



Cisco Networking Academy
Mind Wide Open

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

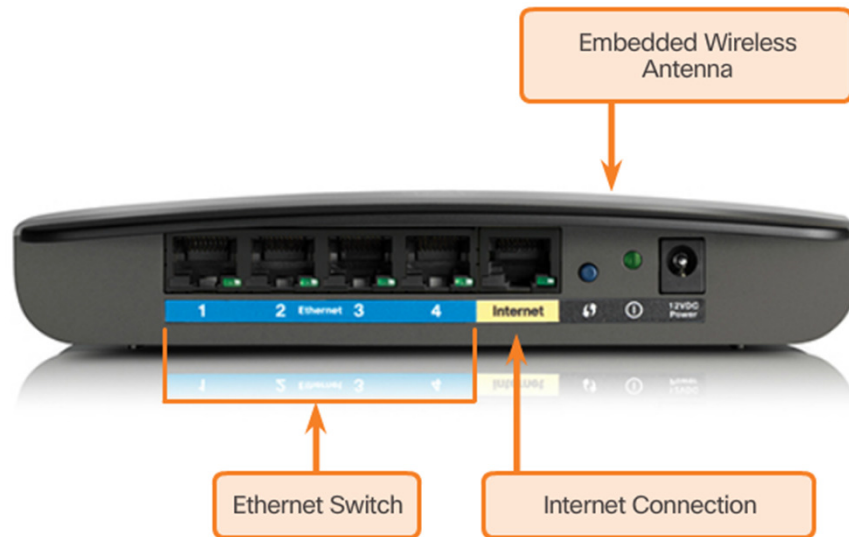
Upon completion of this section, you should be able to:

- 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



Connecting to the
Wired LAN

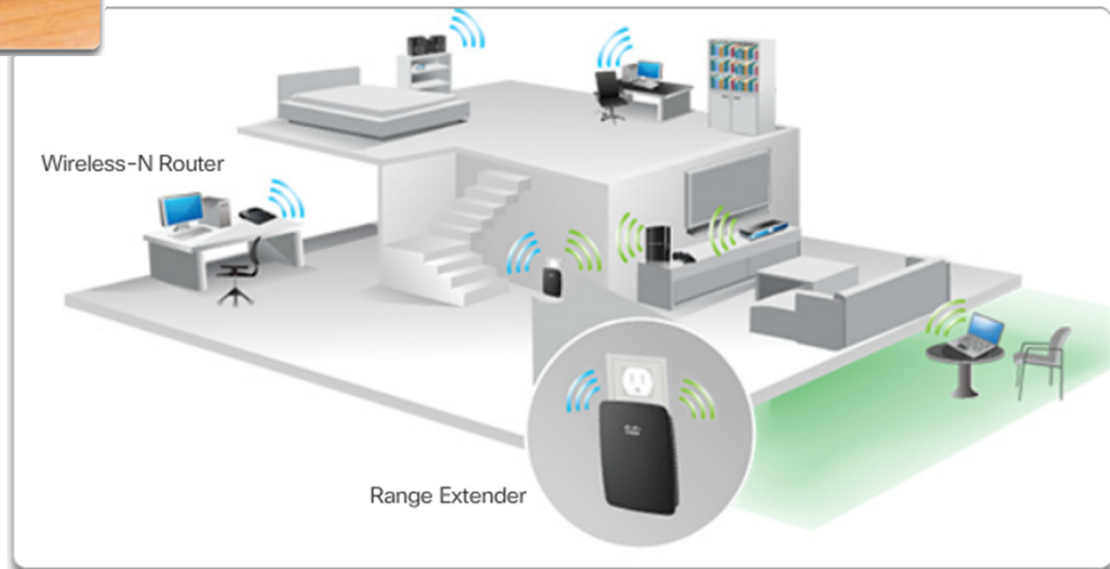


Network Interface Cards



Wired Connection Using an Ethernet NIC

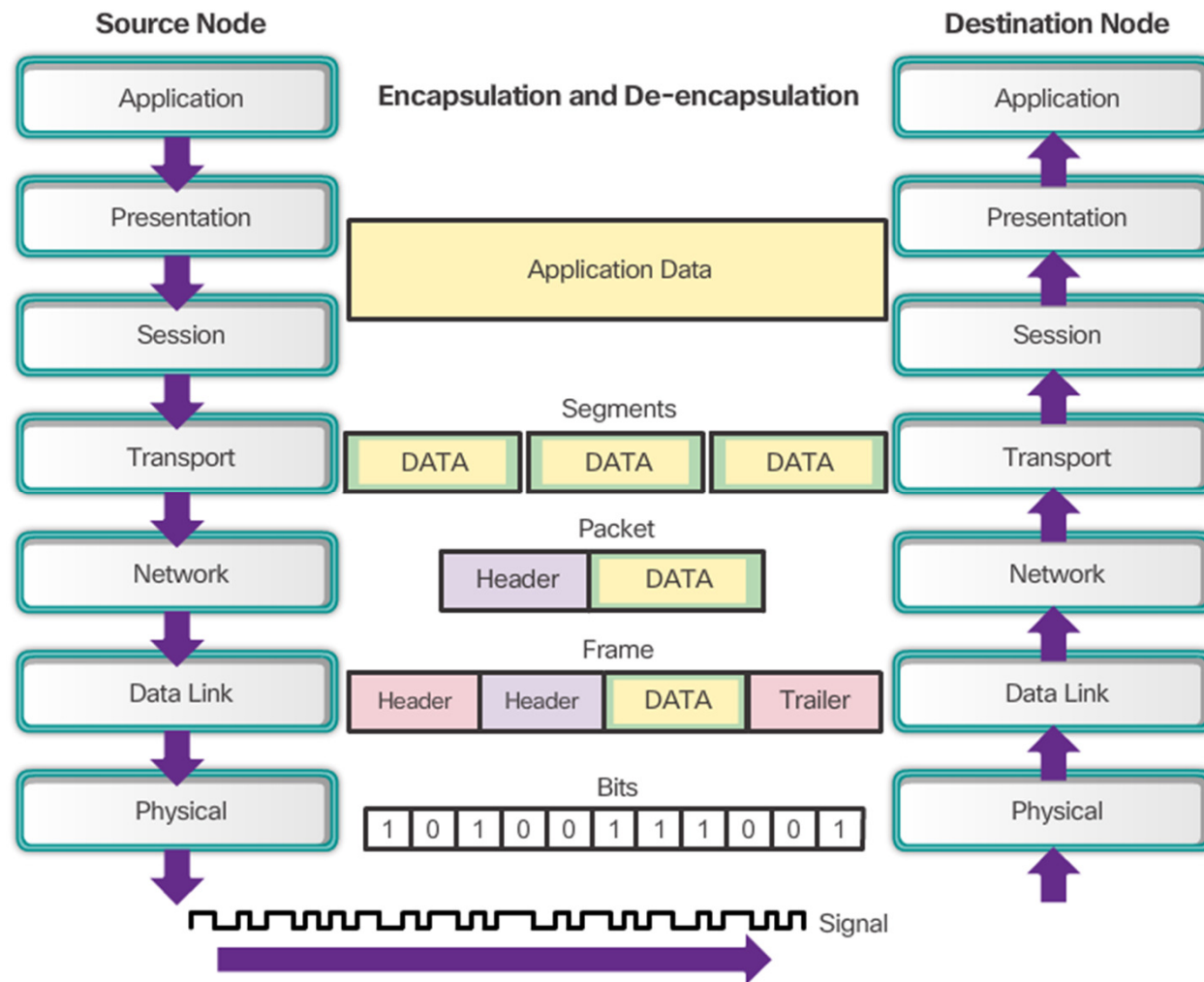
Connecting to the Wireless LAN with Range Extender



Topic 4.1.2: Purpose of the Physical Layer



The Physical Layer



Physical Layer Media

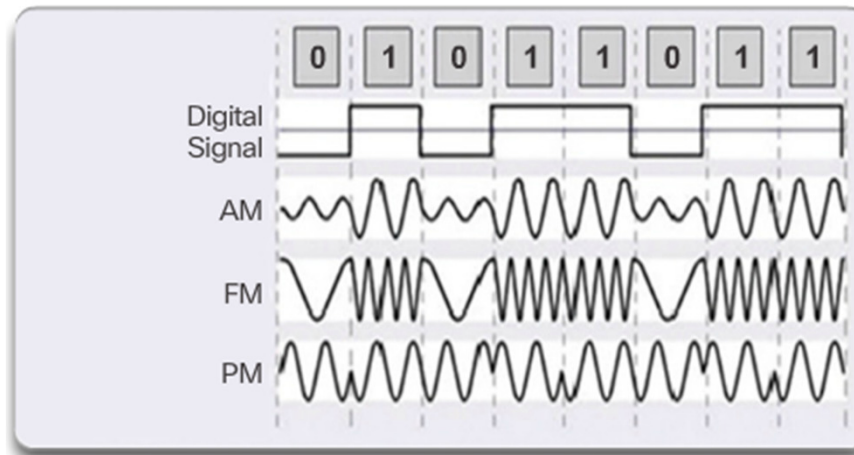
Outbound (Tx) signal



Electrical Signals -
Copper cable

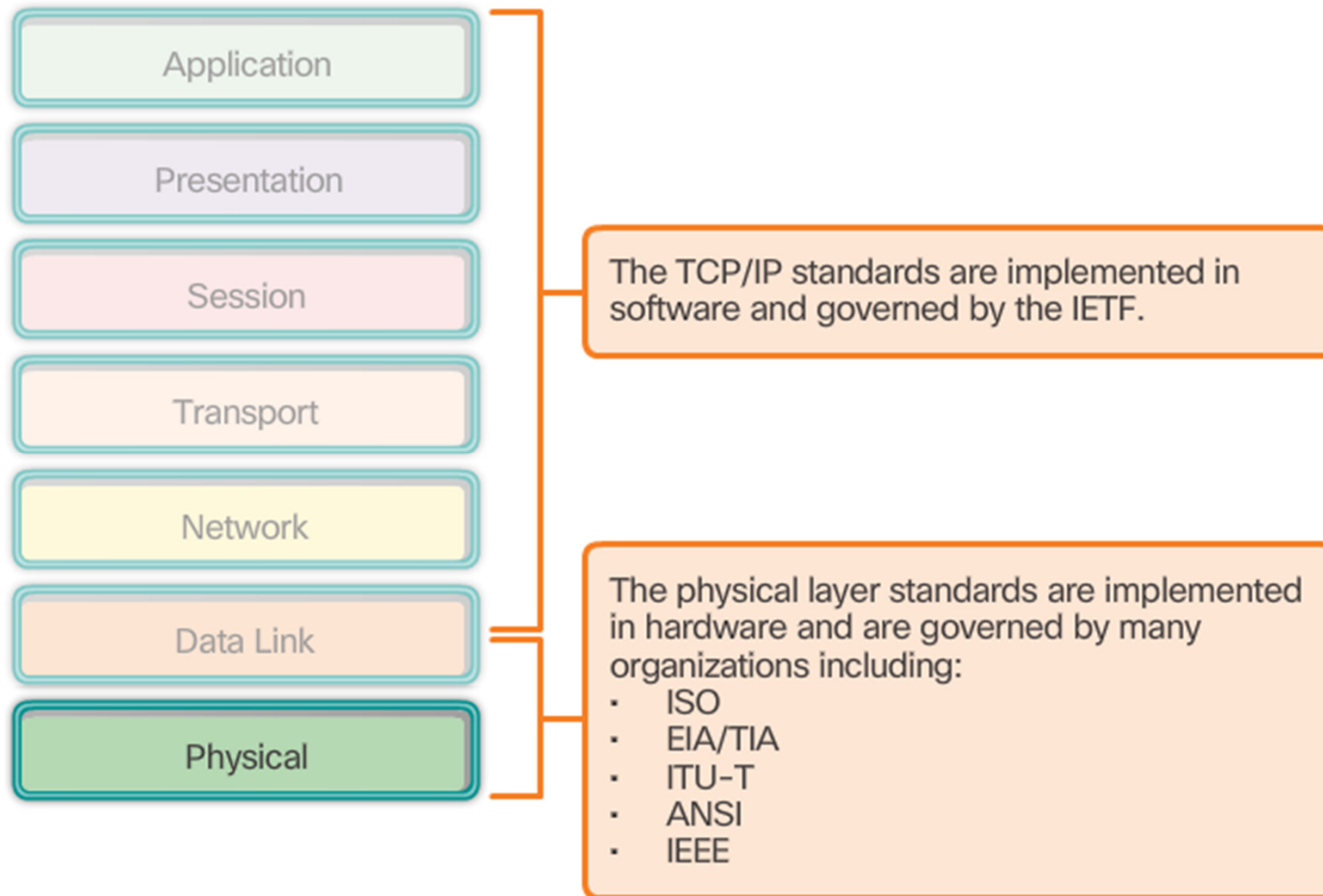


Light Pulse -
Fiber-optic cable



Microwave Signals -
Wireless

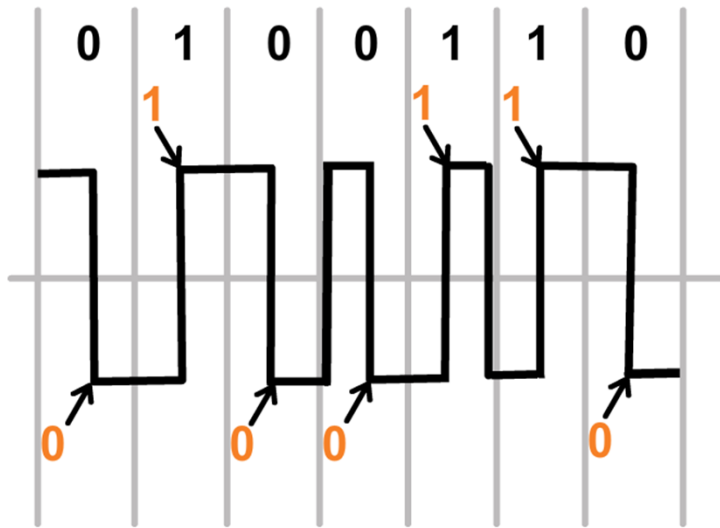
Physical Layer Standards



Topic 4.1.3: Physical Layer Characteristics

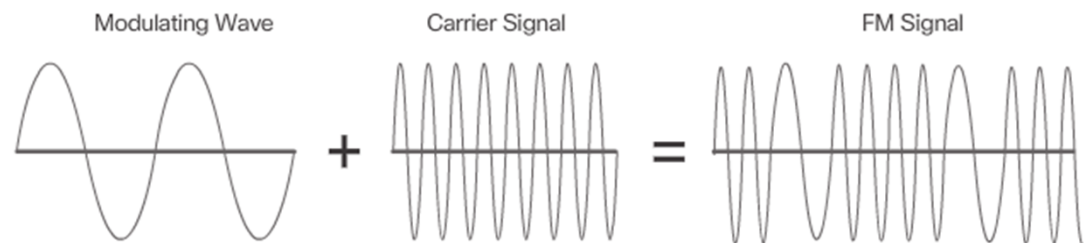


Functions



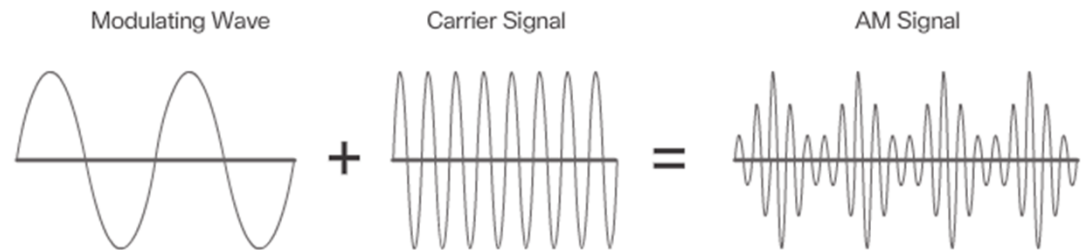
Manchester Encoding

Frequency Modulation (FM)



