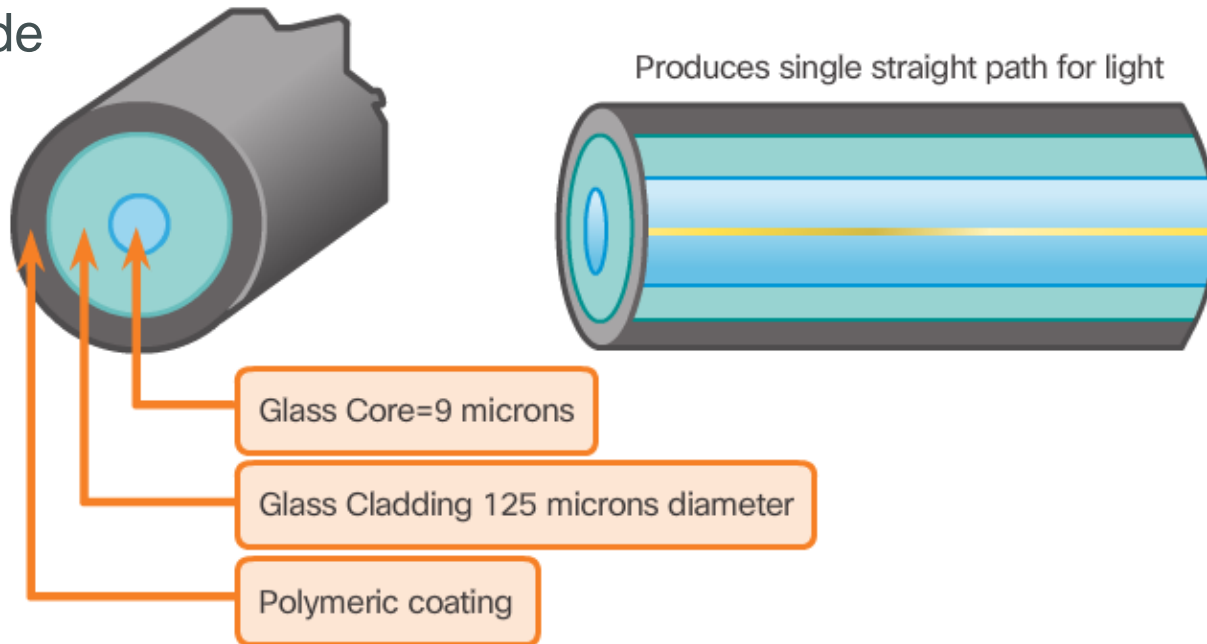
Strengthening Material

Surrounds the buffer, prevents the fiber cable from being stretched when it is being pulled. The material used is often the same material used to produce bulletproof vests.
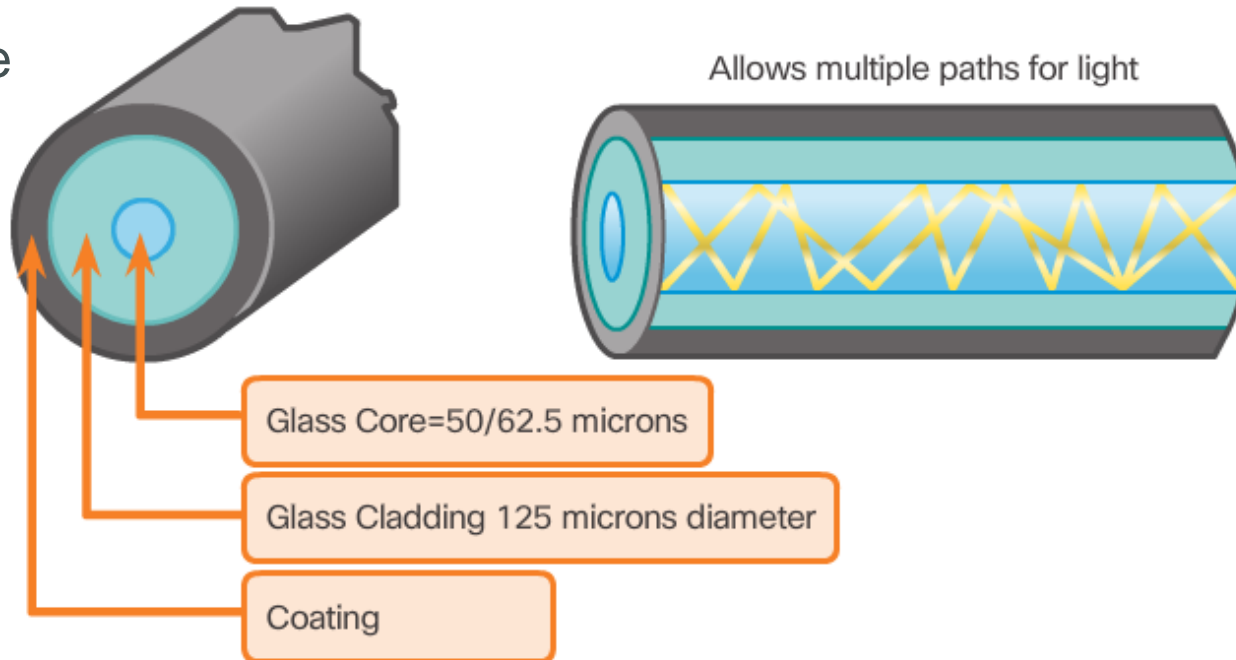
Types of Fiber Media

Single Mode

Produces single straight path for light

Glass Core=9 microns

Glass Cladding 125 microns diameter

Polymeric coating

- Small core
- Less dispersion
- Suited for long distance applications
- Uses lasers as the light source
- Commonly used with campus backbones for distances of several thousand meters

Types of Fiber Media (cont.)

Multimode

Allows multiple paths for light

Glass Core=50/62.5 microns

Glass Cladding 125 microns diameter

Coating

- Larger core than single mode cable
- Allows greater dispersion and therefore, loss of signal
- Suited for long distance applications, but shorter than single mode
- Uses LEDs as the light source
- Commonly used with LANs or distances of a couple hundred meters within a campus network

Network Fiber Connectors

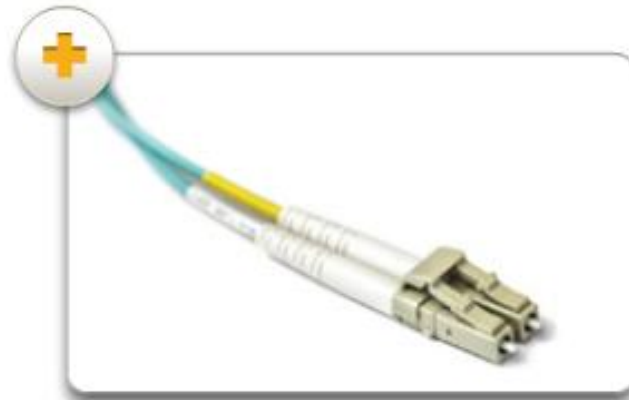Fiber Optic Connectors

ST Connectors

SC Connectors

LC Connector

Duplex Multimode LC
Connectors

Network Fiber Connectors (cont.)

Common Fiber Patch Cords

SC-SC Multimode Patch Cord

LC-LC Single-mode Patch Cord

ST-LC Multimode Patch Cord

SC-ST Single-mode Patch Cord

Testing Fiber Cables

Optical Time Domain Reflectometer (OTDR)

Fiber versus Copper

Implementation Issues	UTP Cabling	Fiber-optic Cabling
Bandwidth supported	10 Mb/s – 10 Gb/s	10 Mb/s – 100 Gb/s
Distance	Relatively short (1 – 100 meters)	Relatively high (1 – 100,000 meters)
Immunity to EMI and RFI	Low	High (Completely immune)
Immunity to electrical hazards	Low	High (Completely immune)
Media and connector costs	Lowest	Highest
Installation skills required	Lowest	Highest
Safety precautions	Lowest	Highest

Topic 4.2.4:
Wireless Media

Properties of Wireless Media

Types of Wireless Media

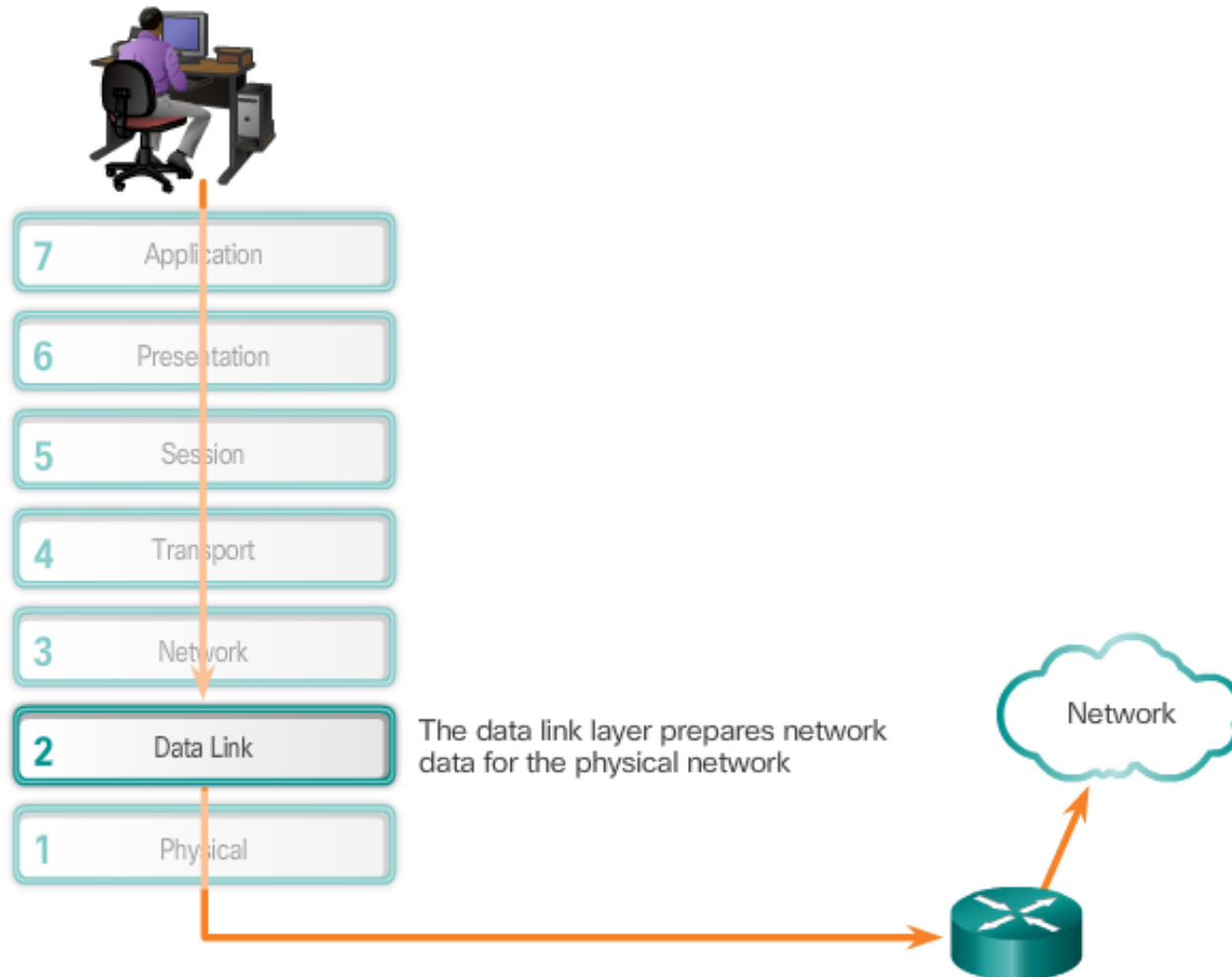# Wireless LAN

Section 4.3:
Data Link Layer Protocols

Upon completion of this section, you should be able to:

- Describe the purpose and function of the data link layer in preparing communication for transmission on specific media.