Modulation

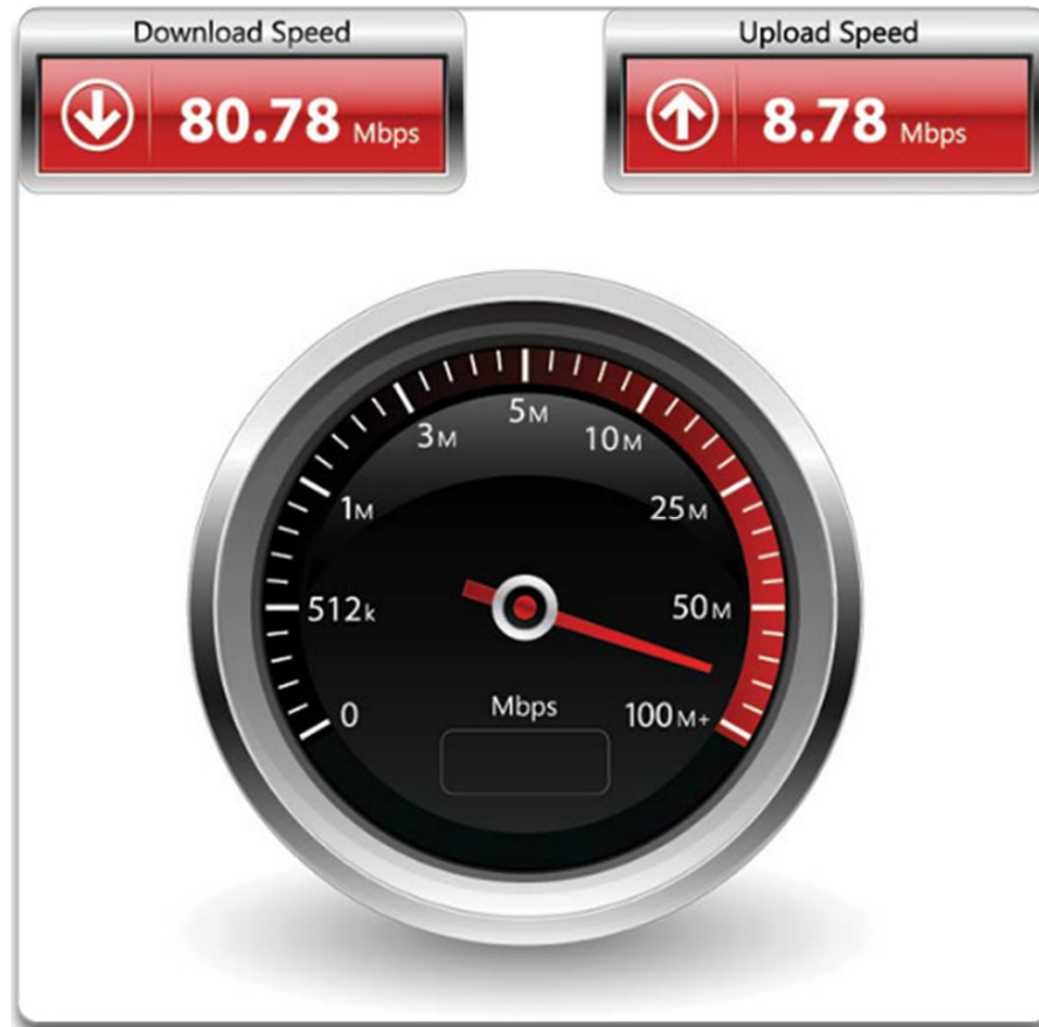
Amplitude Modulation (AM)



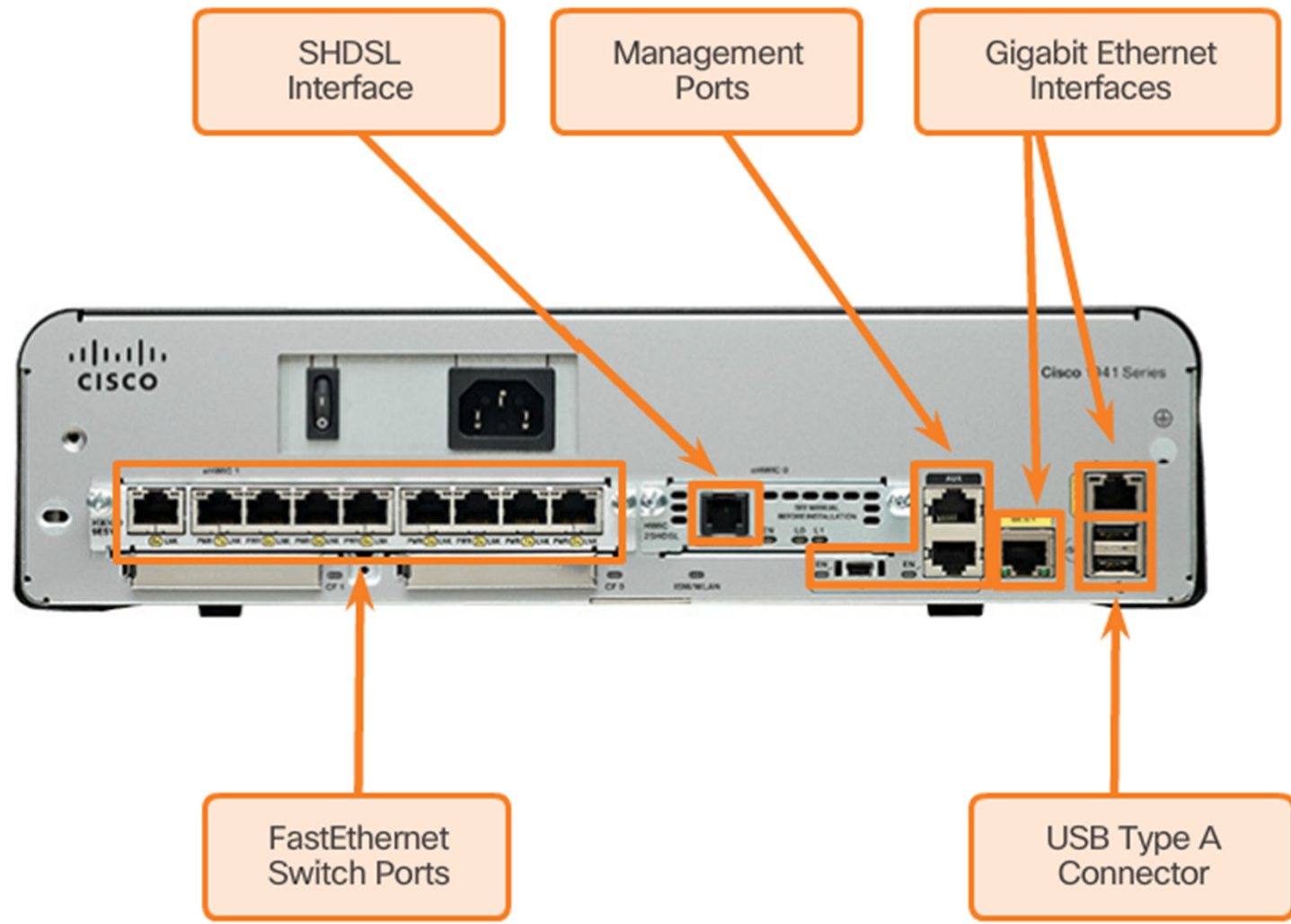
Bandwidth

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



Section 4.2: Network Media

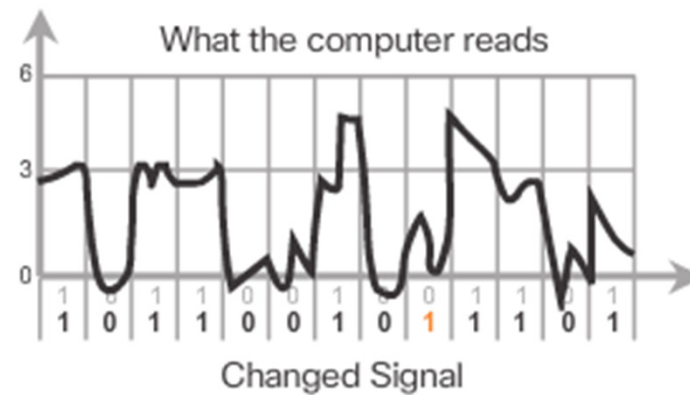
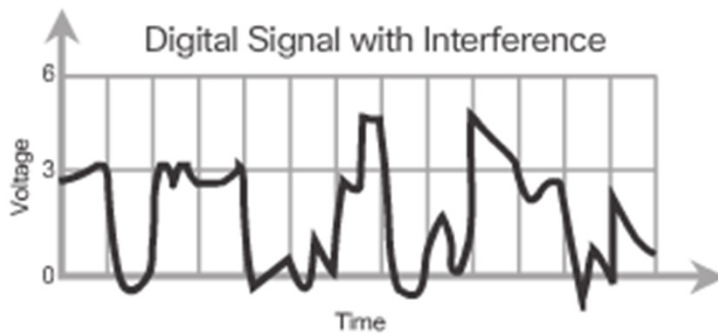
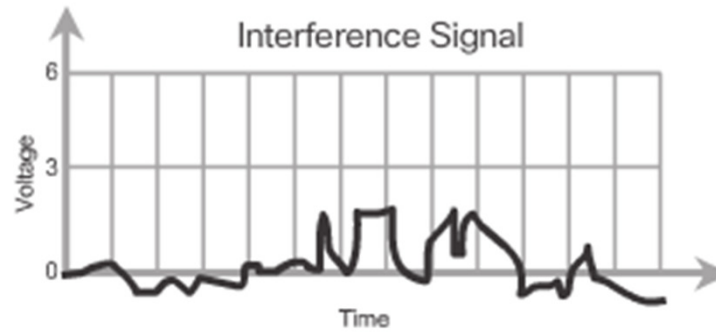
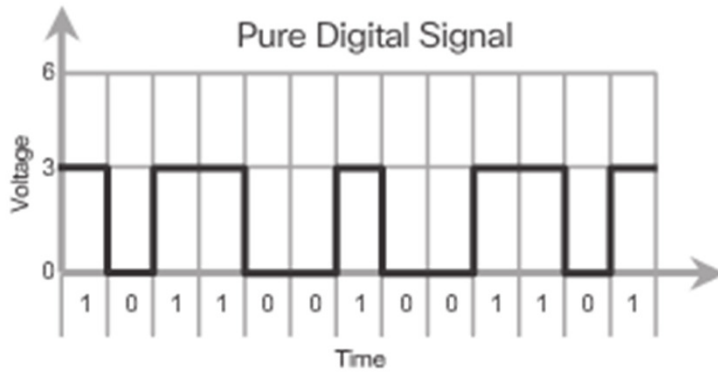
Upon completion of this section, you should be able to:

- 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.

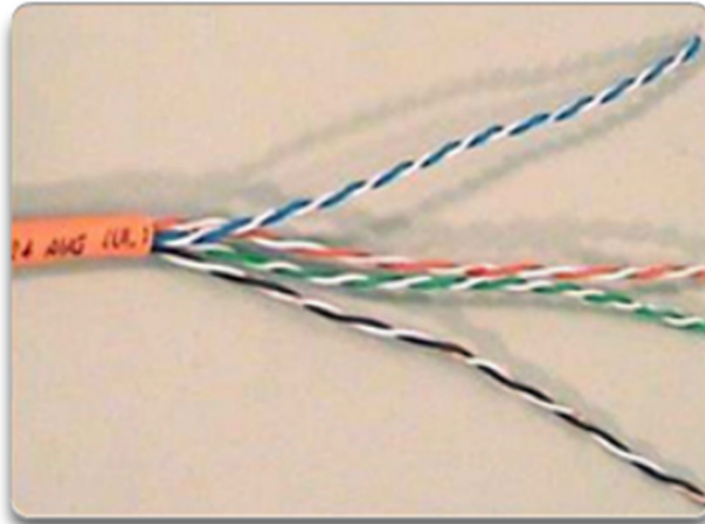
Topic 4.2.1: Copper Cabling



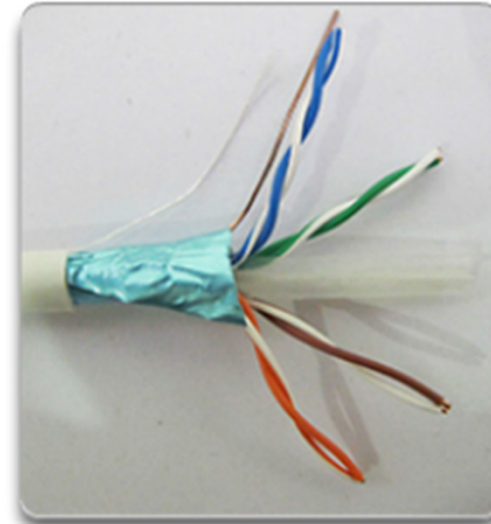
Characteristics of Copper Cabling



Copper Media



Unshielded Twisted-Pair (UTP) cable

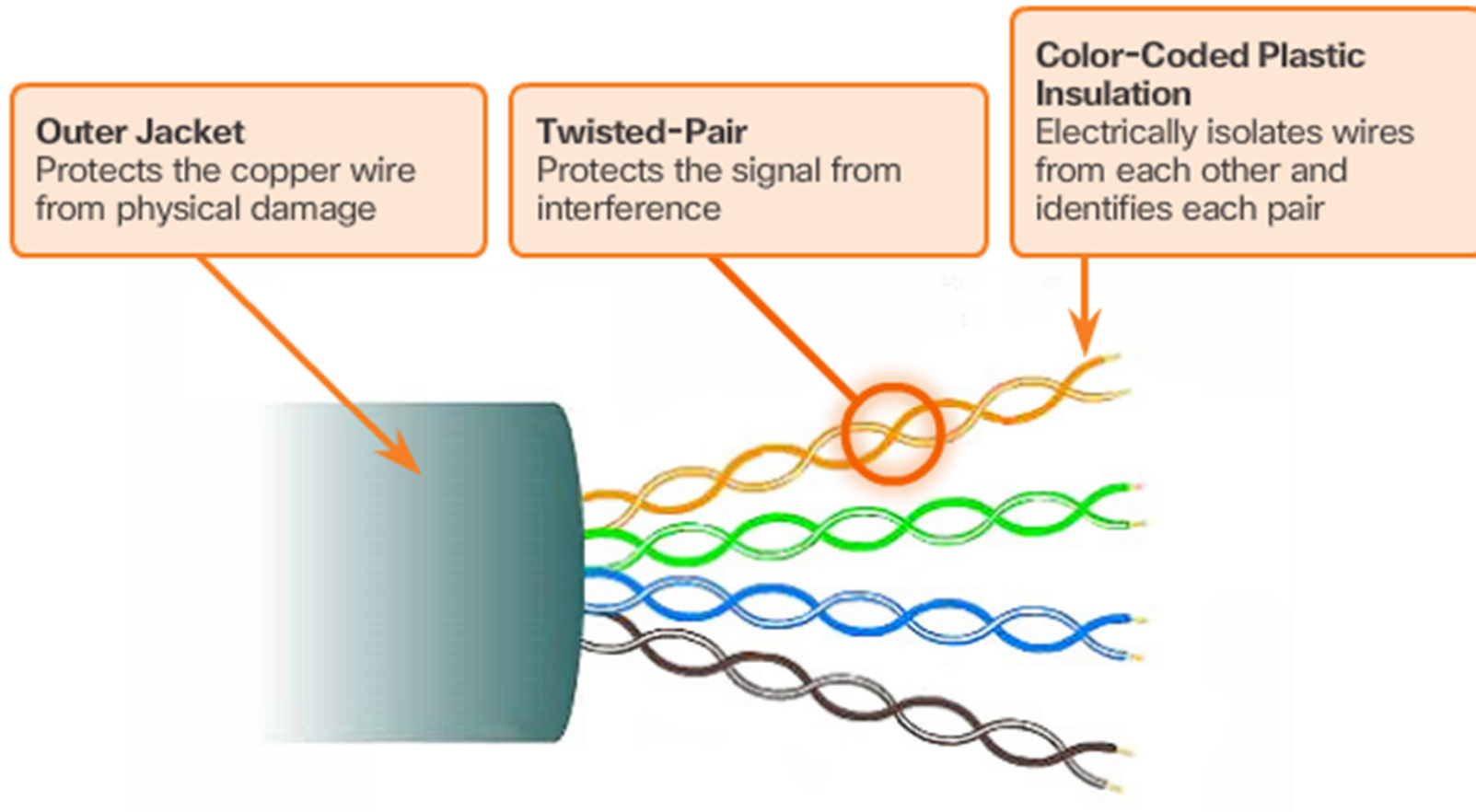


Shielded Twisted-Pair (STP) cable

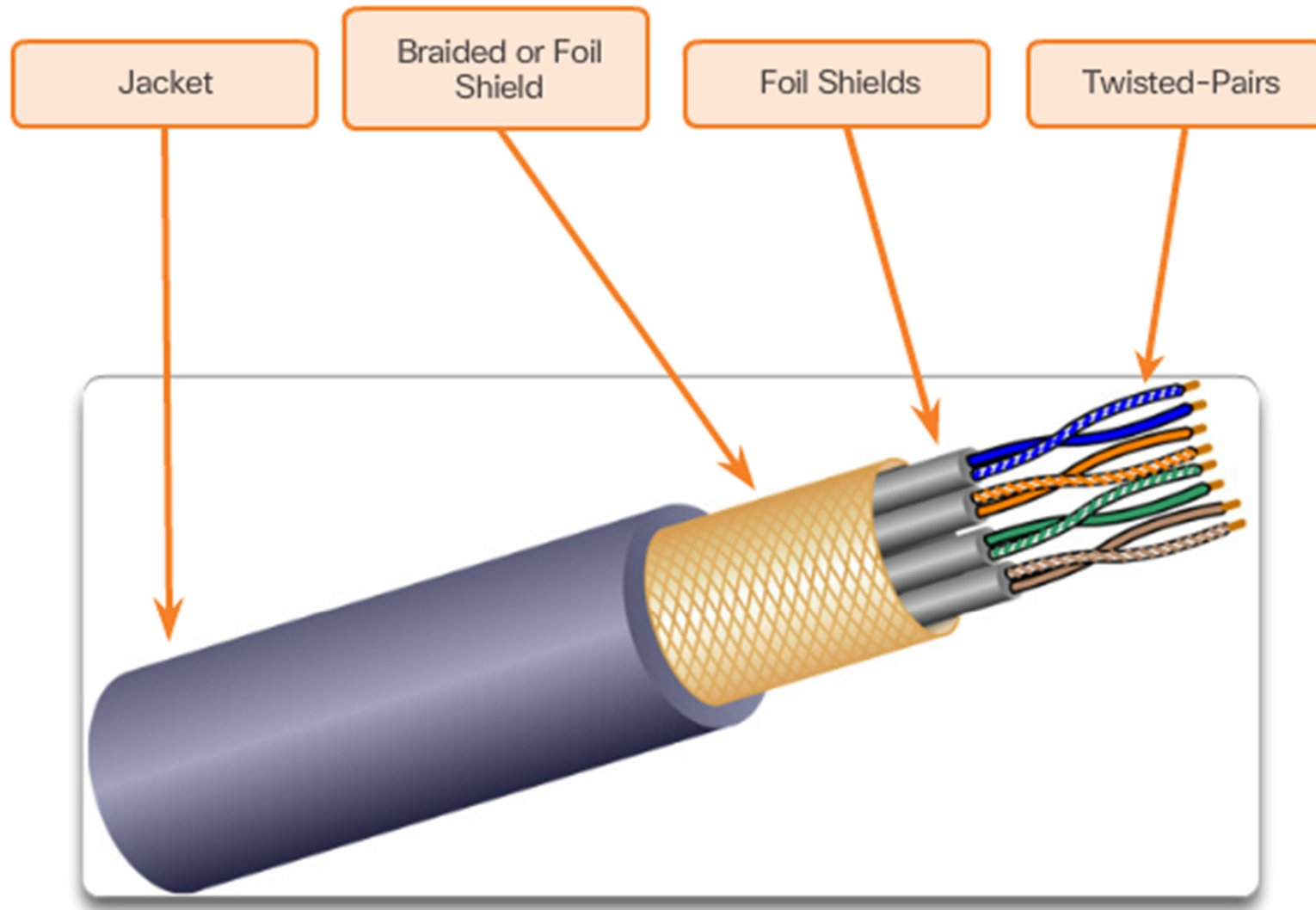


Coaxial cable

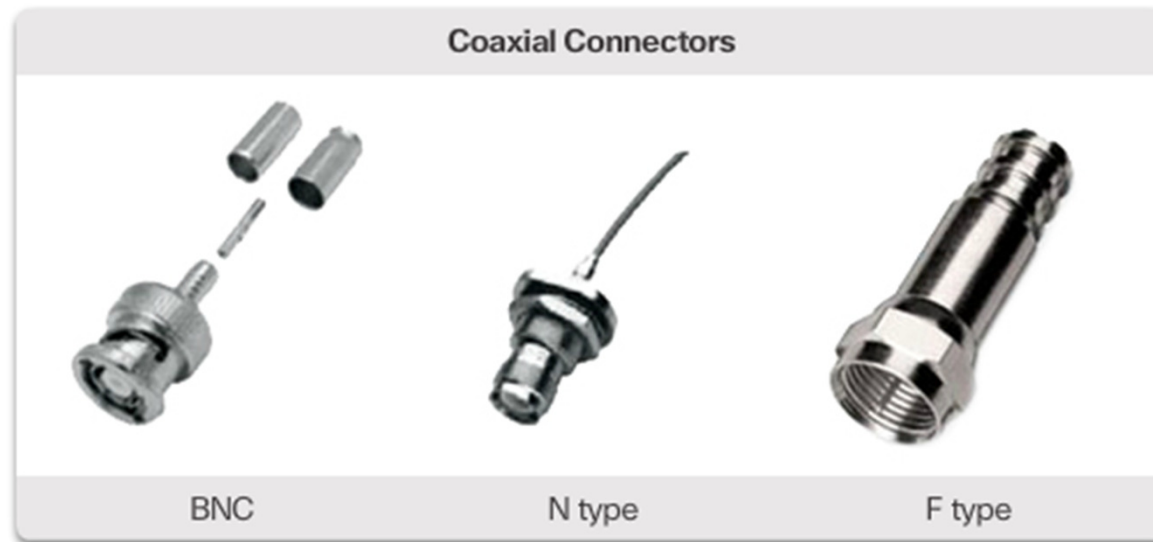
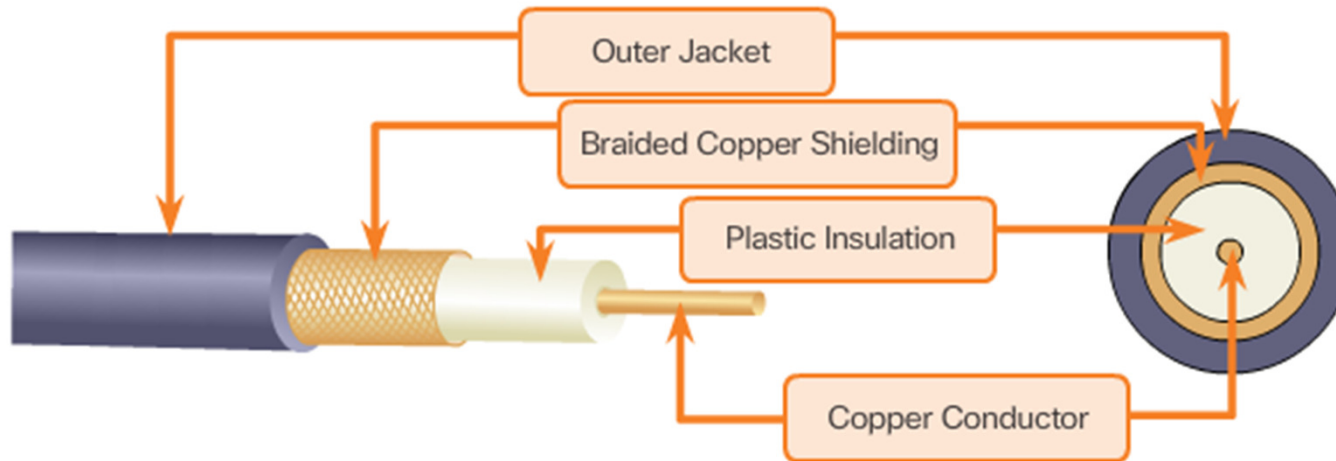
Unshielded Twisted-Pair Cable



Shielded Twisted-Pair Cable



Coaxial Cable



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.

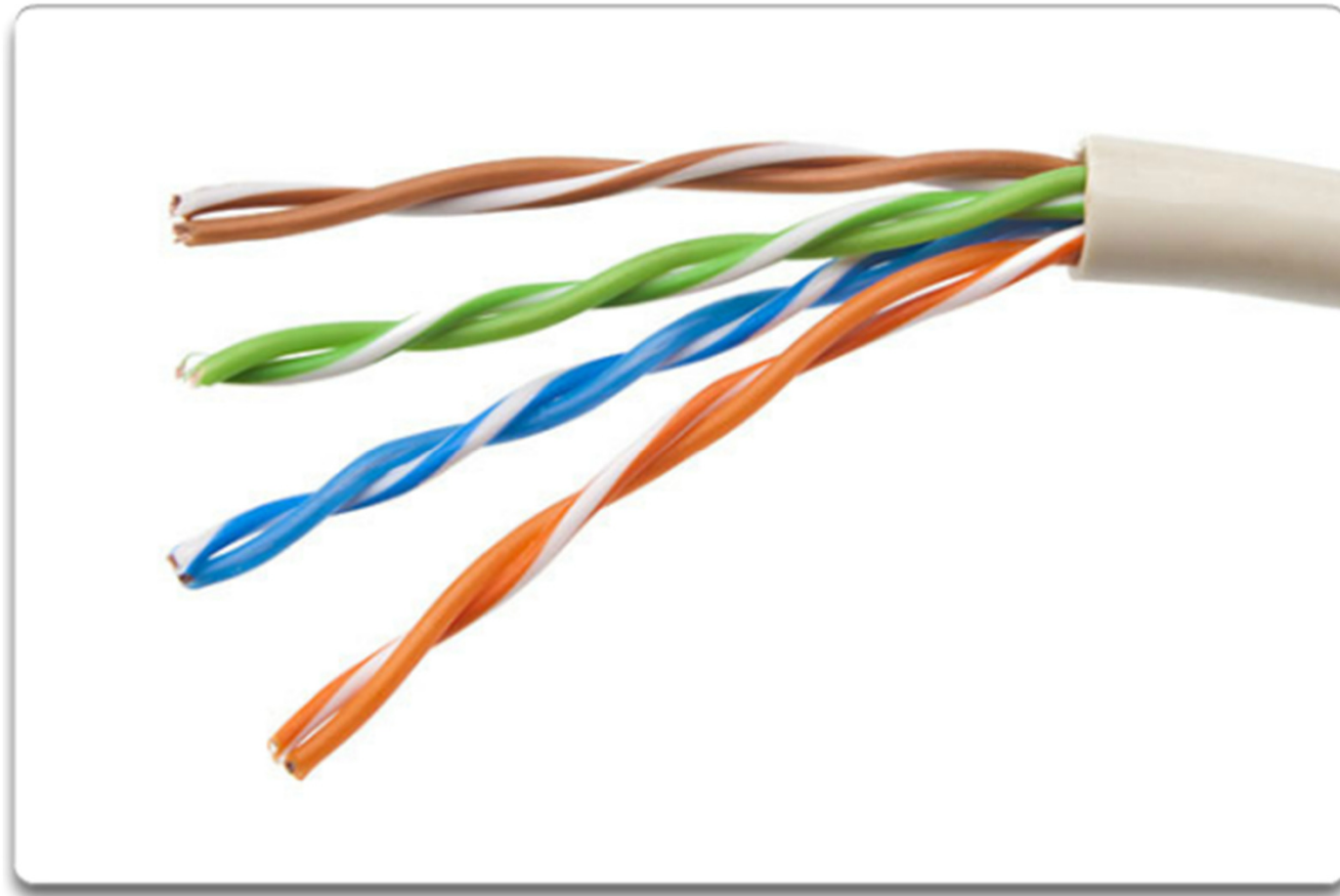


Equipment must be grounded correctly.

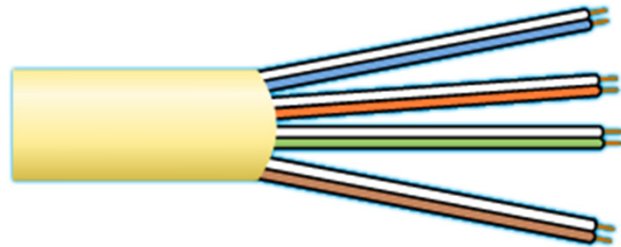
Topic 4.2.2: UTP Cabling



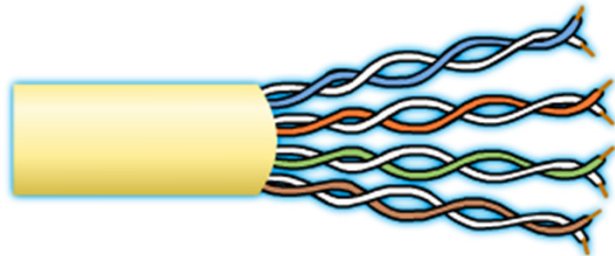
Properties of UTP Cabling



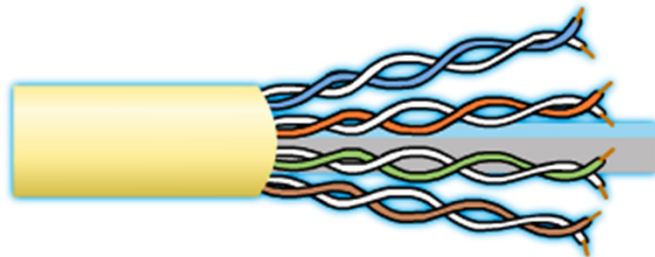
UTP Cabling Standards



Category 3 Cable (UTP)



Category 5 and 5e Cable (UTP)



Category 6 Cable (UTP)

Category 3 Cable (UTP)

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

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

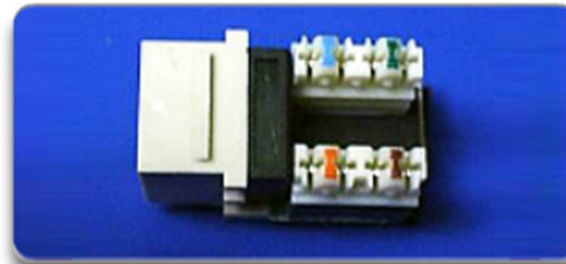
Category 6 Cable (UTP)

- 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



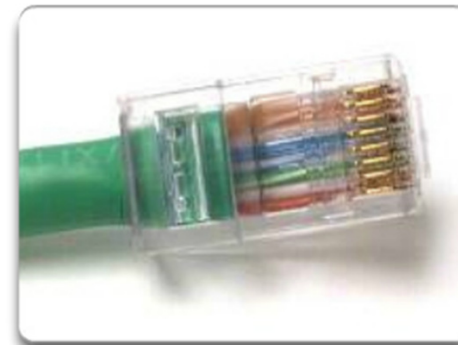
RJ-45 UTP Plugs



RJ-45 UTP Socket

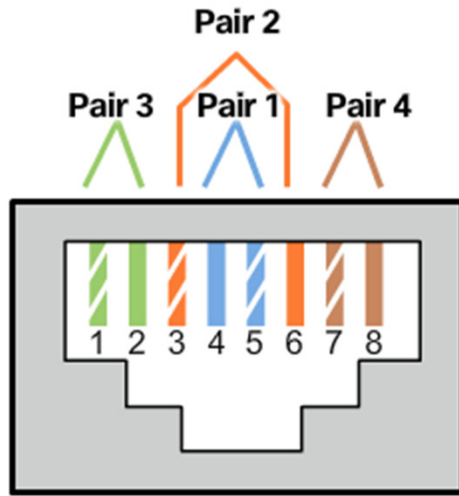


Bad connector - Wires are exposed, untwisted, and not entirely covered by the sheath.