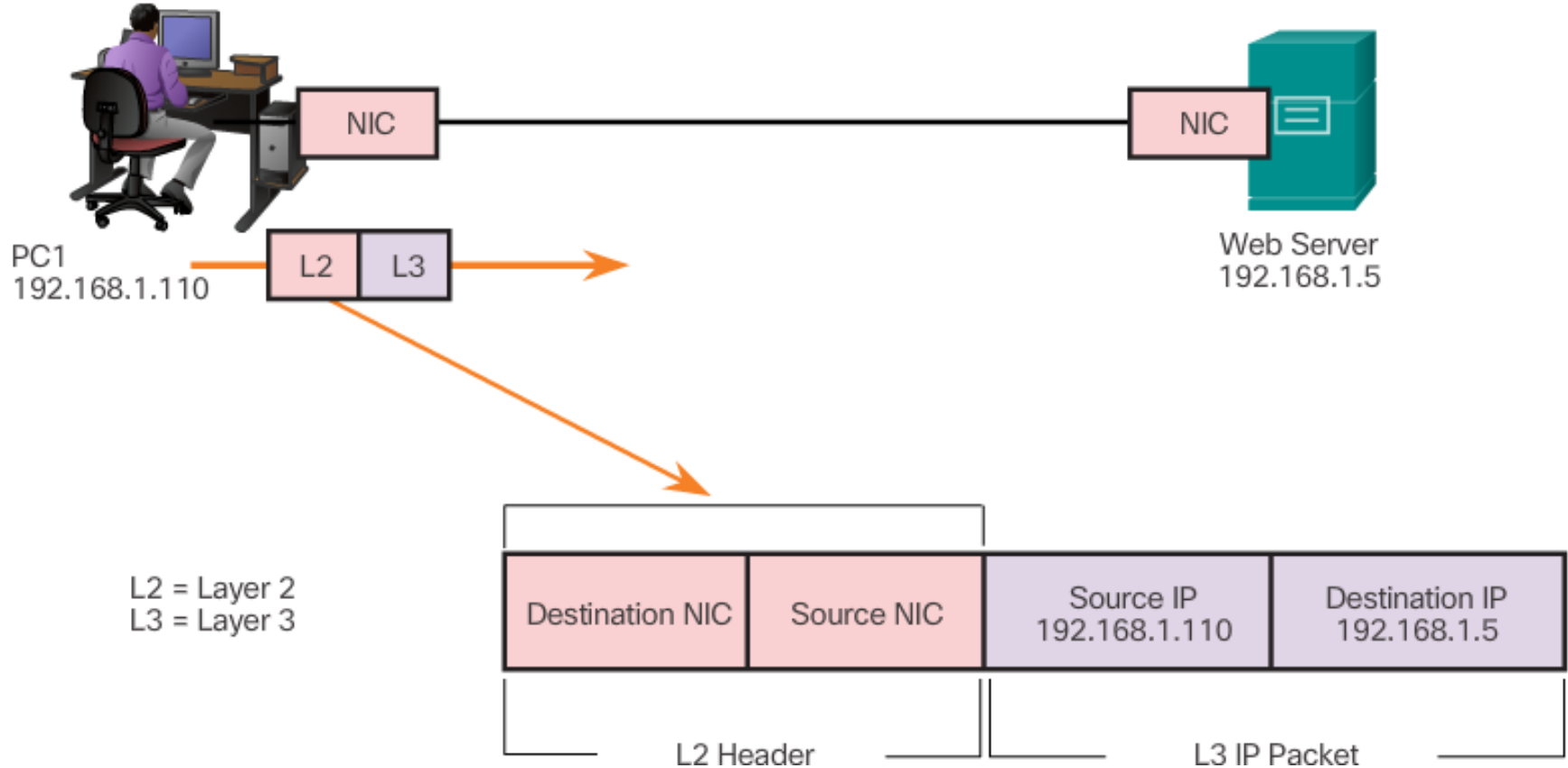# Topic 4.3.1:
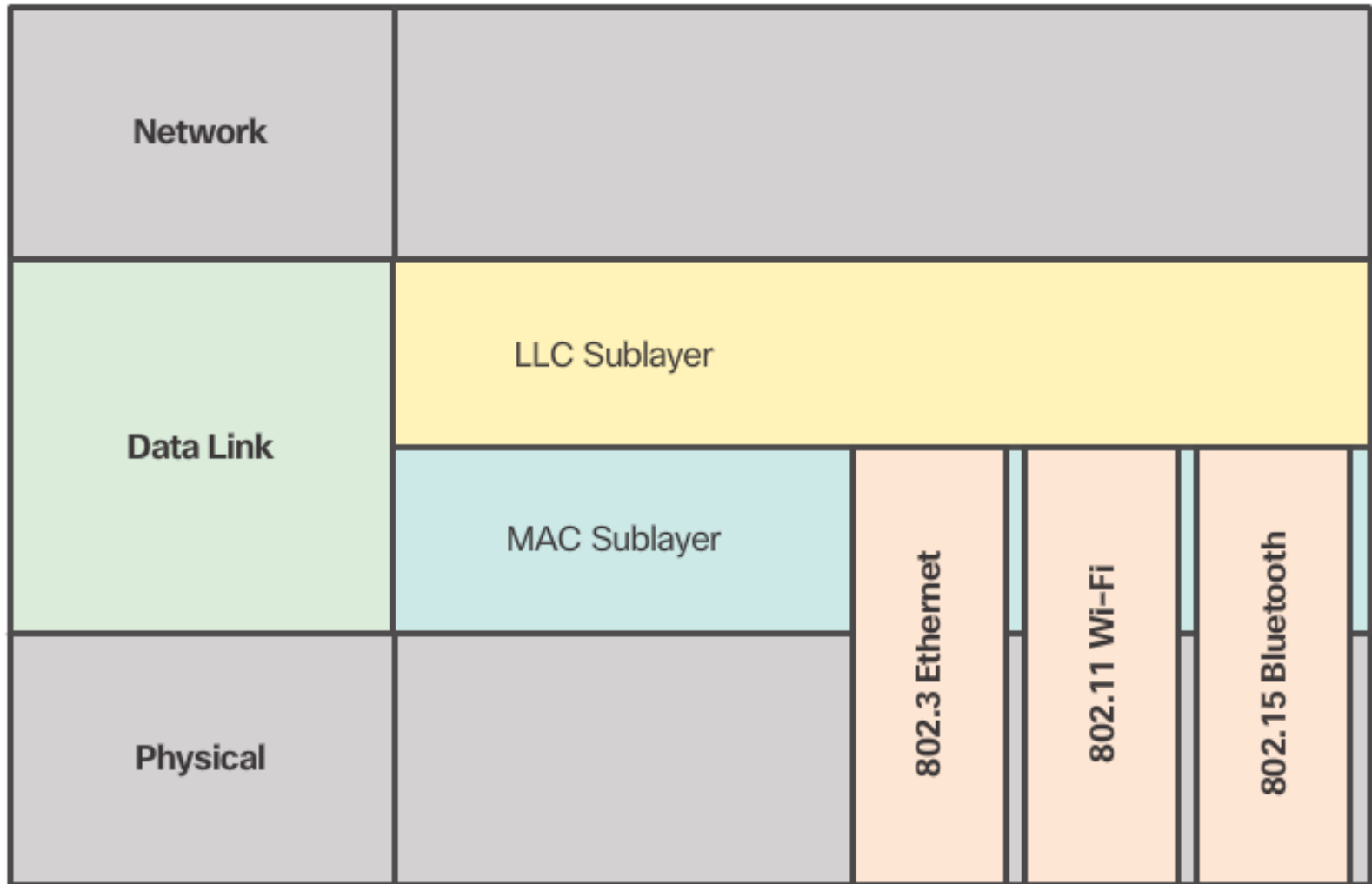# Purpose of the Data Link Layer

The Data Link Layer

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical

The data link layer prepares network data for the physical network

Network

The Data Link Layer (cont.)

Layer 2 Data Link Address

L2 = Layer 2
L3 = Layer 3

Destination NIC	Source NIC	Source IP 192.168.1.110	Destination IP 192.168.1.5
L2 Header		L3 IP Packet	

PC1
192.168.1.110

Web Server
192.168.1.5

Data Link Sublayers

Network				
Data Link	LLC Sublayer			
	MAC Sublayer	802.3 Ethernet	802.11 Wi-Fi	802.15 Bluetooth
Physical				

Media Access Control

Data link layer protocols govern how to format a frame for use on different media.

Different protocols may be in use for different media.

At each hop along the path, an intermediary device accepts frames from one medium, de-encapsulates the frame and then forwards the packets in a new frame. The headers of each frame are formatted for the specific medium that it will cross.