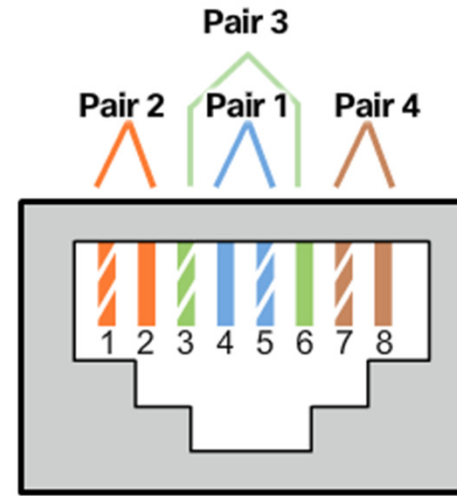


Good connector - Wires are untwisted to the extent necessary to attach the connector.

Types of UTP Cable



T568A



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	<ul style="list-style-type: none"> 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:

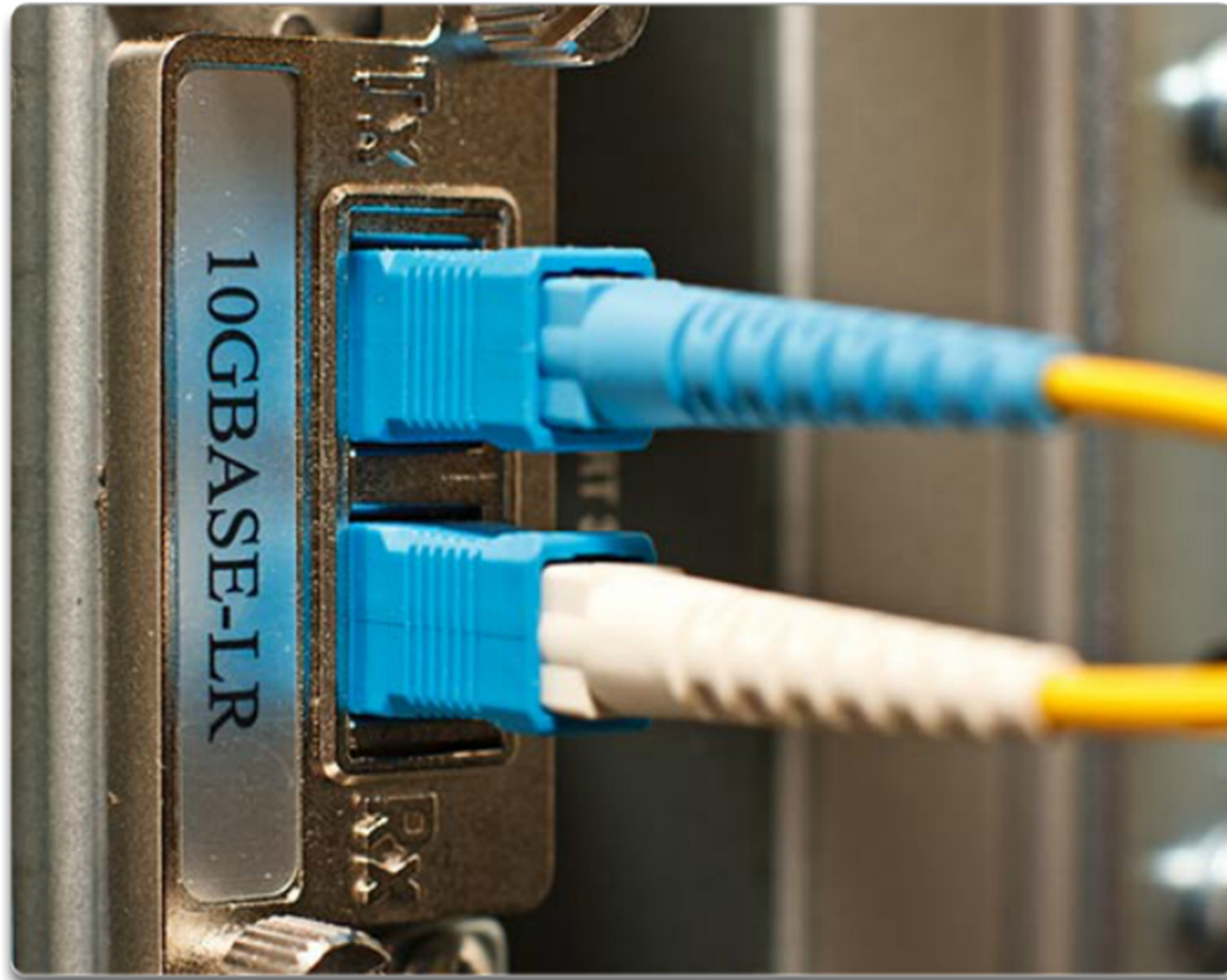
- Wire map
- Cable length
- Signal loss due to attenuation
- Crosstalk



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.

Buffer

Used to help shield the core and cladding from damage.

Cladding

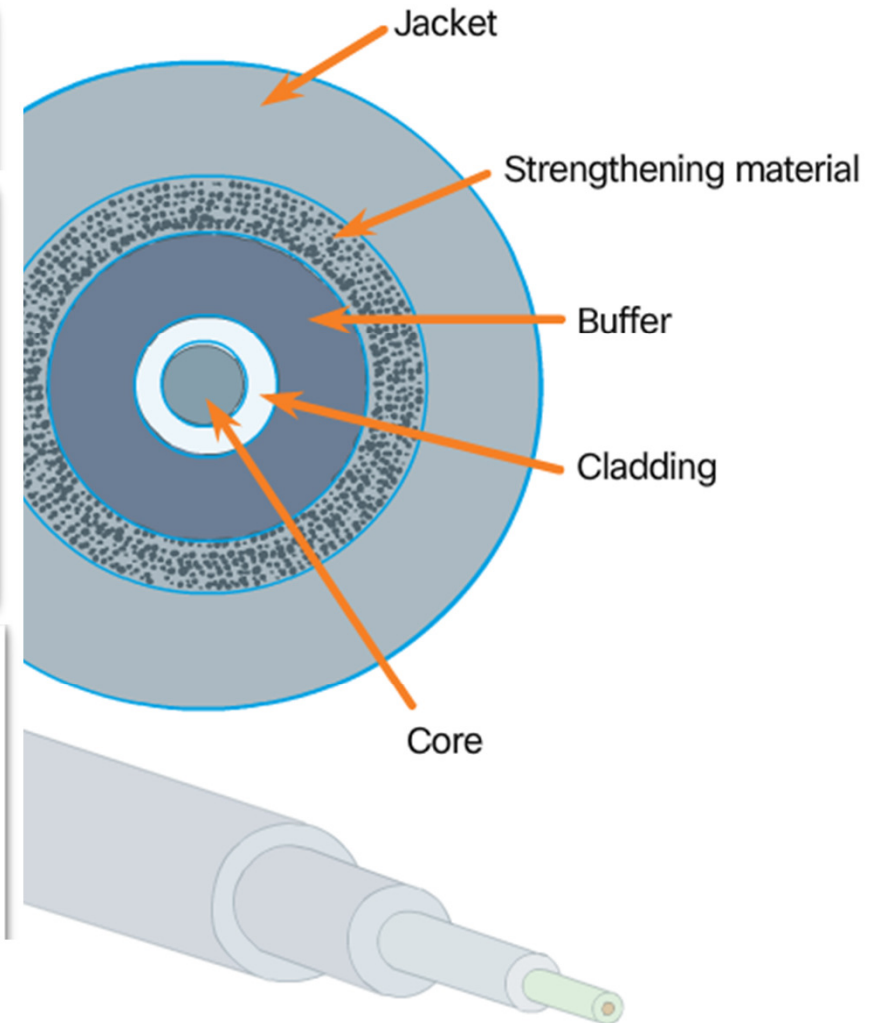
Made from slightly different chemicals than those used to create the core. It tends to act like a mirror by reflecting light back into the core of the fiber. This keeps light in the core as it travels down the fiber.

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.