Paris

Frame

Japan
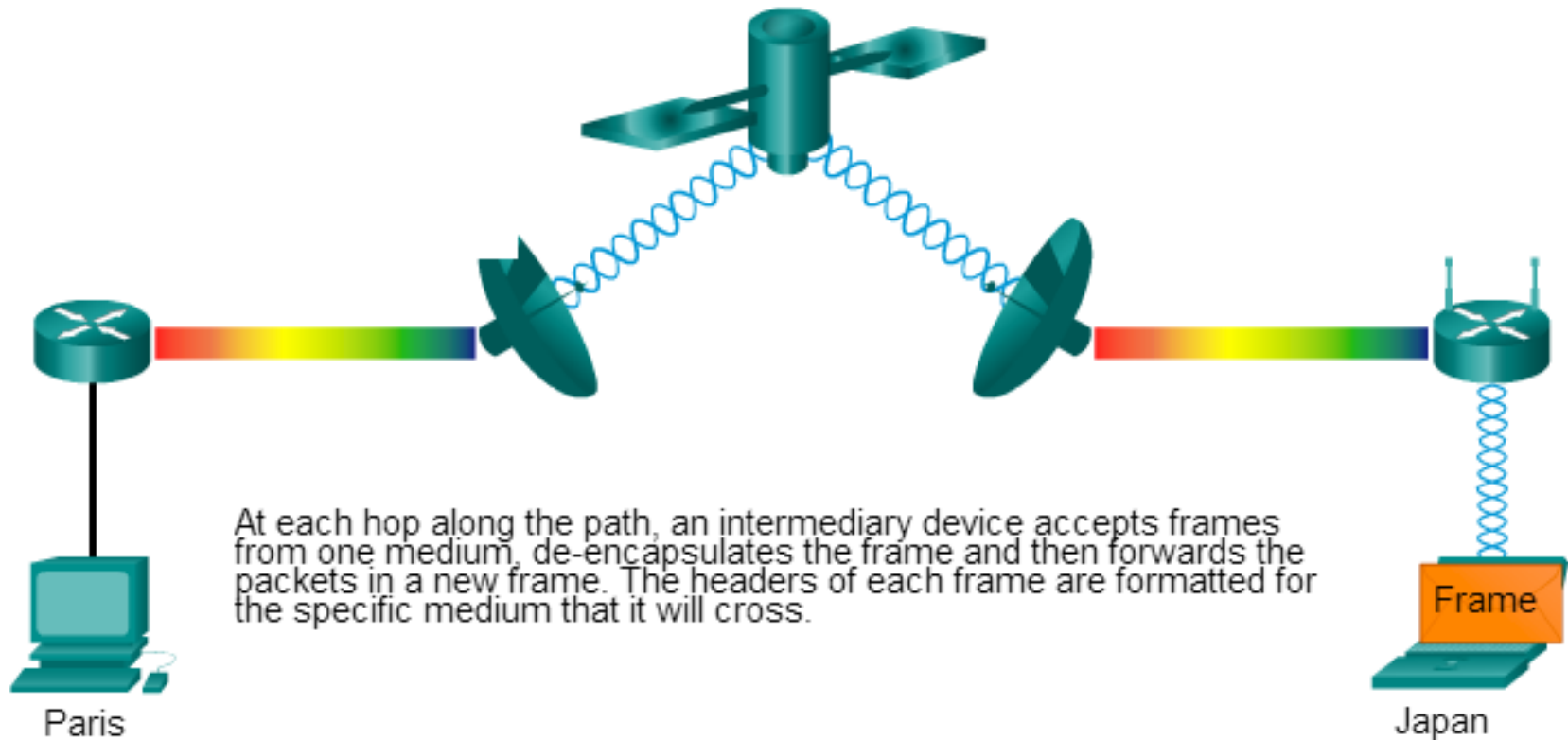
Providing Access to Media

Serial Connection

Ethernet Connection

| LAN Header | Packet | LAN Trailer |

The data link layer is responsible for controlling the transfer of frames across the media.
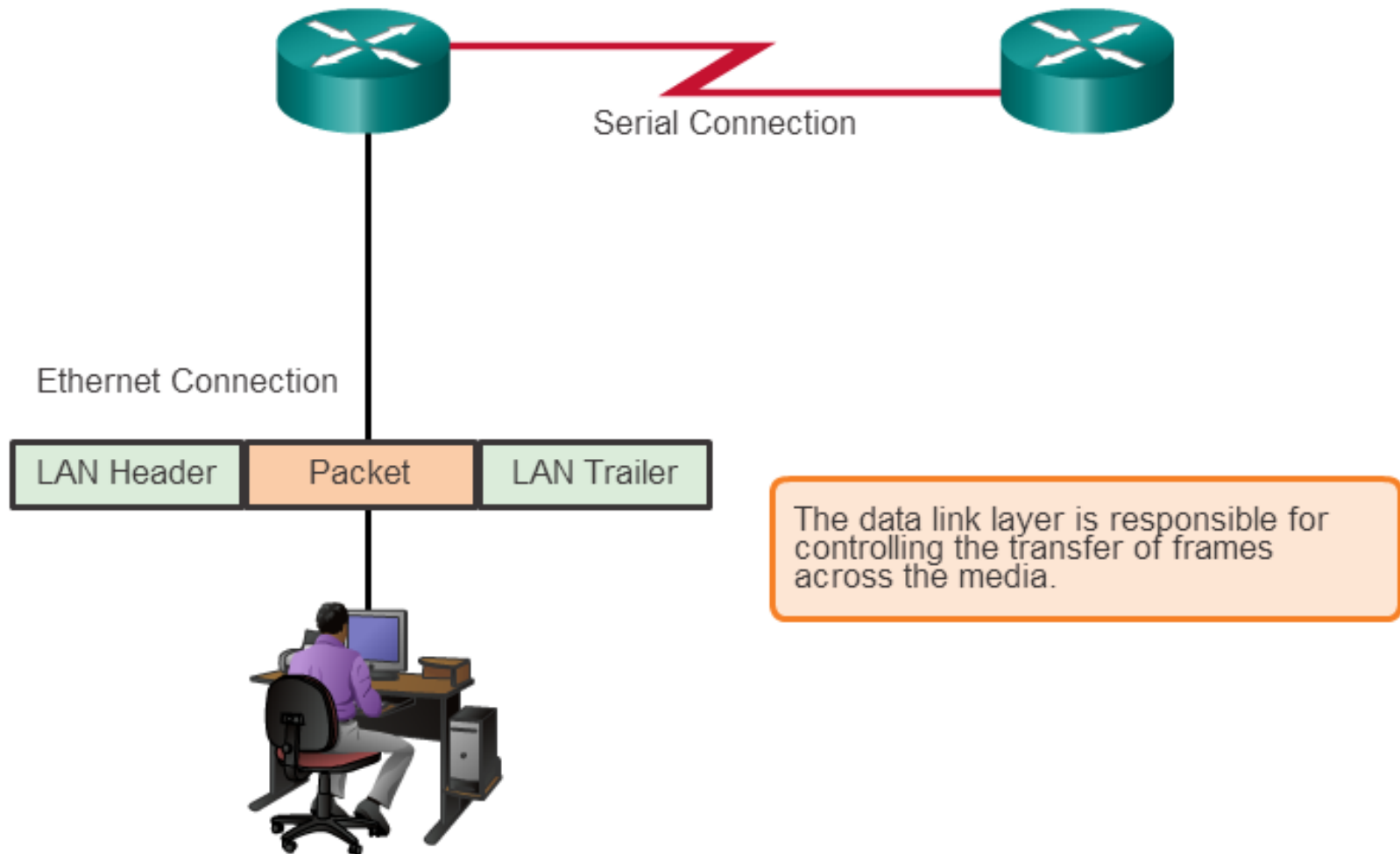
Data Link Layer Standards

Section 4.4:
Media Access Control

Upon completion of this section, you should be able to:

- Compare the functions of logical topologies and physical topologies.

- Describe the basic characteristics of media access control methods on WAN topologies.

- Describe the basic characteristics of media access control methods on LAN topologies.

- Describe the characteristics and functions of the data link frame.

Topic 4.4.1:
Topologies

Controlling Access to the Media
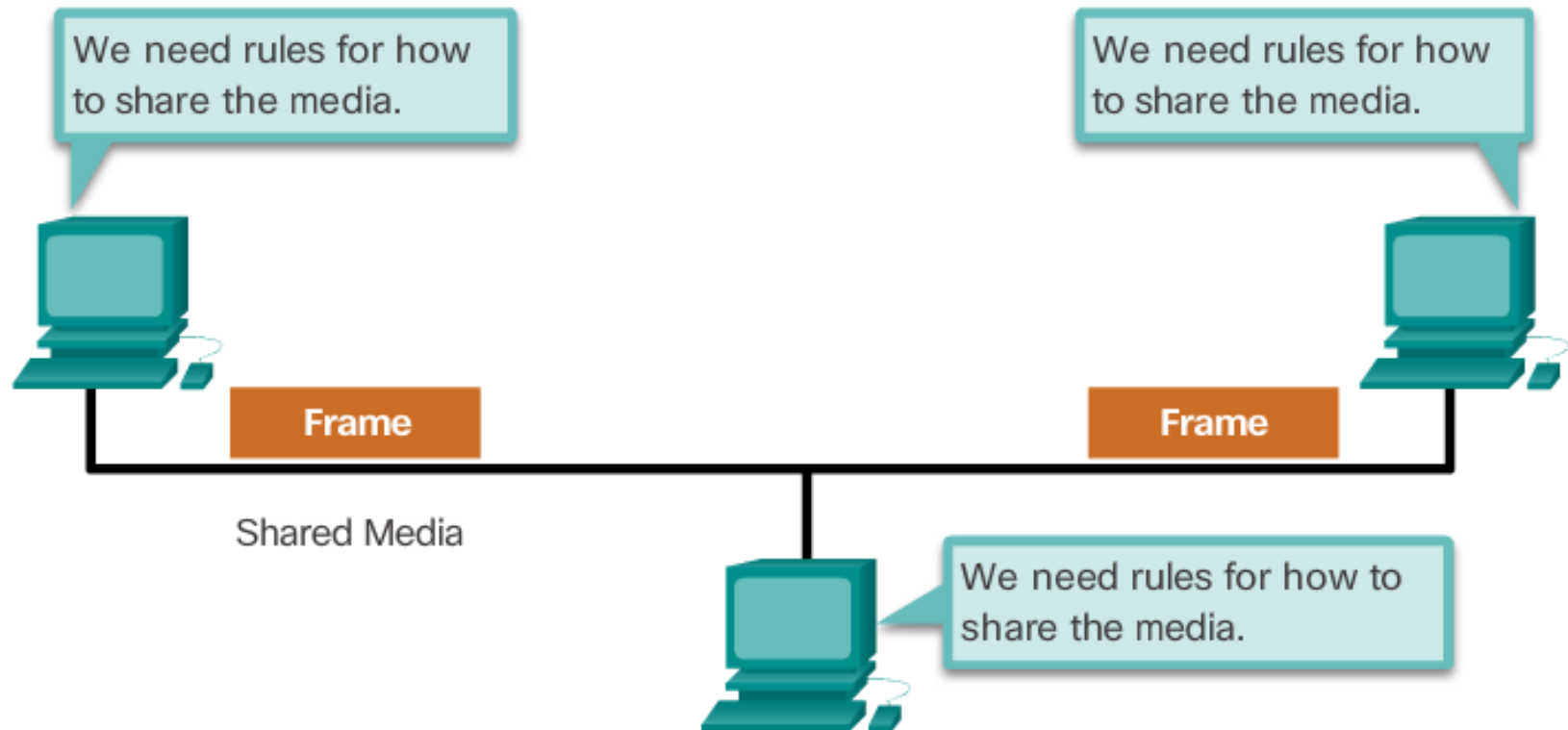
Physical and Logical Topologies