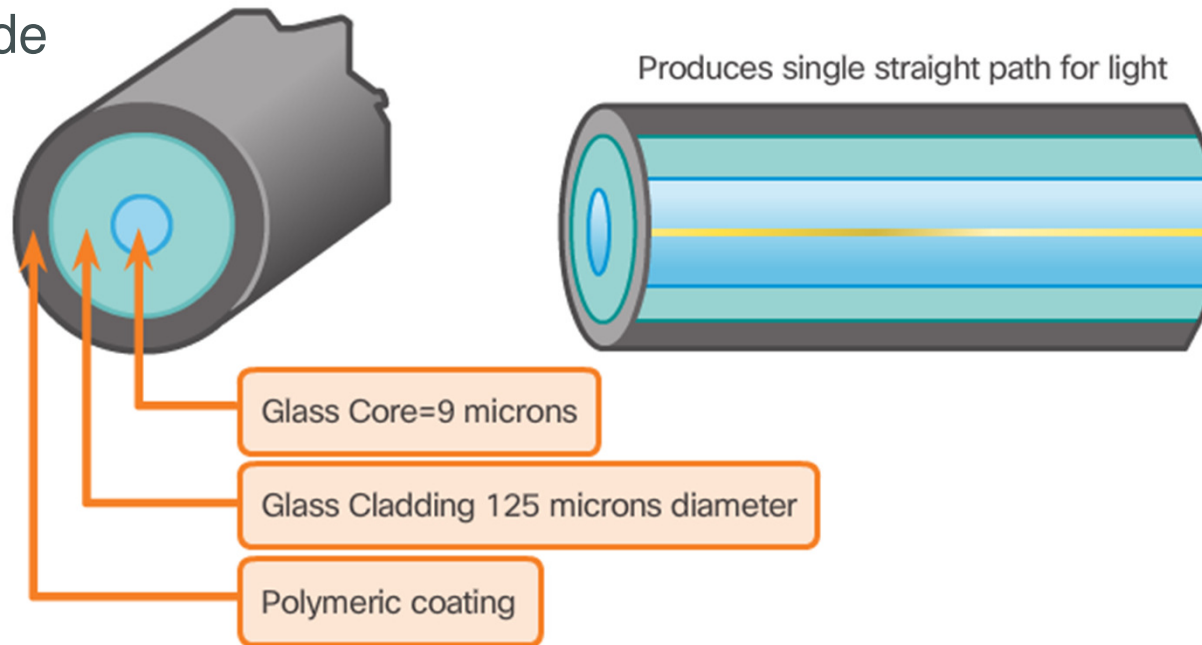
Strengthening Material

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

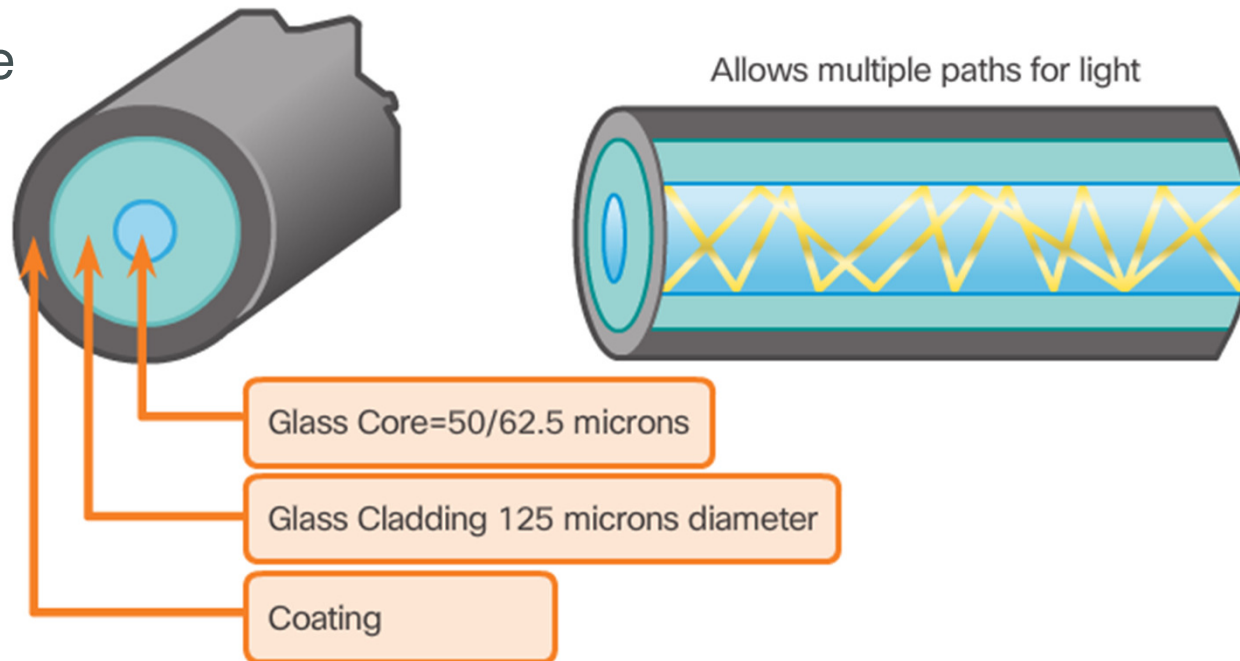
Single Mode



- 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



- 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



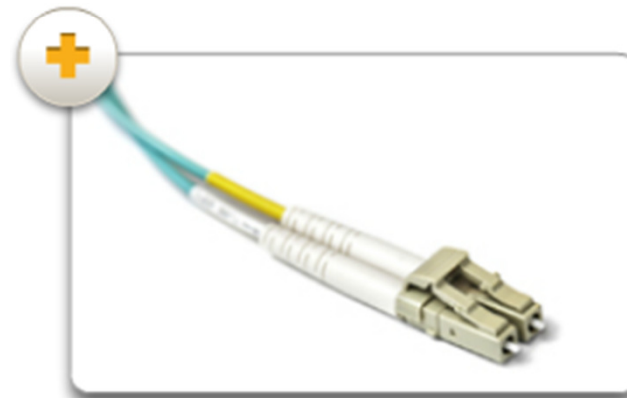
ST Connectors



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

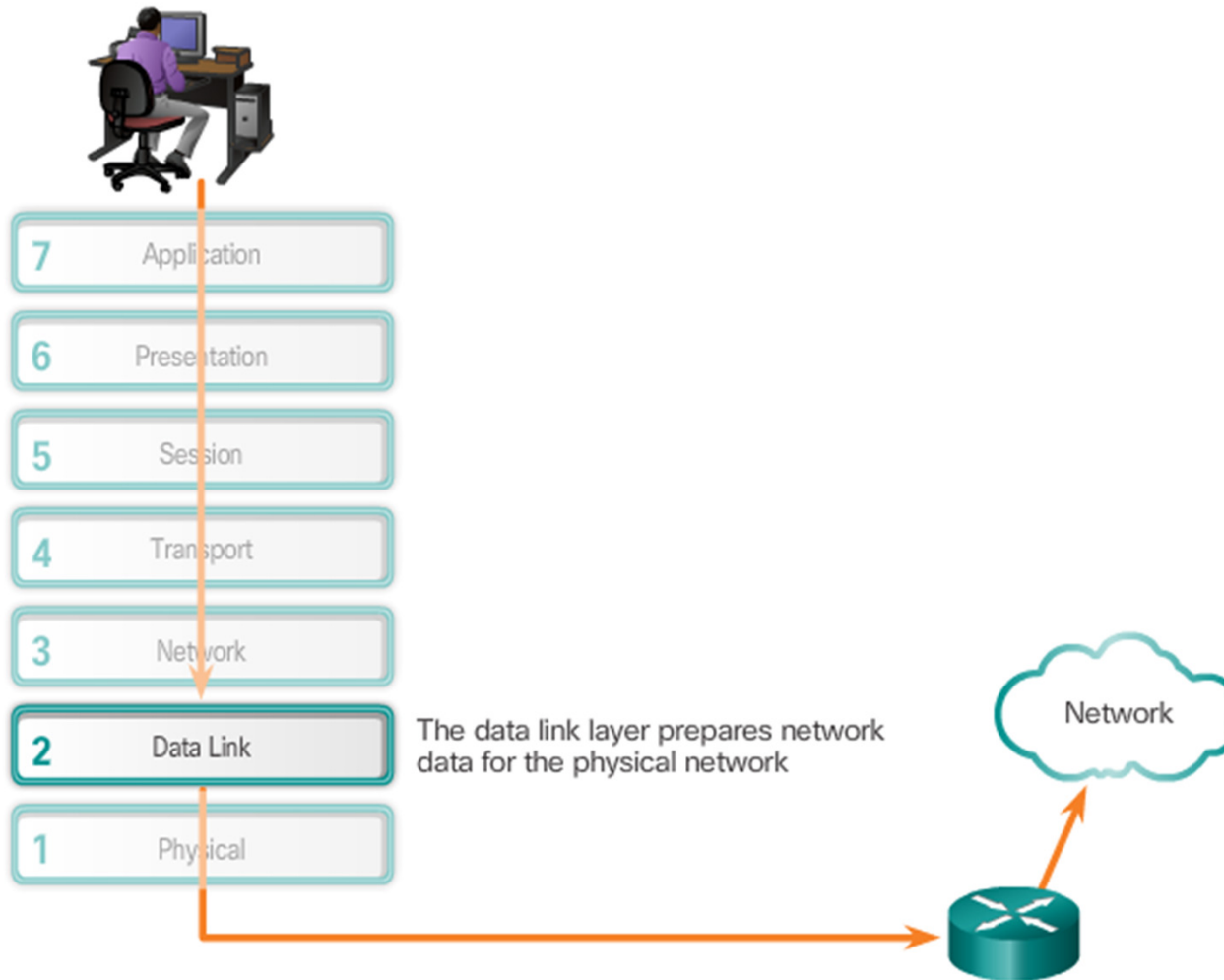
Upon completion of this section, you should be able to:

- 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

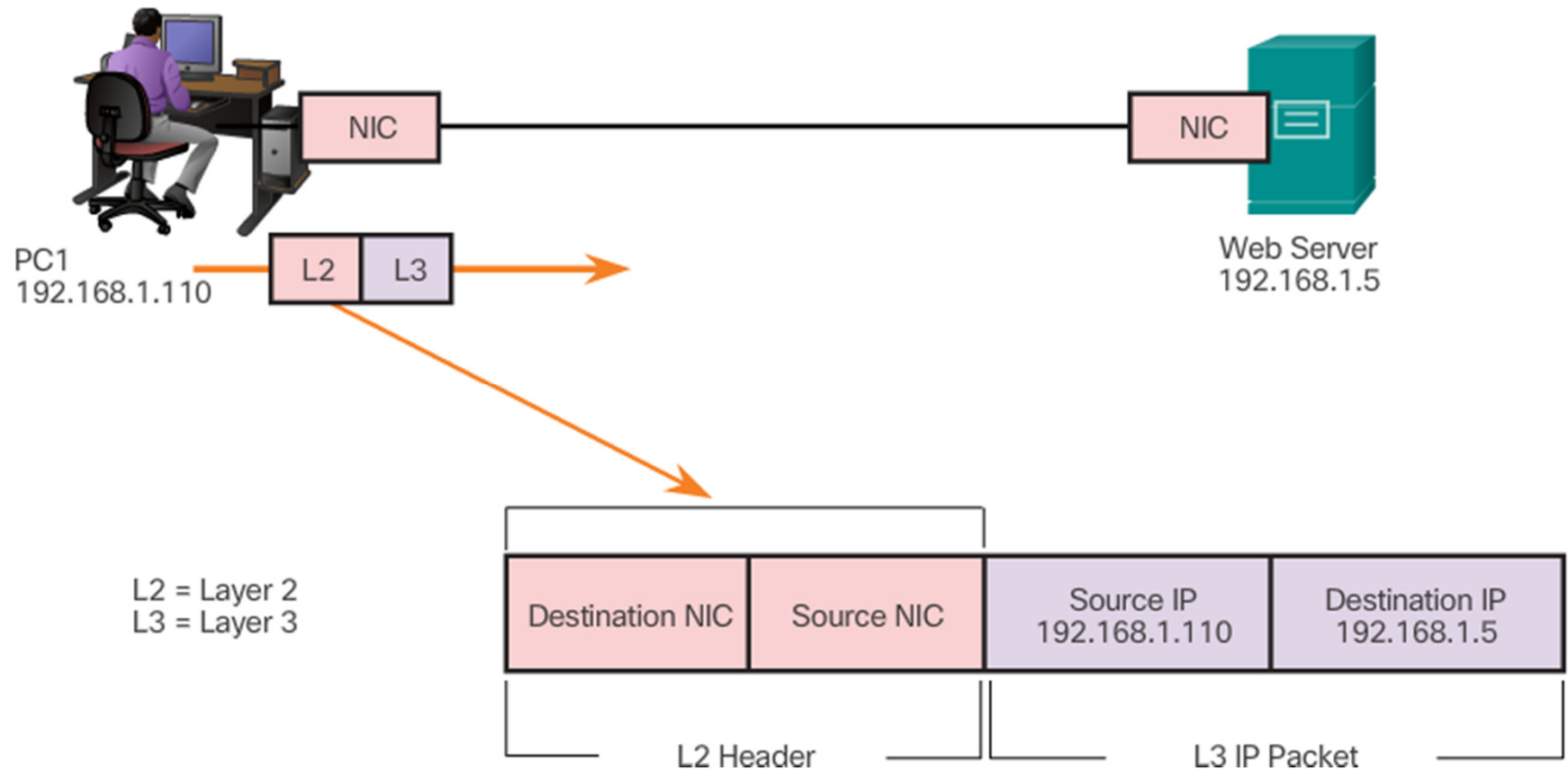


The Data Link Layer

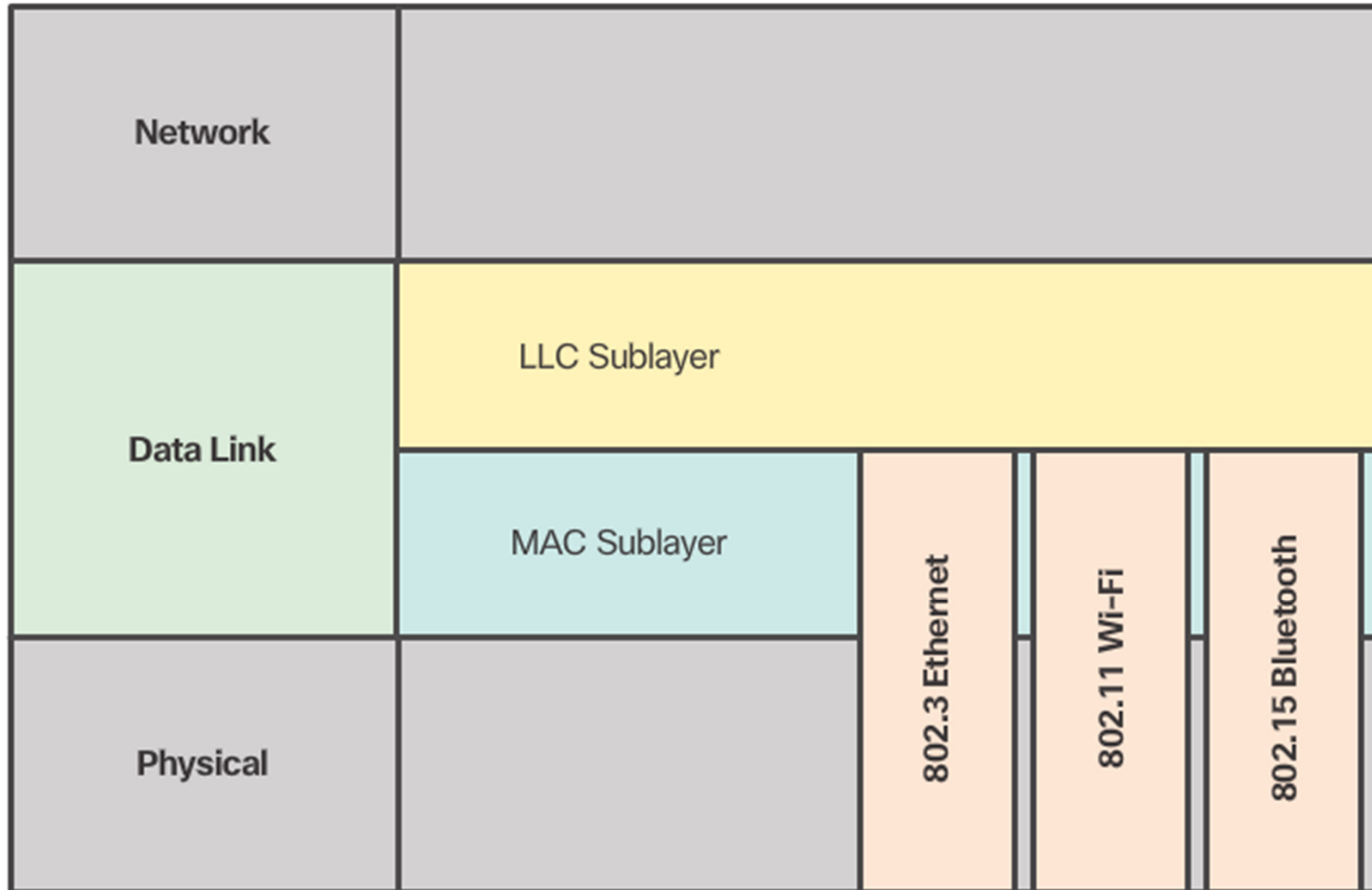


The Data Link Layer (cont.)

Layer 2 Data Link Address



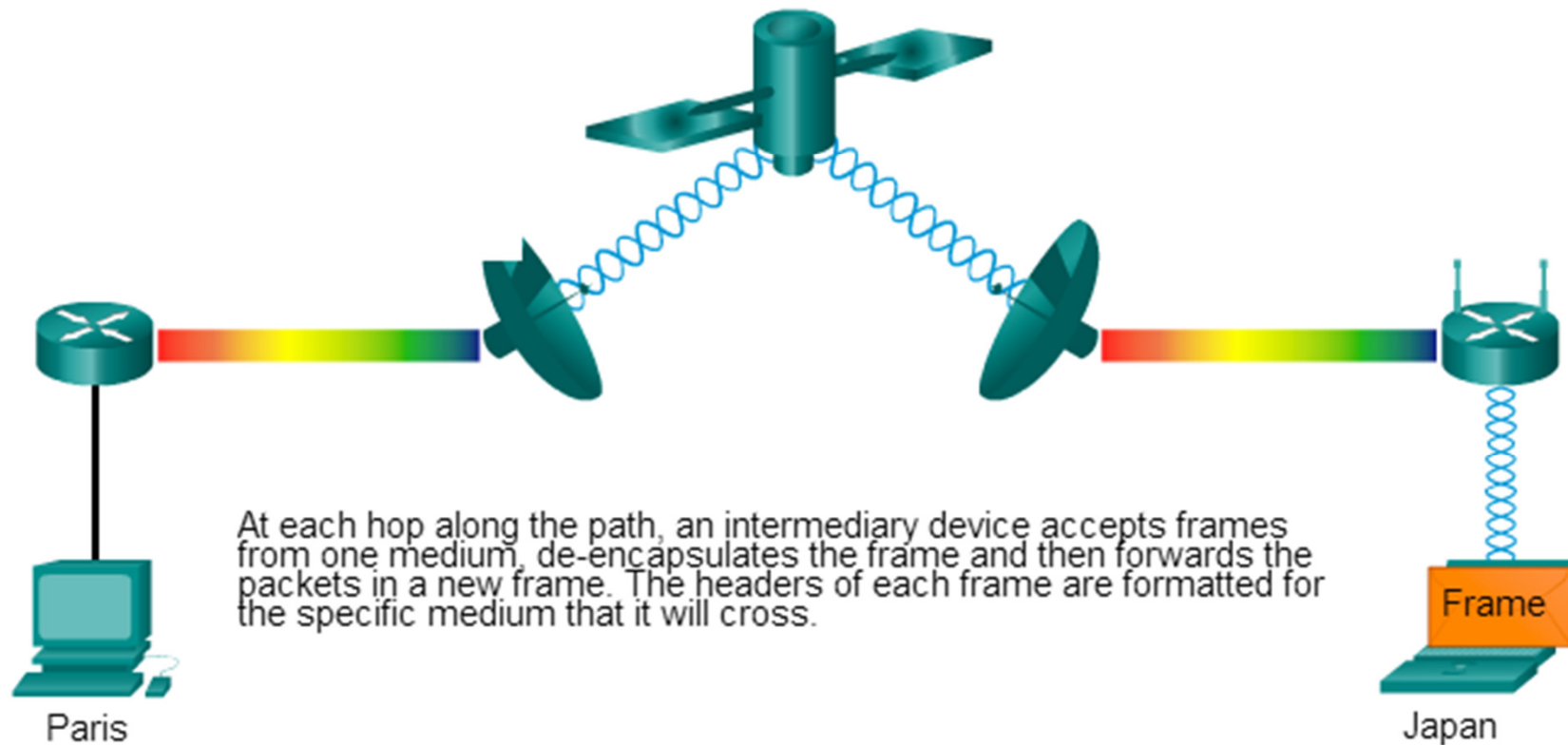
Data Link Sublayers



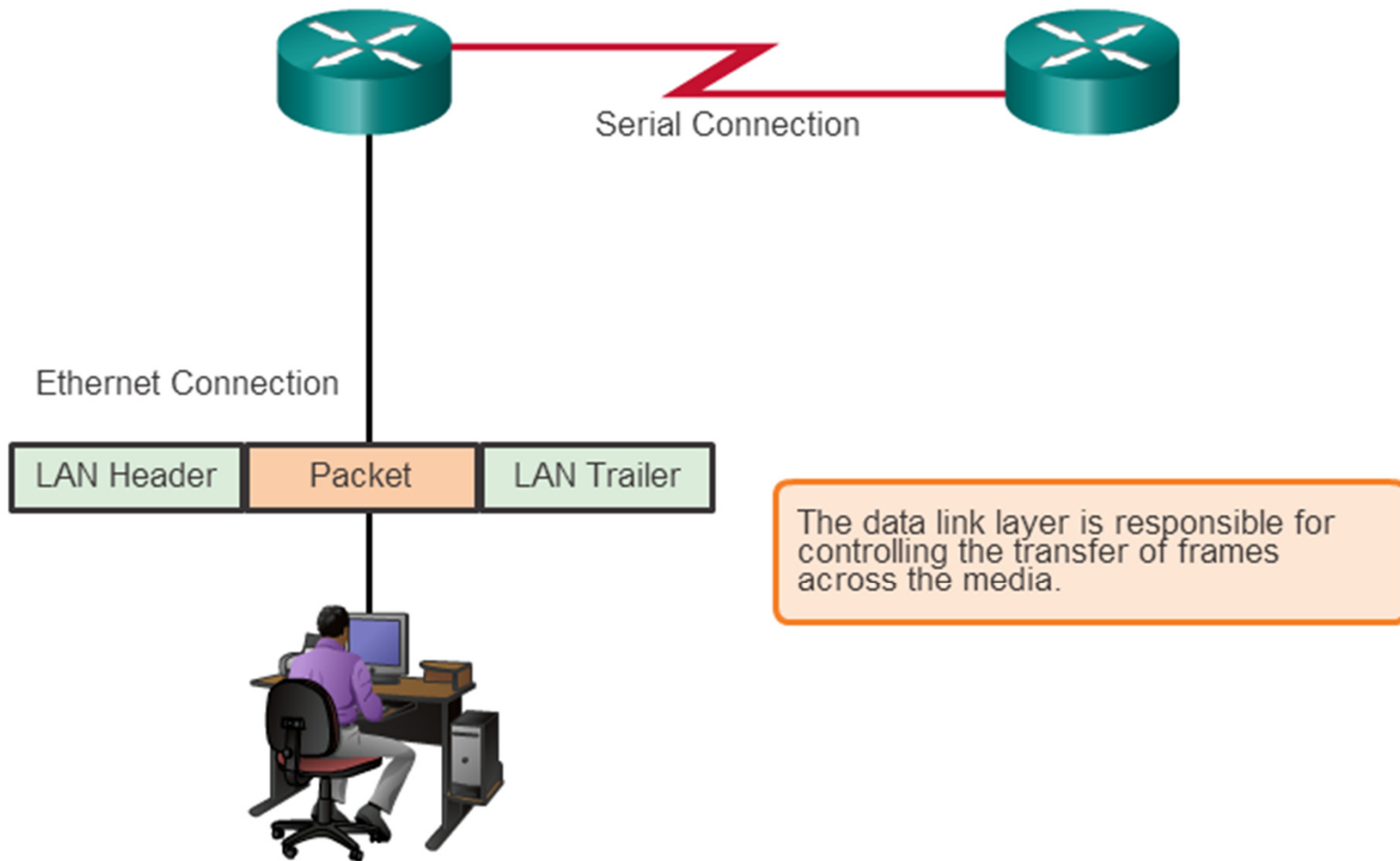
Media Access Control

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

Different protocols may be in use for different media.



Providing Access to Media



Data Link Layer Standards



Section 4.4: Media Access Control

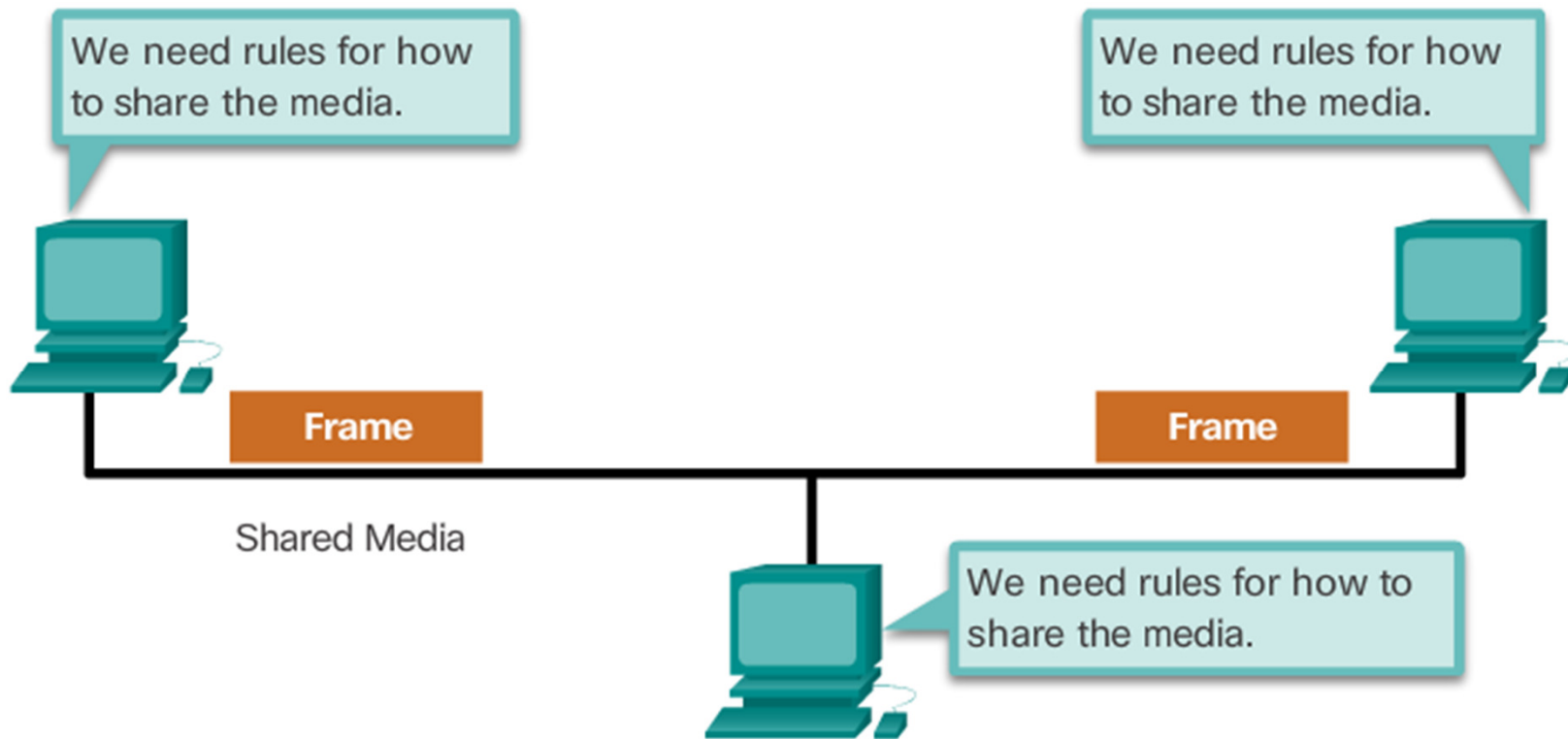
Upon completion of this section, you should be able to:

- 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

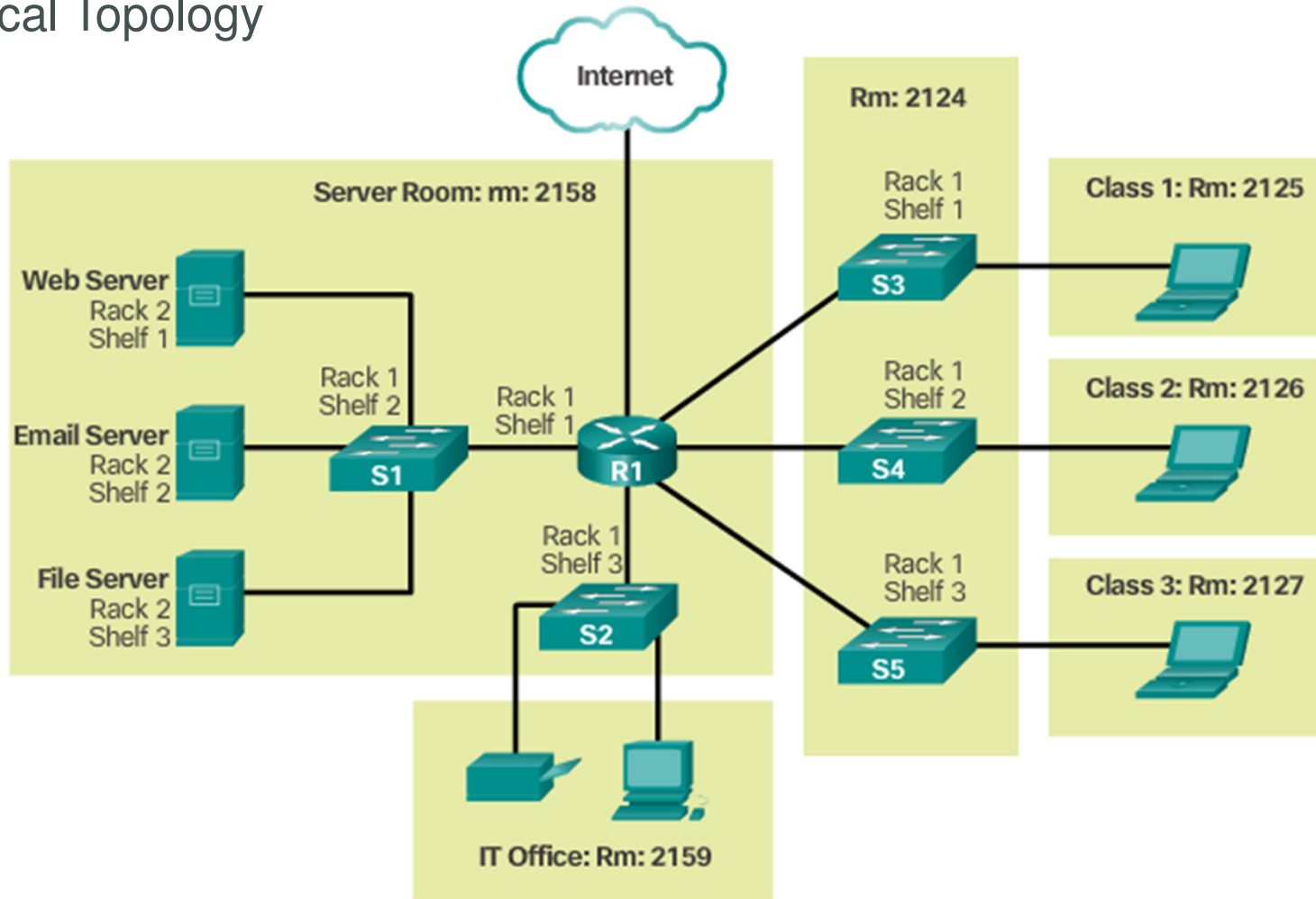


Controlling Access to the Media



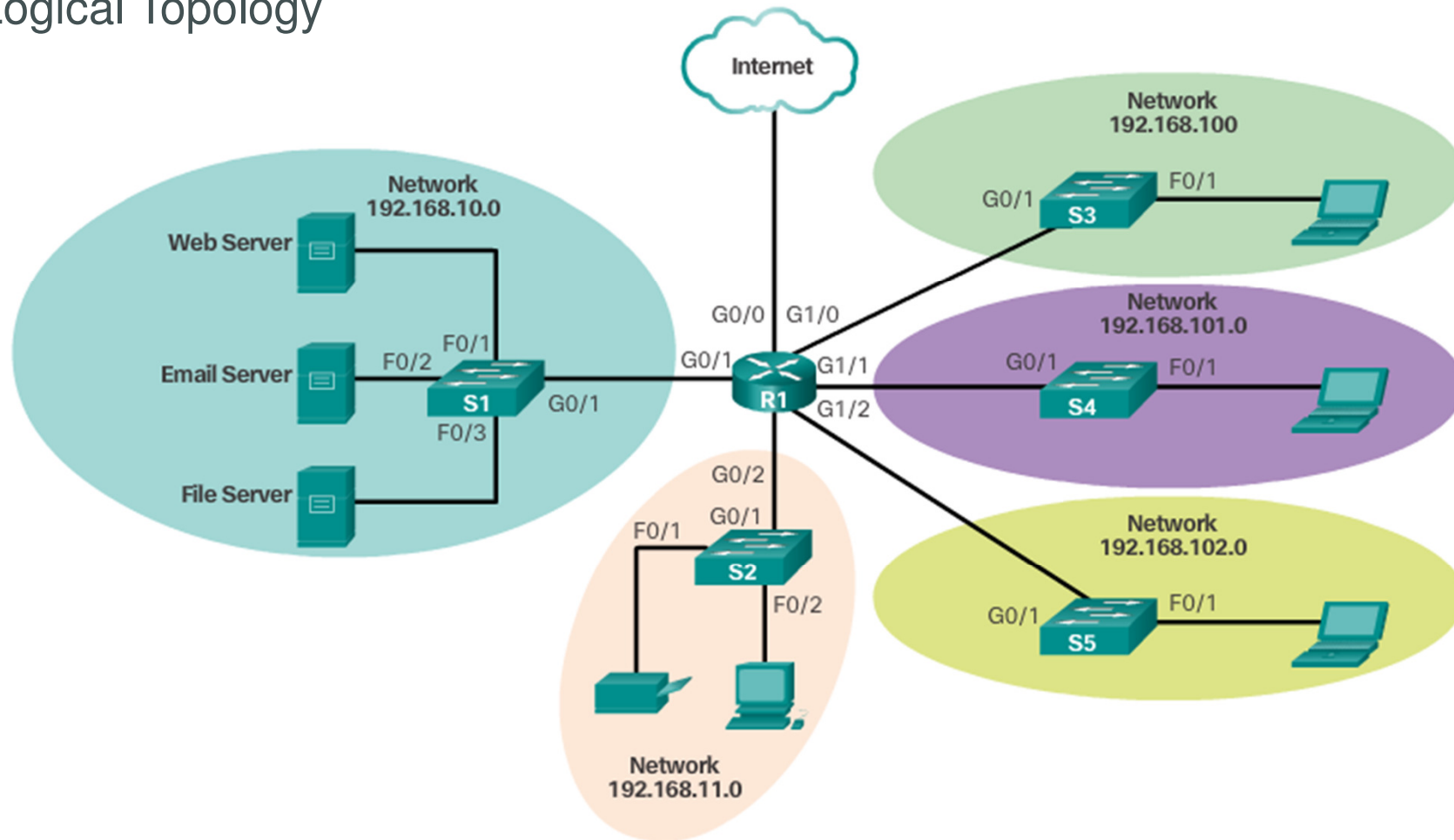
Physical and Logical Topologies

Physical Topology



Physical and Logical Topologies (cont.)