Physical Topology
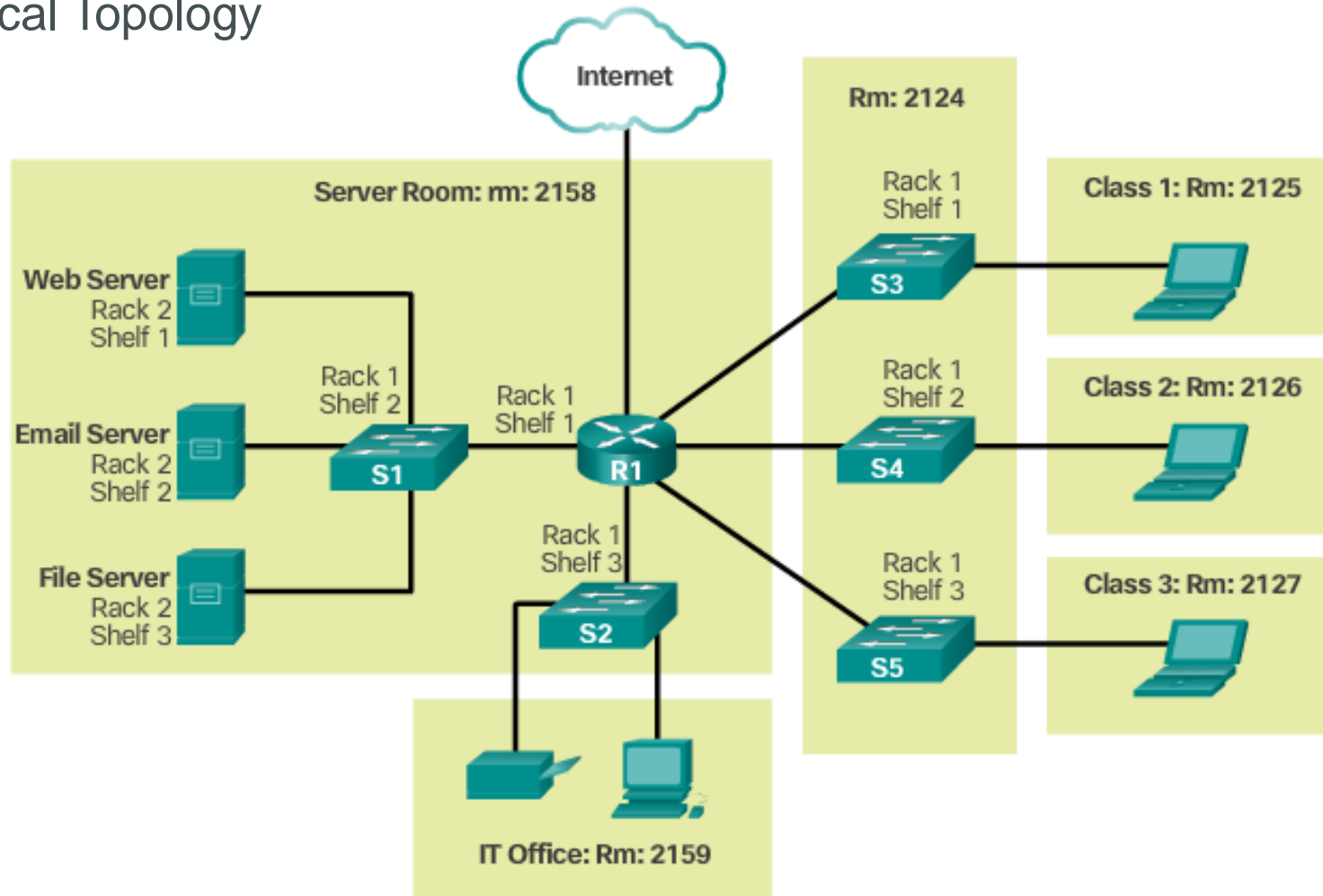
Physical and Logical Topologies (cont.)

Logical Topology
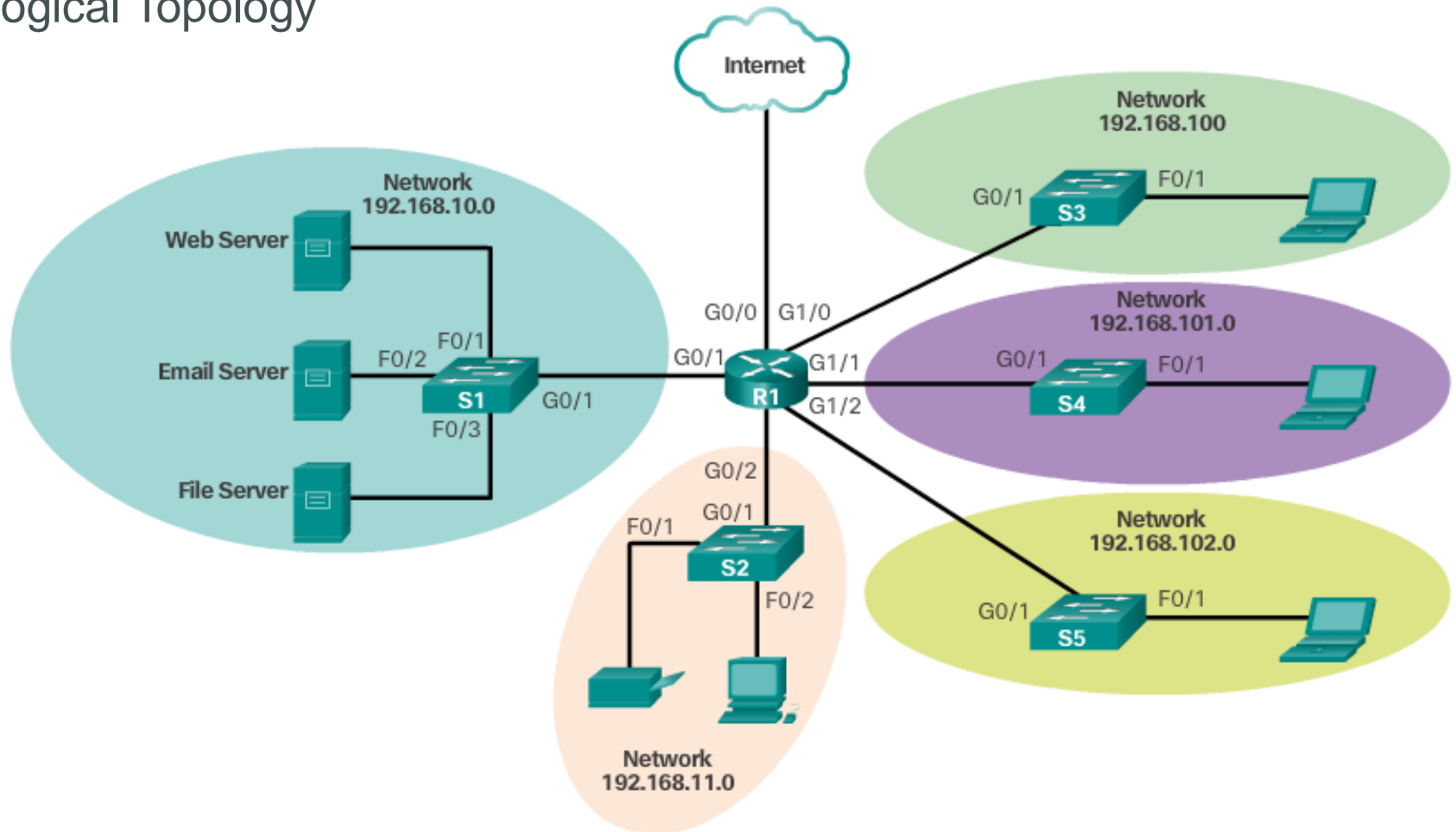
Topic 4.4.2:
WAN Topologies

Common Physical WAN Topologies
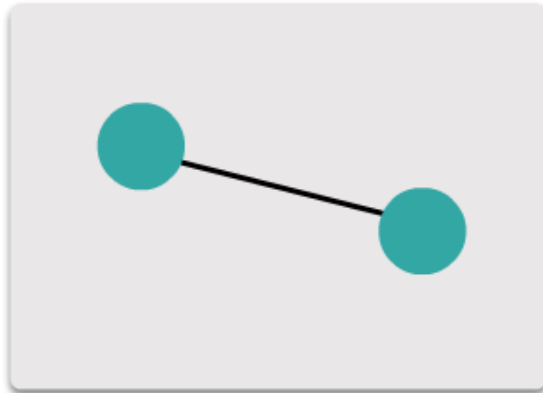
Point-to-point topology
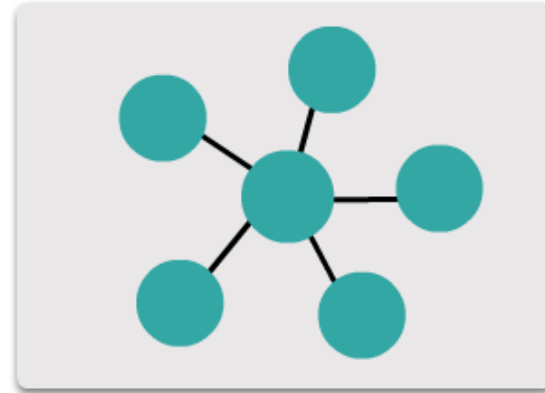
Hub and spoke topology
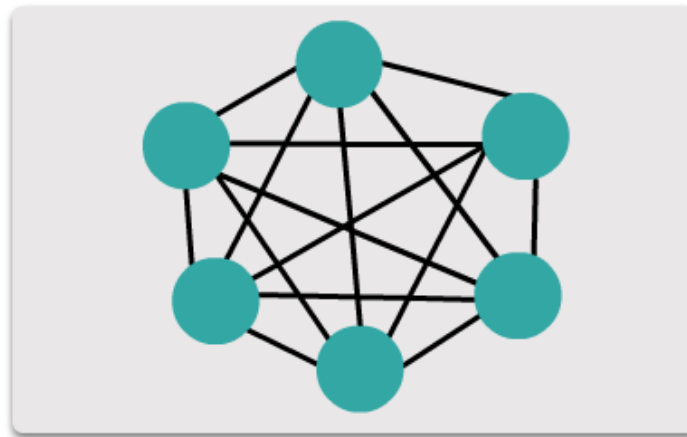
Full mesh topology

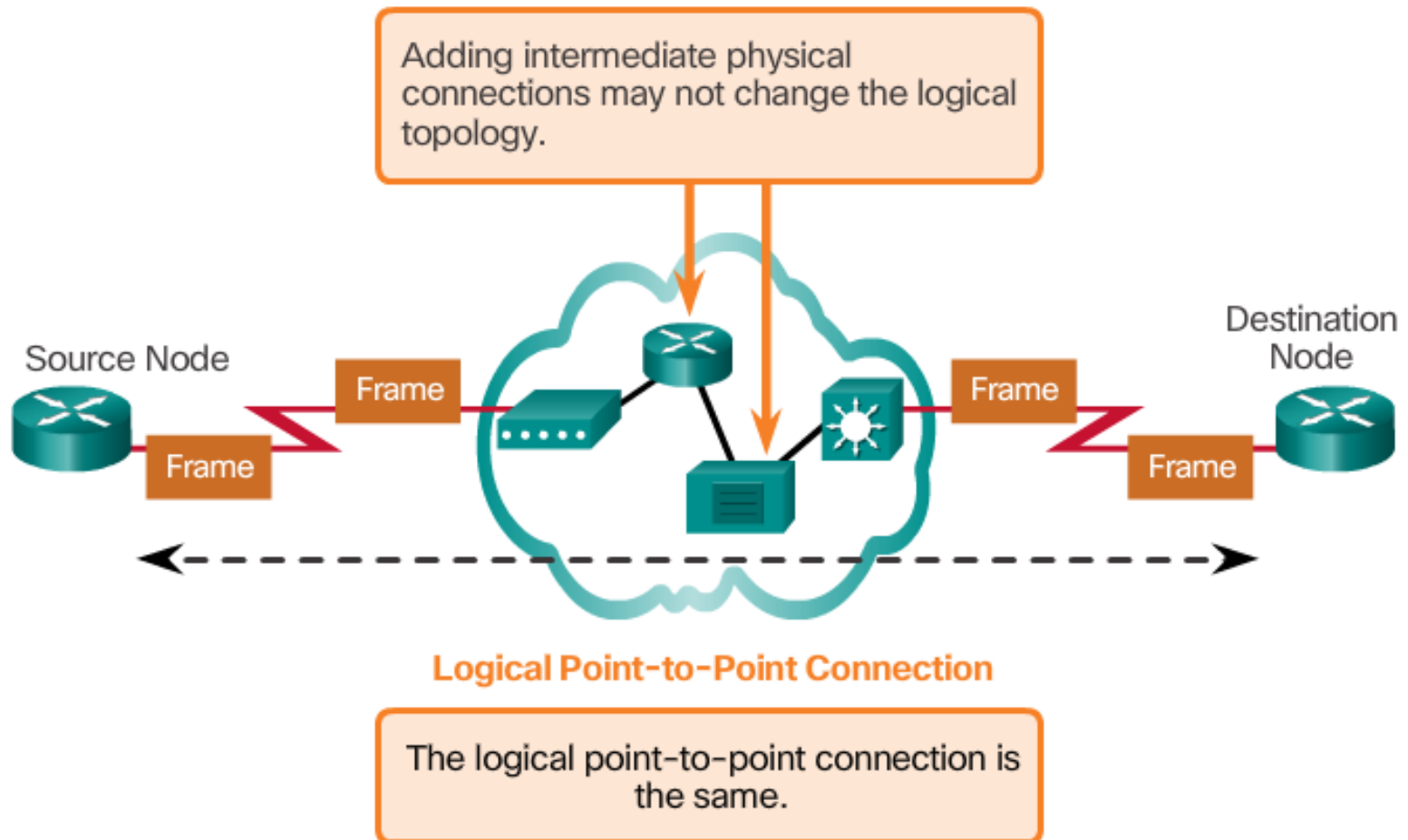# Physical Point-to-Point Topology

Node 1

Network

Node 2

Limited to two nodes
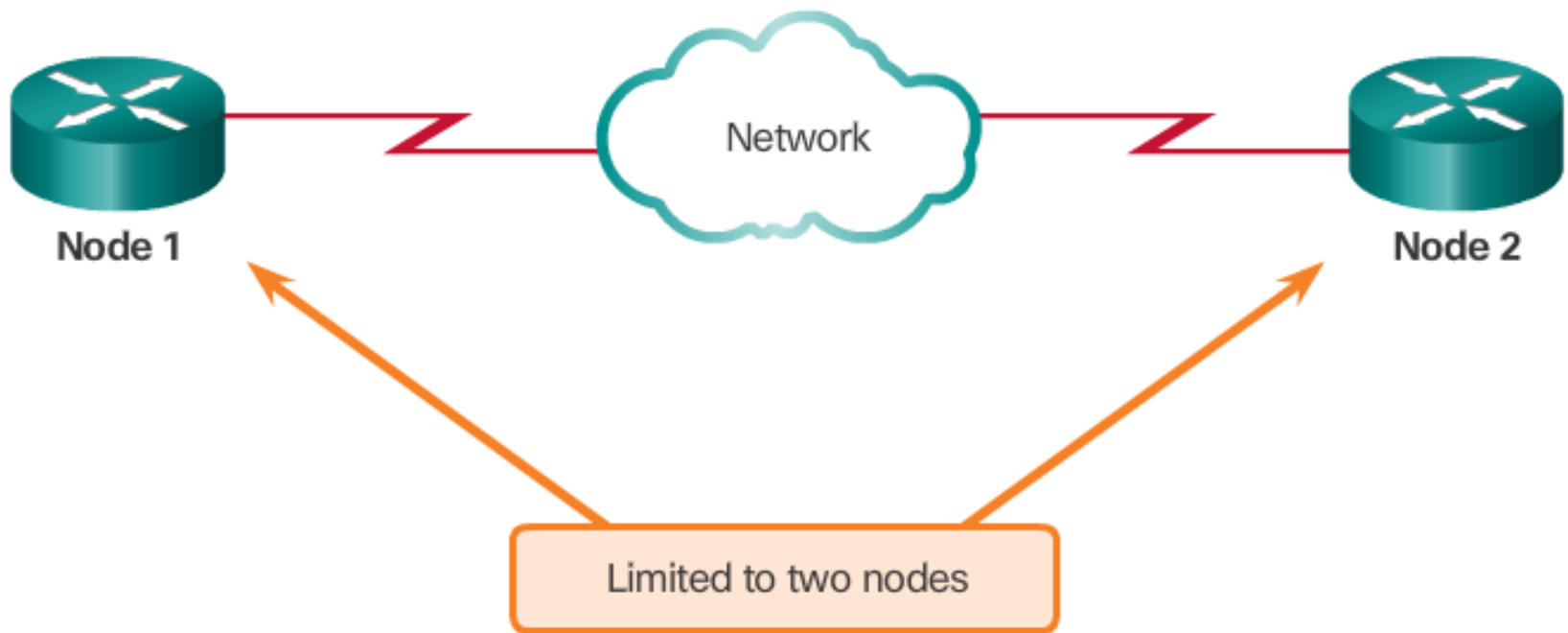
Logical Point-to-Point Topology

Logical Point-to-Point Connection

Logical Point-to-Point Topology (cont.)

Adding intermediate physical connections may not change the logical topology.

Source Node

Frame

Frame

Destination Node

Frame

Frame

Logical Point-to-Point Connection

The logical point-to-point connection is the same.

Topic 4.4.3:
LAN Topologies

Physical LAN Topologies
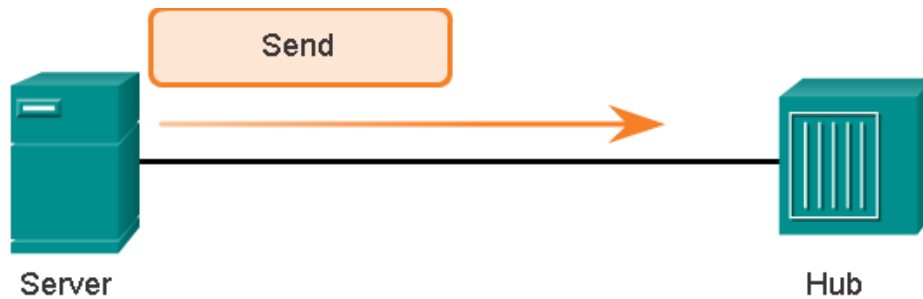
Star topology
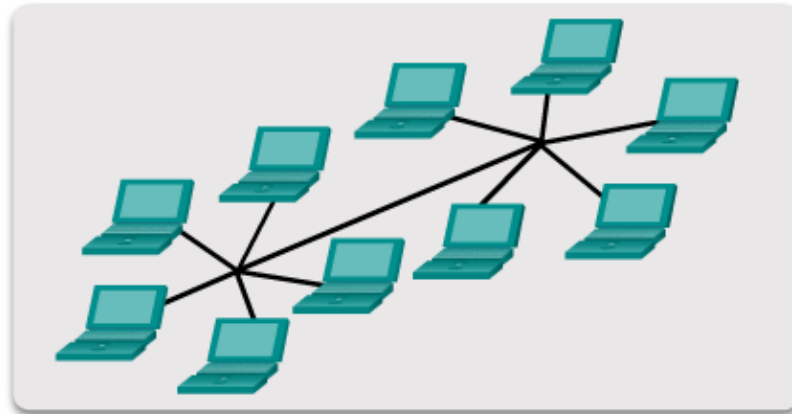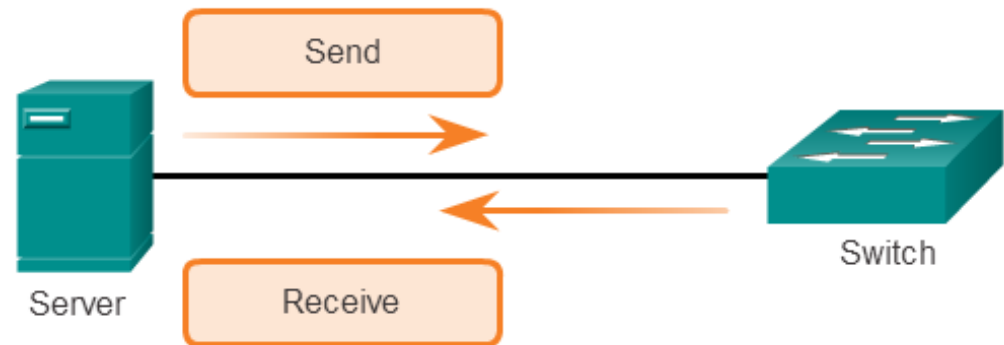
Extended star topology
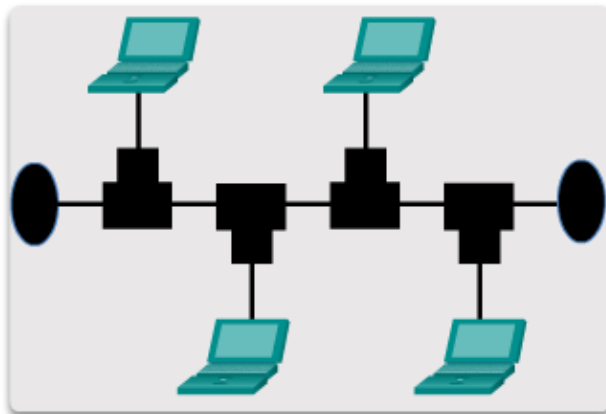
Bus topology