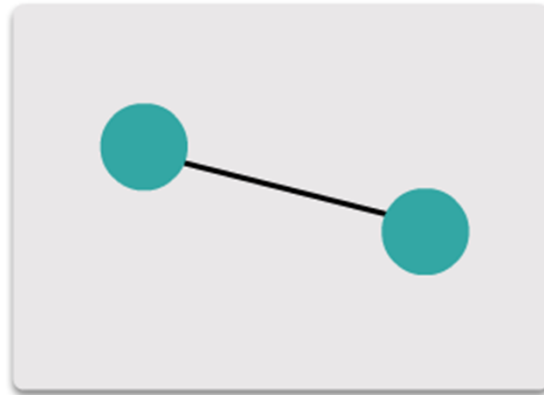
Logical Topology



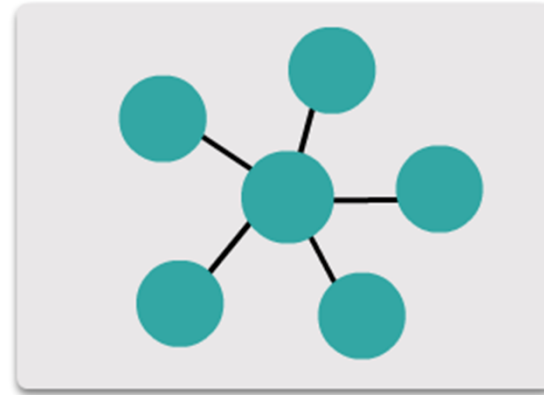
Topic 4.4.2: WAN Topologies



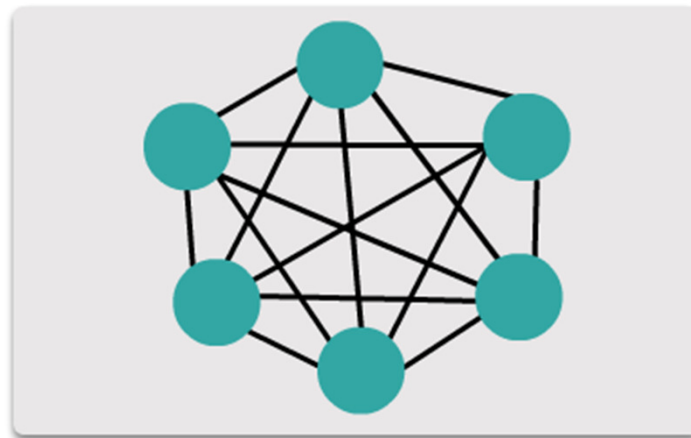
Common Physical WAN Topologies



Point-to-point topology

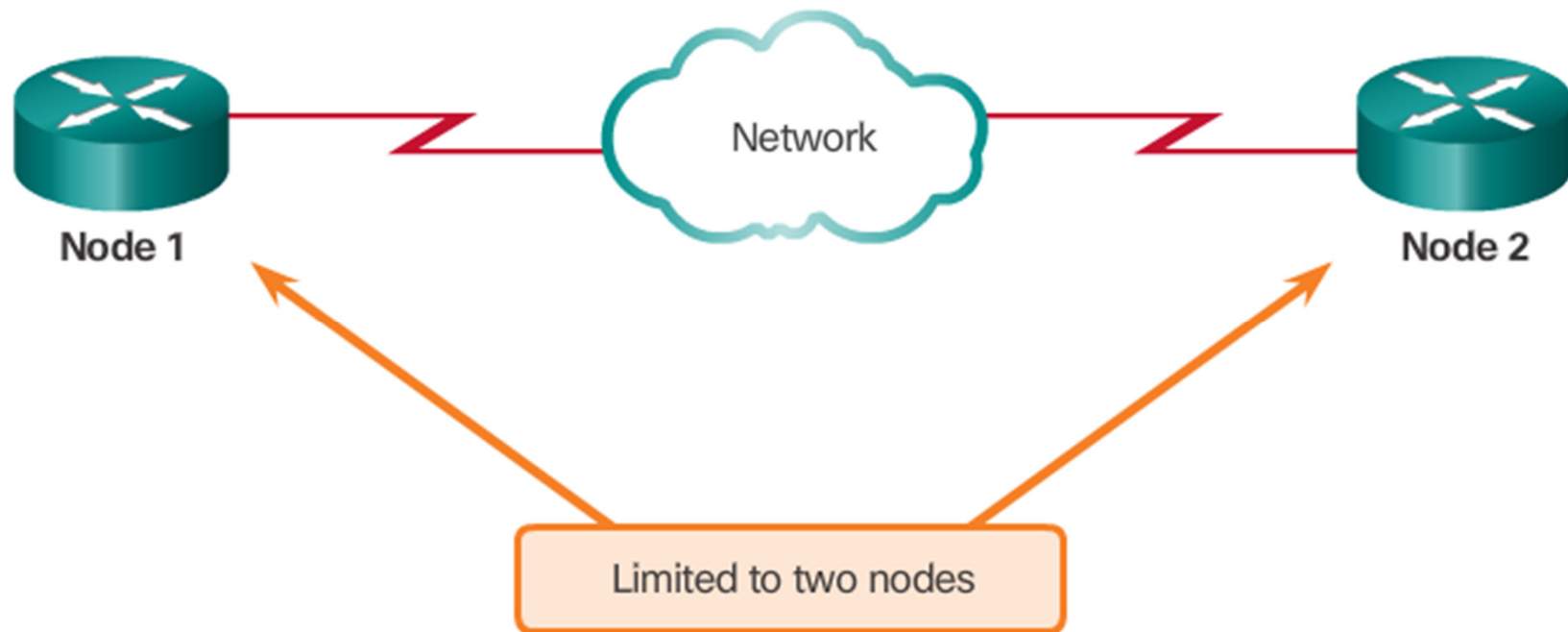


Hub and spoke topology



Full mesh topology

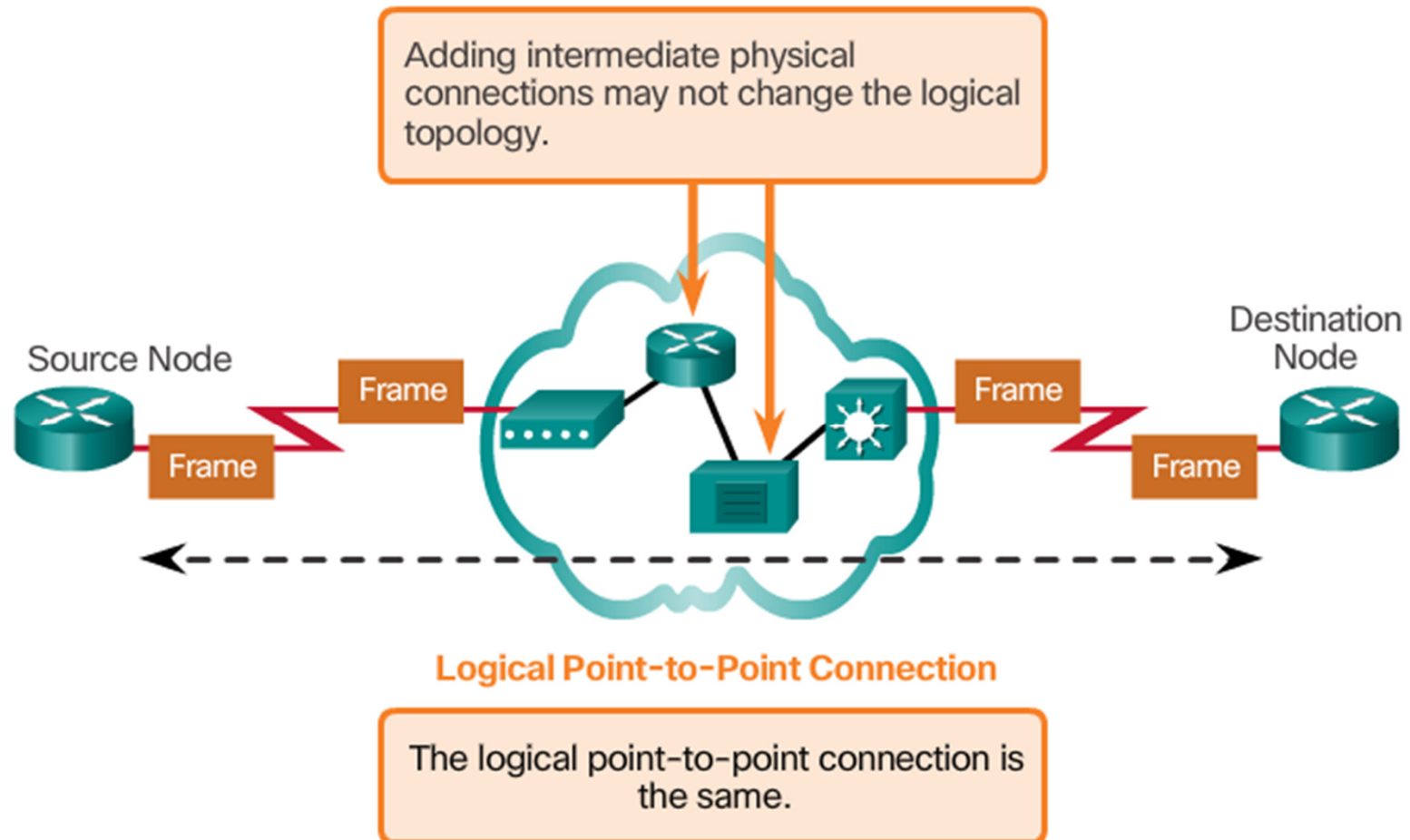
Physical Point-to-Point Topology



Logical Point-to-Point Topology



Logical Point-to-Point Topology (cont.)