Ring topology
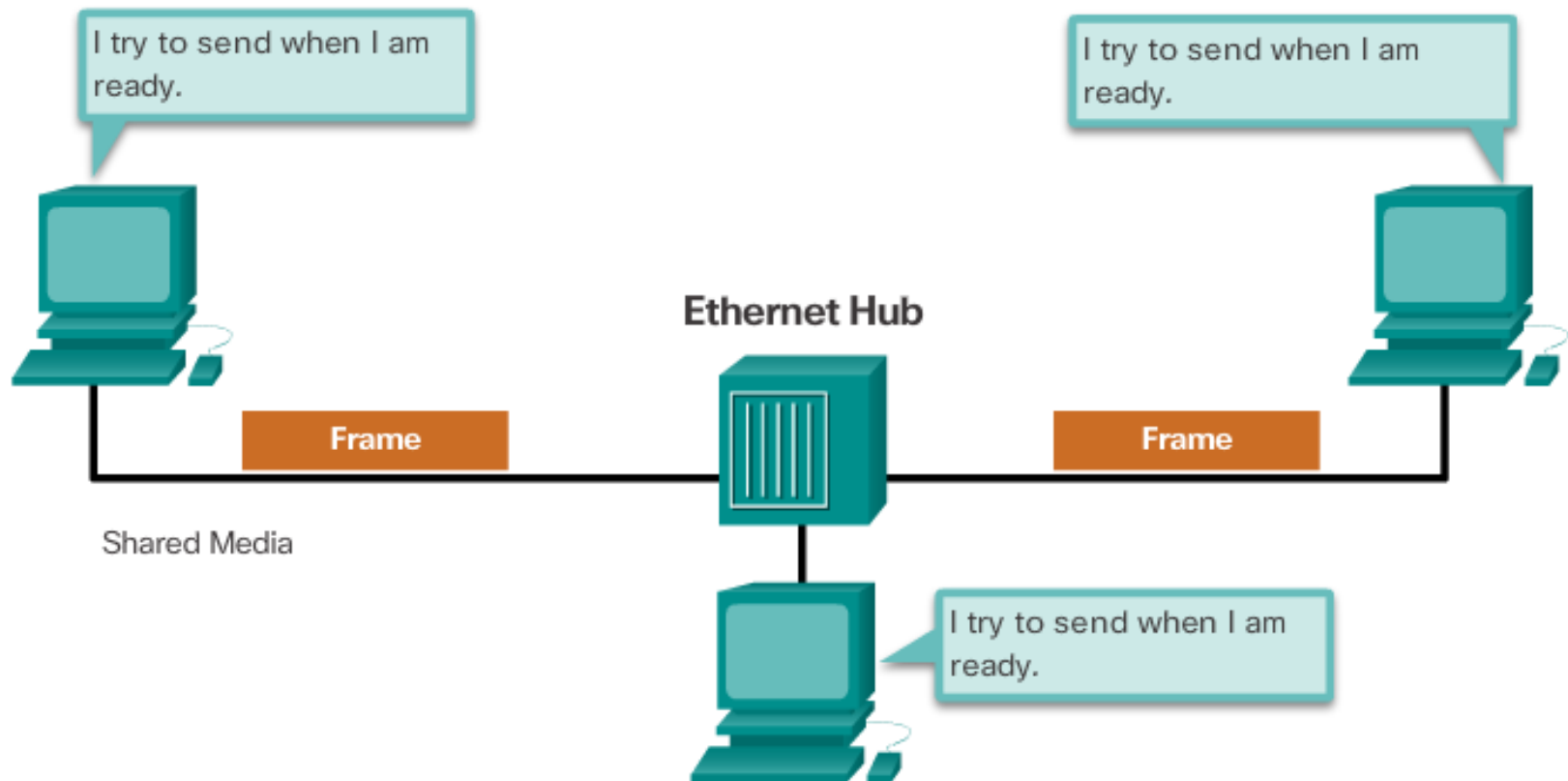
Half and Full Duplex
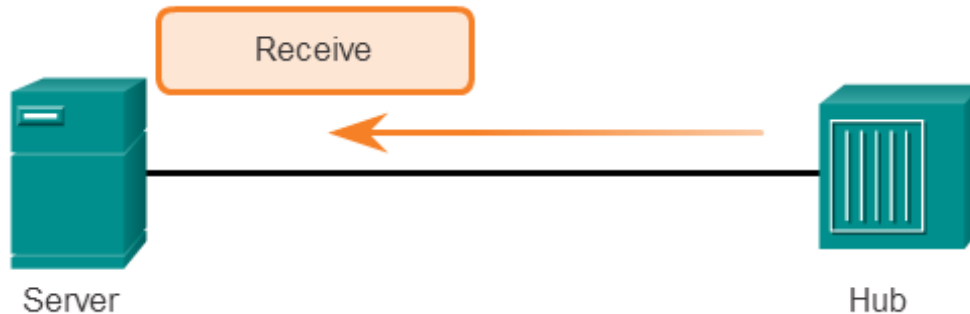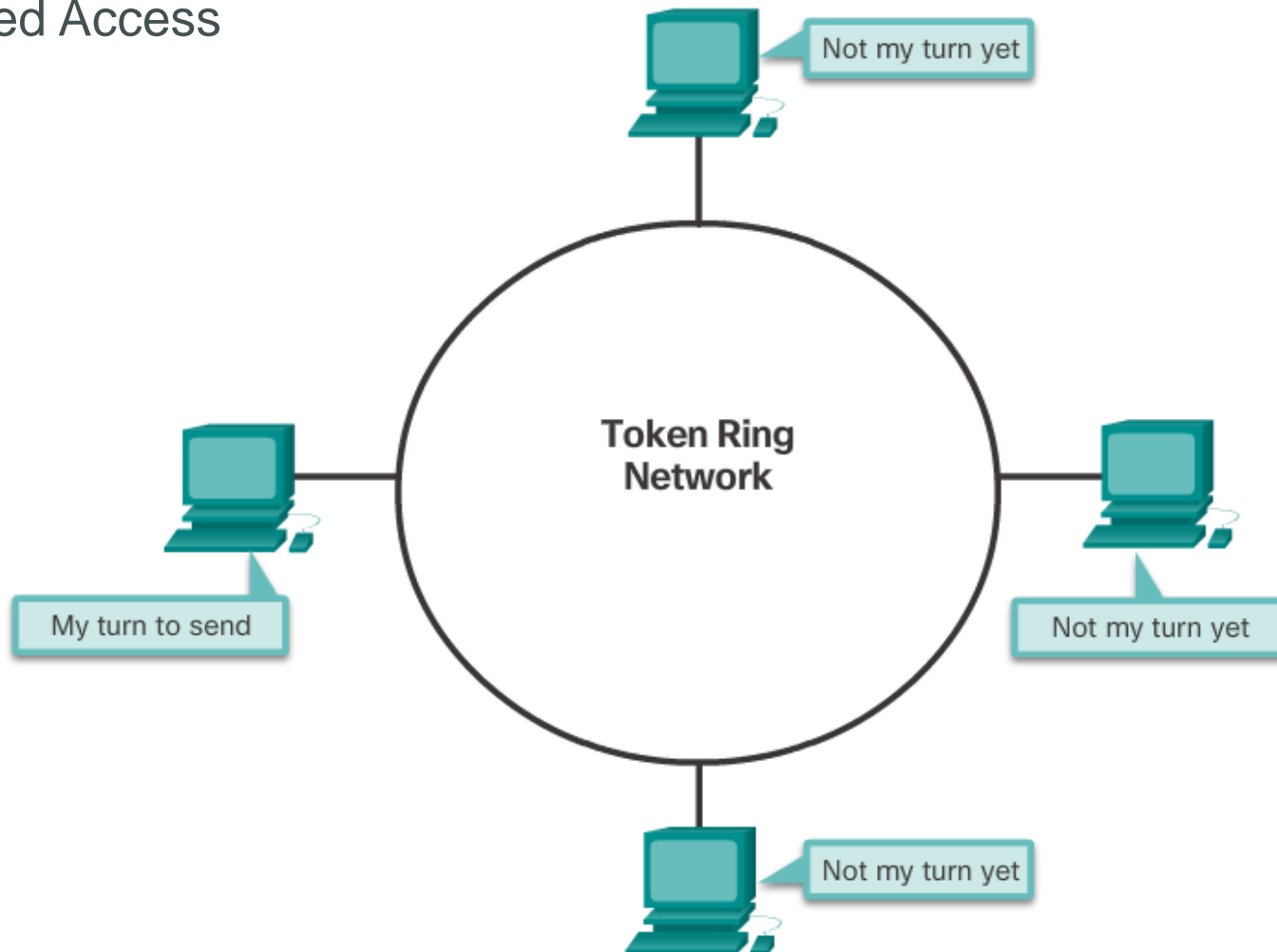

Half-Duplex Communication

Full-Duplex Communication
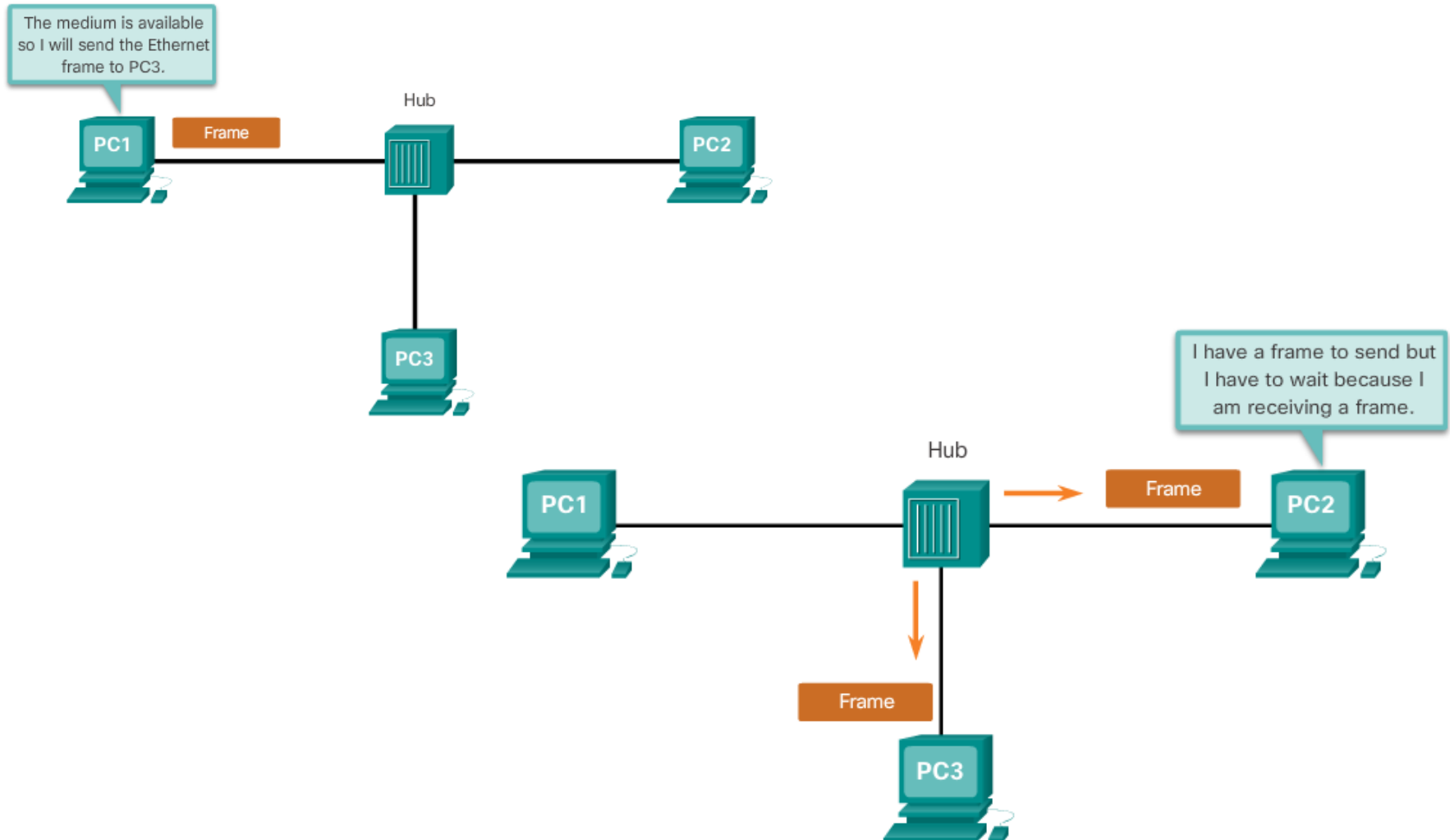
Media Access Control Methods

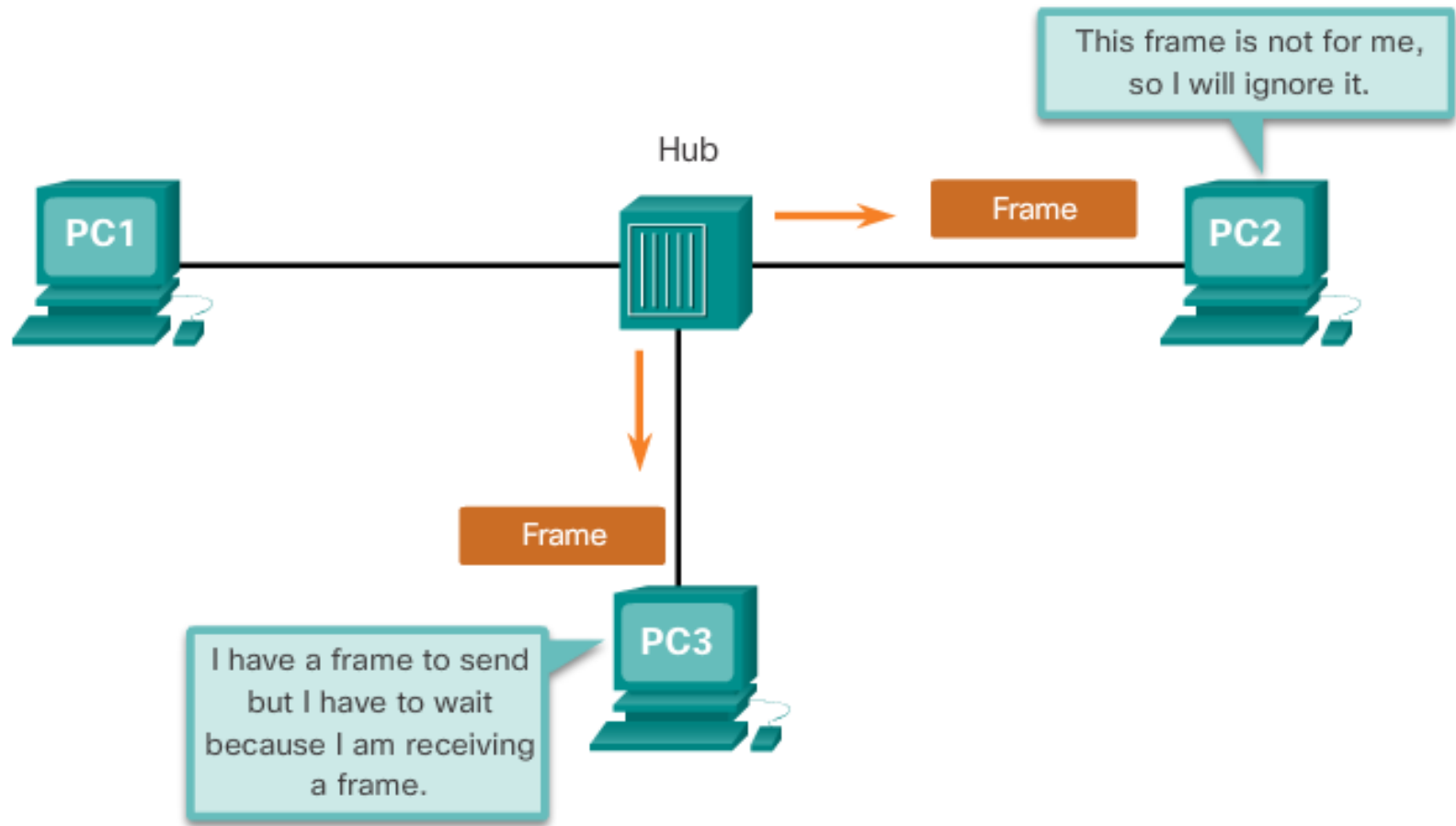Contention-Based Access

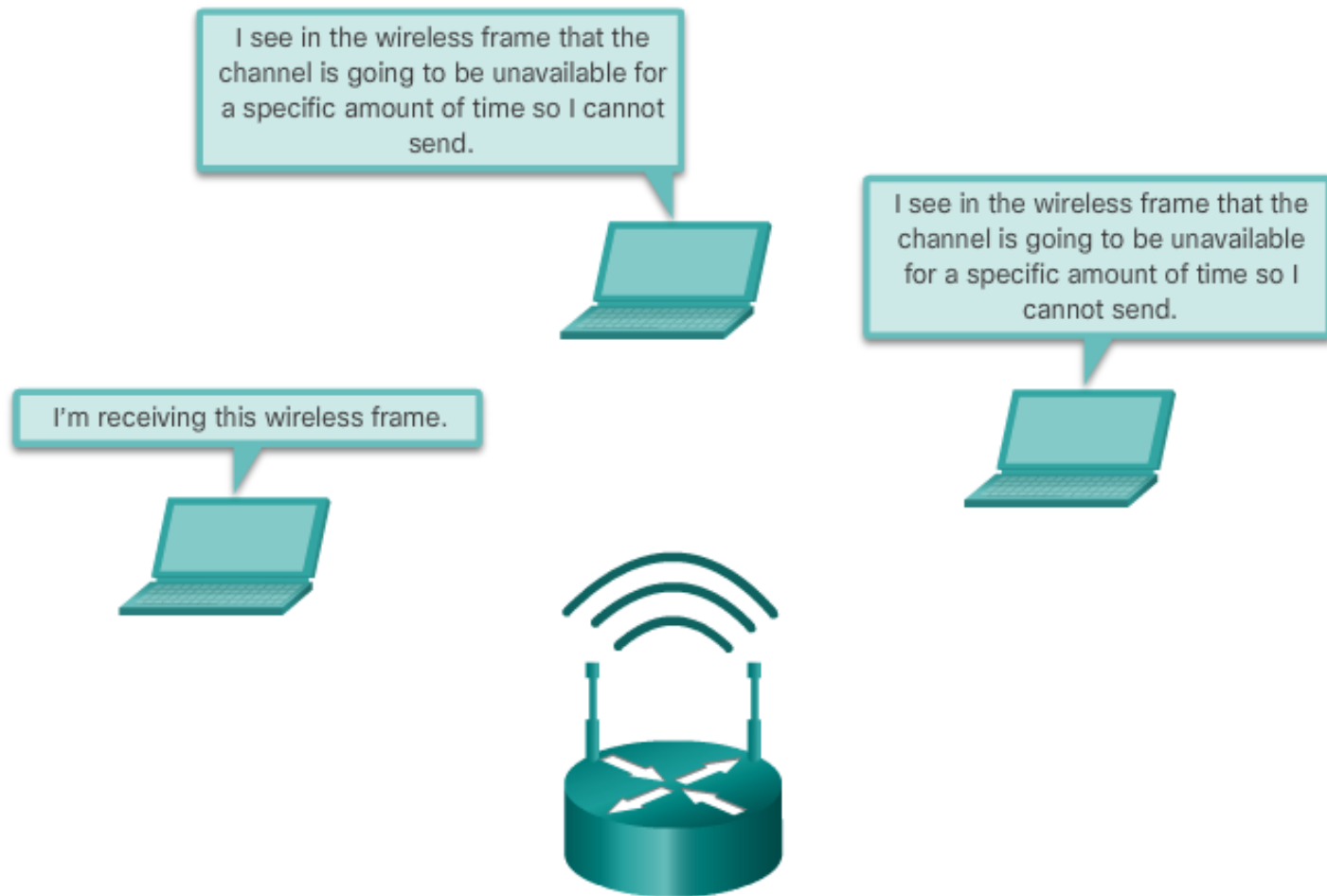# Media Access Control Methods (cont.)

Controlled Access

Contention Based Access – CSMA/CD

Contention Based Access – CSMA/CD (cont.)

Contention Based Access – CSMA/CA
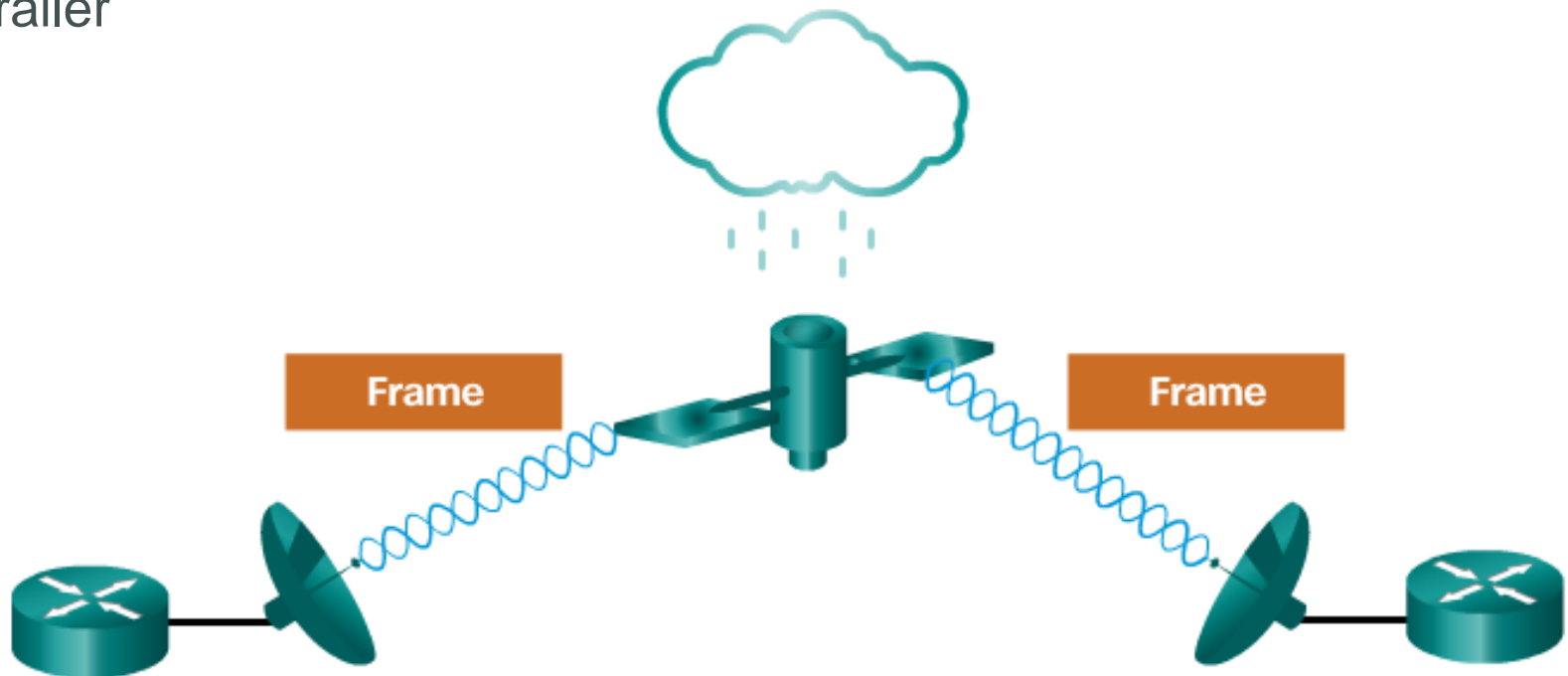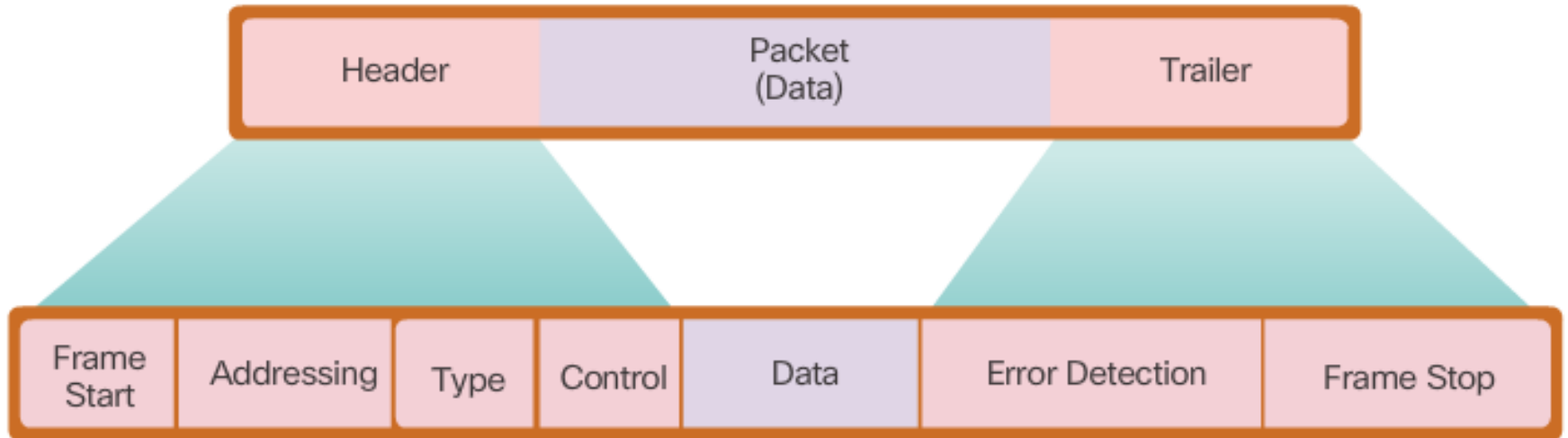
Topic 4.4.4:
Data Link Frame

The Frame

Frames have three basic parts:

- Header

- Data

- Trailer

Frame Fields

Layer 2 Address

Original Source

Final Destination

PC1
192.168.1.110

Web Server
172.16.1.99

Destination NIC	Source NIC	Source IP 192.168.1.110	Destination IP 172.16.1.99

L2 Header   **L3 IP Packet**

L2 = Layer 2

L3 = Layer 3

Layer 2 Address (cont.)

Original Source

Final Destination

NIC | NIC | R1 | NIC | NIC | R2 | NIC | NIC

PC1
192.168.1.110

Web Server
172.16.1.99

L2 | L3

L2 | L3

L2 | L3

| Destination NIC | Source NIC | Source IP 192.168.1.110 | Destination IP 172.16.1.99 |

L2 Header

L3 IP Packet

L2 = Layer 2
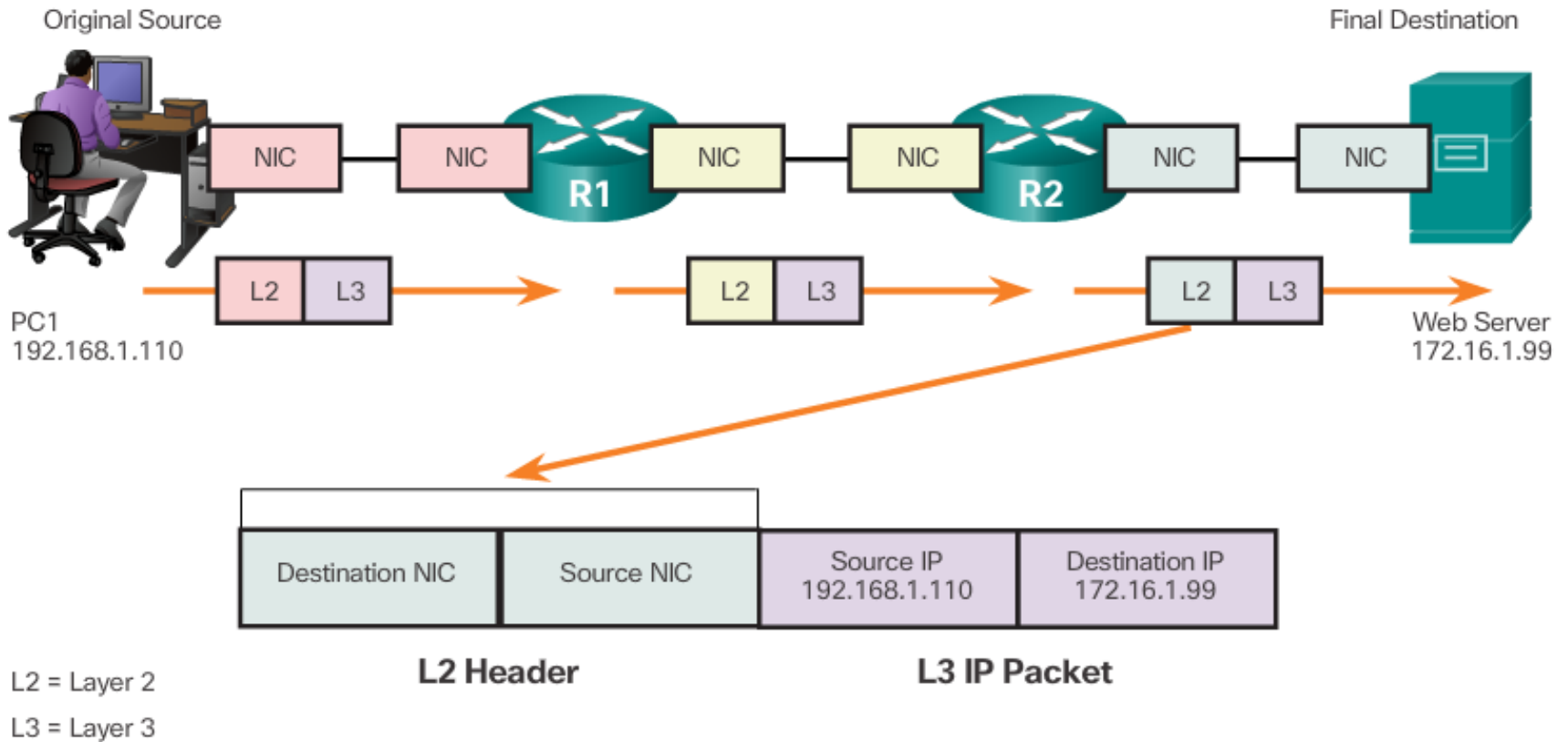
L3 = Layer 3

Layer 2 Address (cont.)

L2 = Layer 2
L3 = Layer 3

LAN and WAN Frames

Examples of Layer 2 protocols:

- 802.11 Wireless Frame

- PPP Frame

- HDLC

- Frame Relay

- Ethernet Frame

Section 4.5: Summary

Chapter Objectives:

- Explain how physical layer protocols and services support communications across data networks.

- Build a simple network using the appropriate media.

- Explain how the Data Link layer supports communications across data networks.

- Compare media access control techniques and logical topologies used in networks.

Thank you.