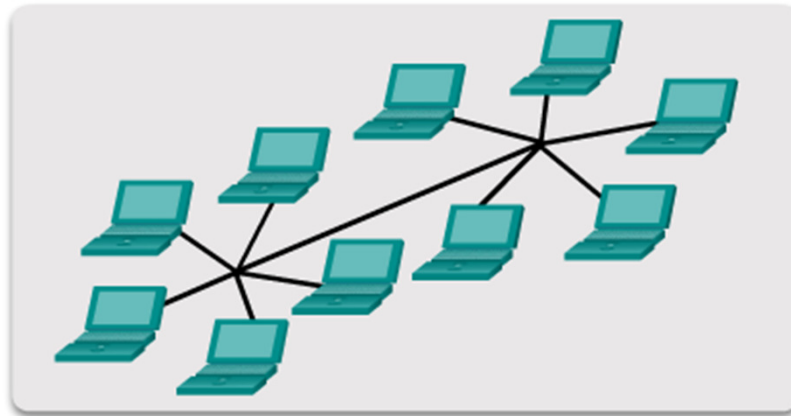
Topic 4.4.3: LAN Topologies



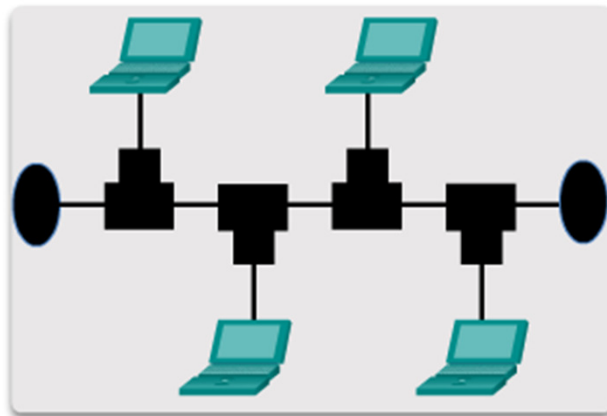
Physical LAN Topologies



Star topology



Extended star topology

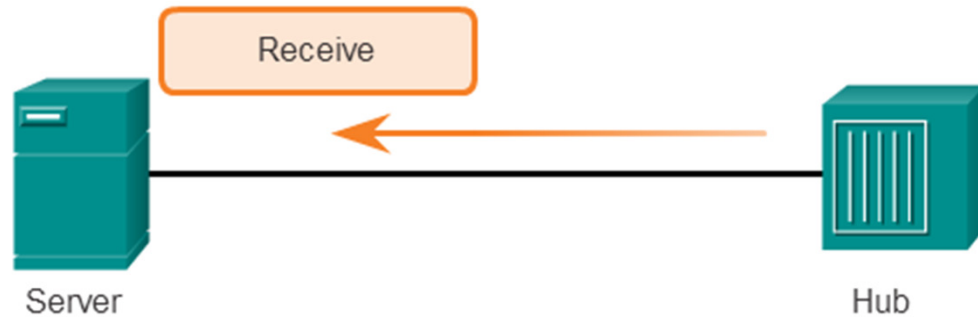


Bus topology

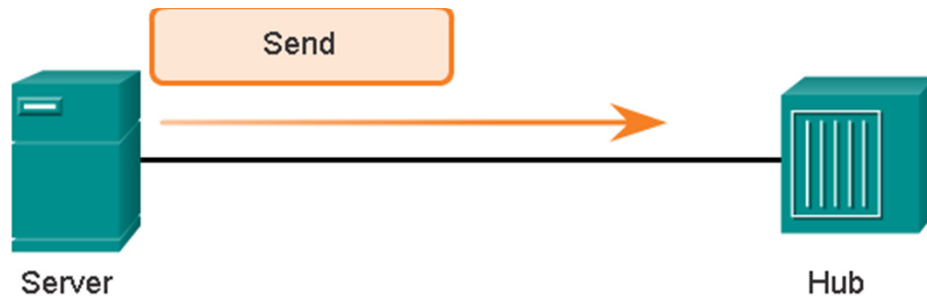


Ring topology

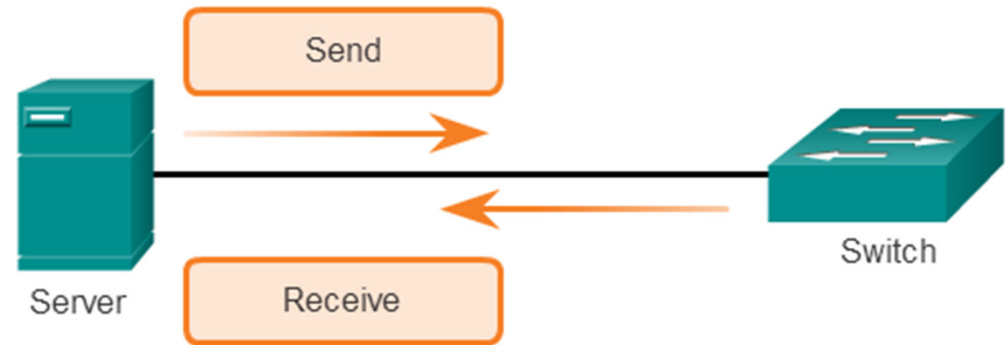
Half and Full Duplex



Half-Duplex Communication

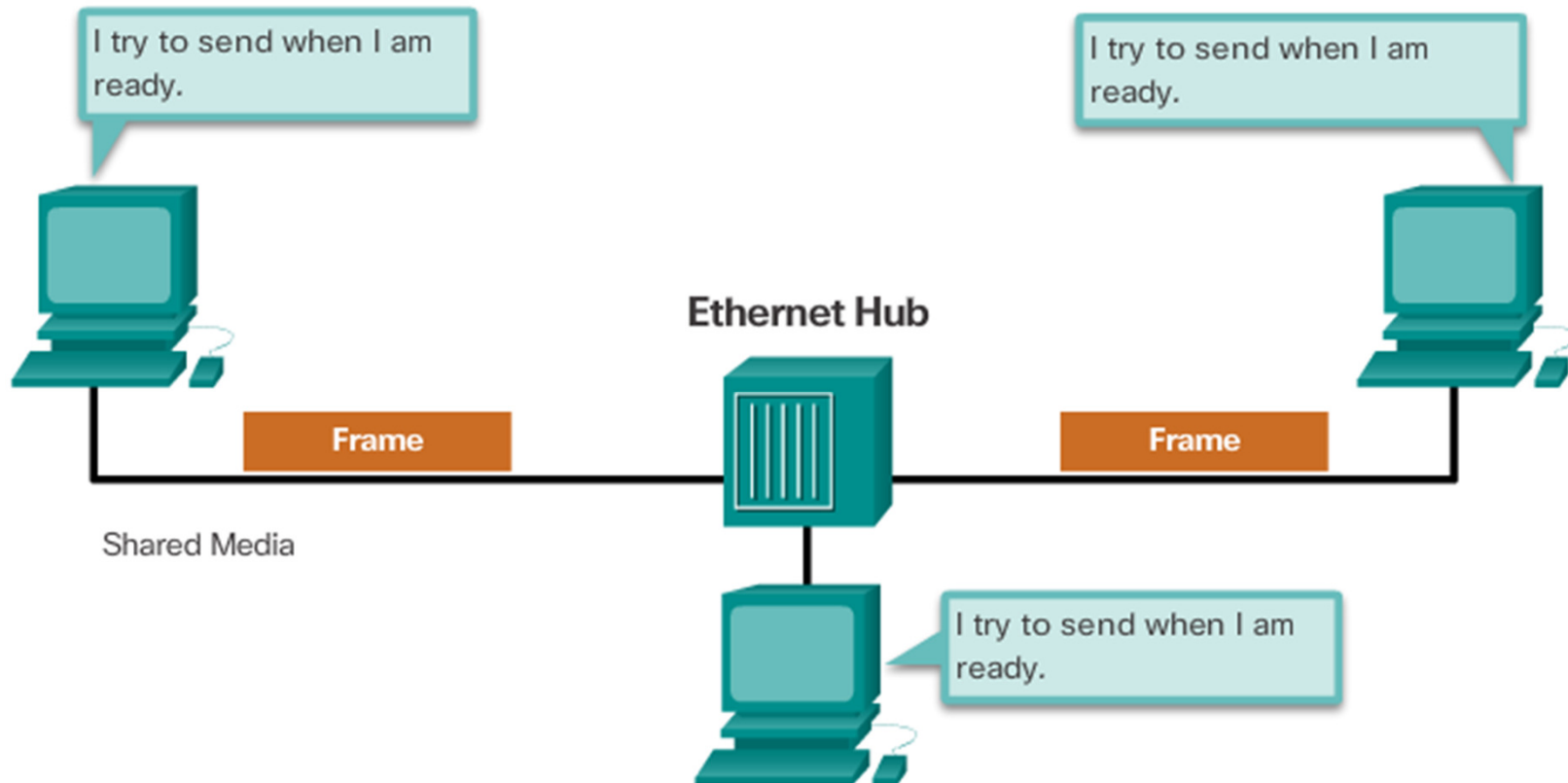


Full-Duplex Communication



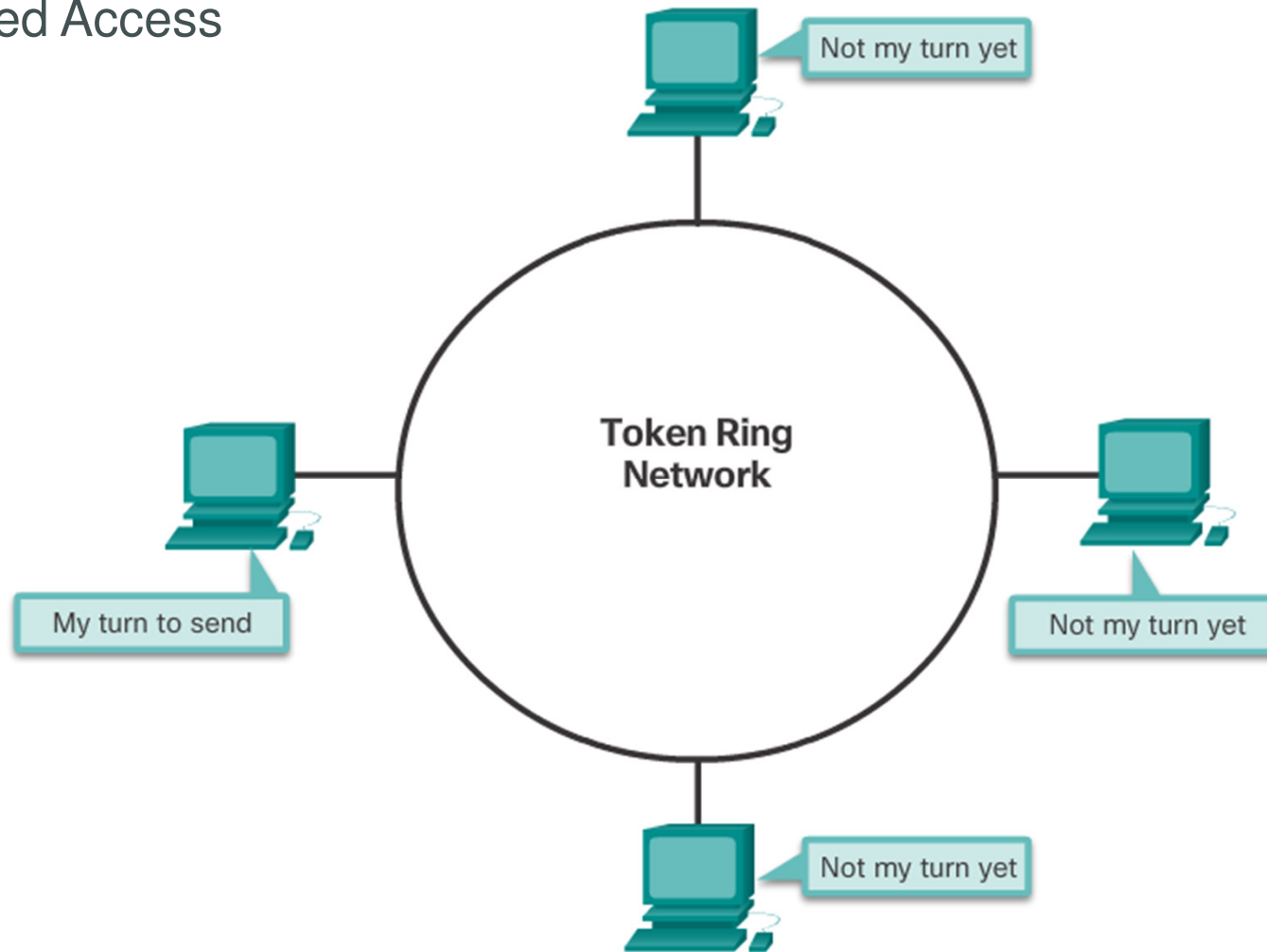
Media Access Control Methods

Contention-Based Access



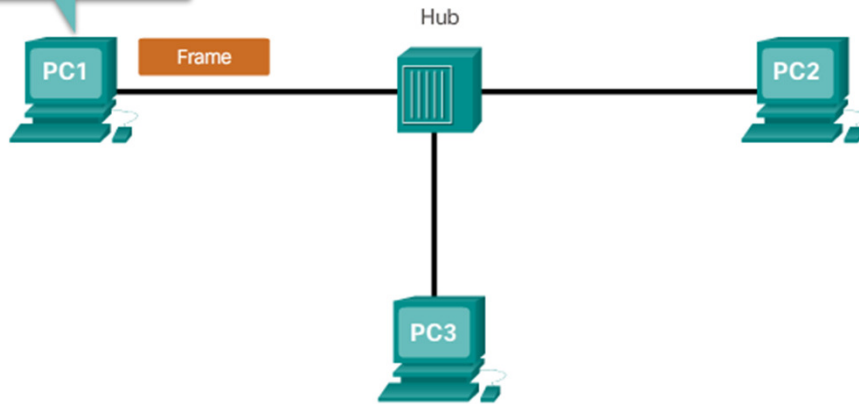
Media Access Control Methods (cont.)

Controlled Access

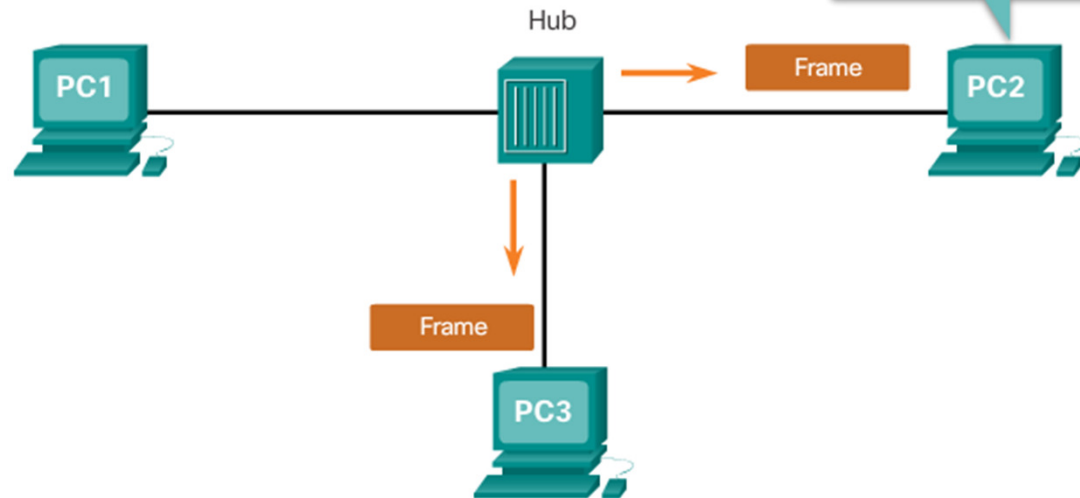


Contention Based Access – CSMA/CD

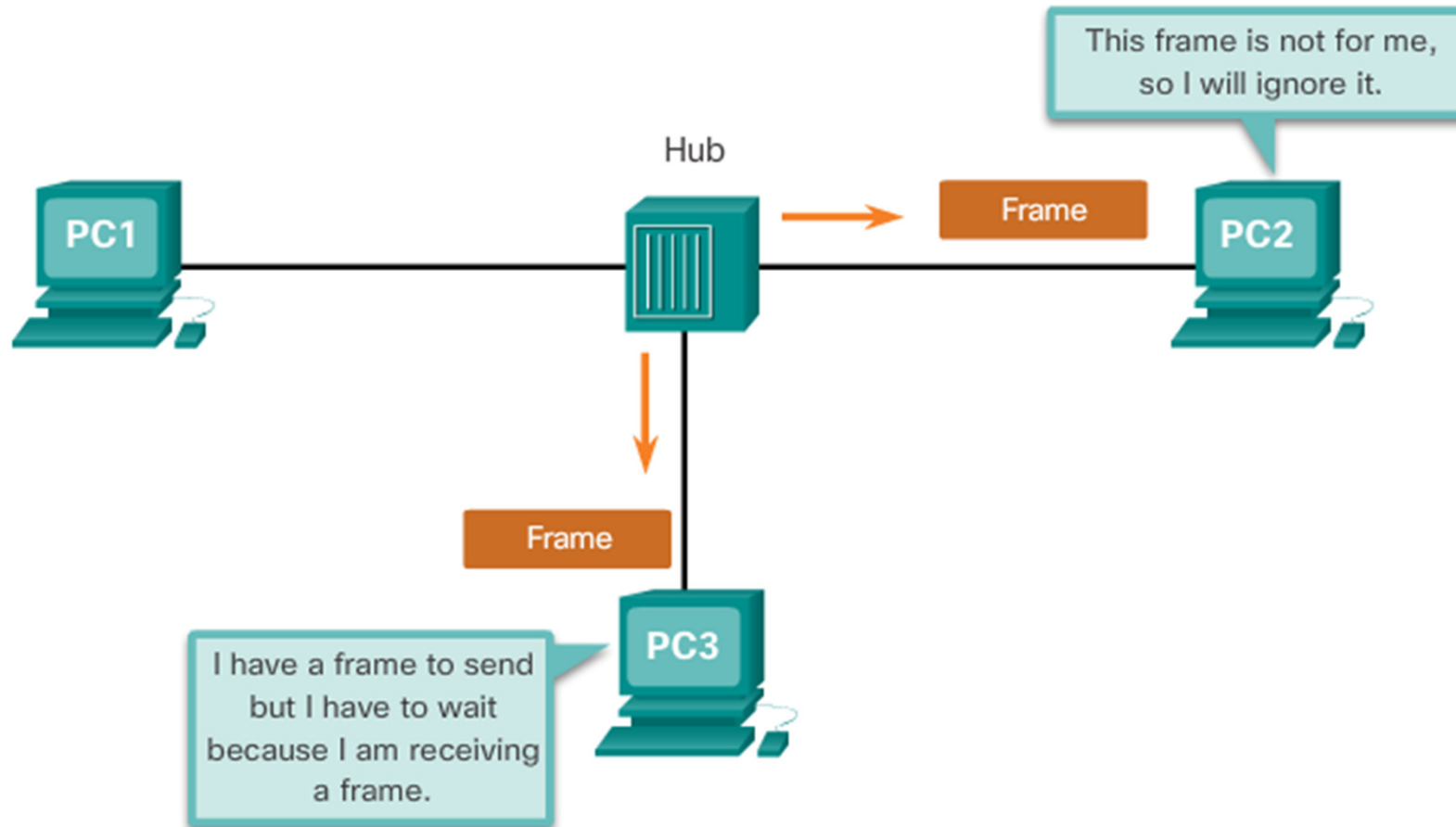
The medium is available so I will send the Ethernet frame to PC3.



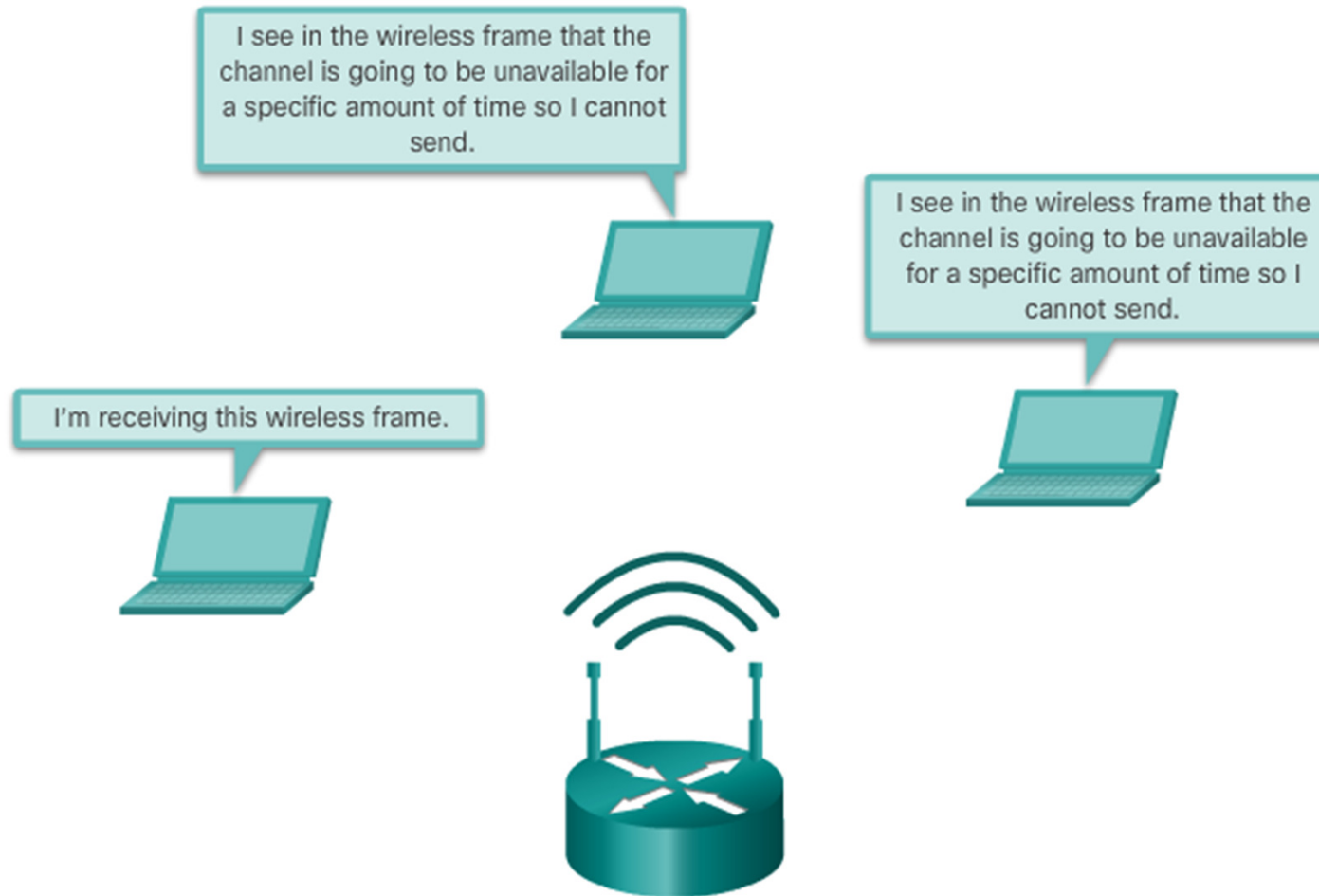
I have a frame to send but I have to wait because I am receiving a frame.



Contention Based Access – CSMA/CD (cont.)



Contention Based Access – CSMA/CA



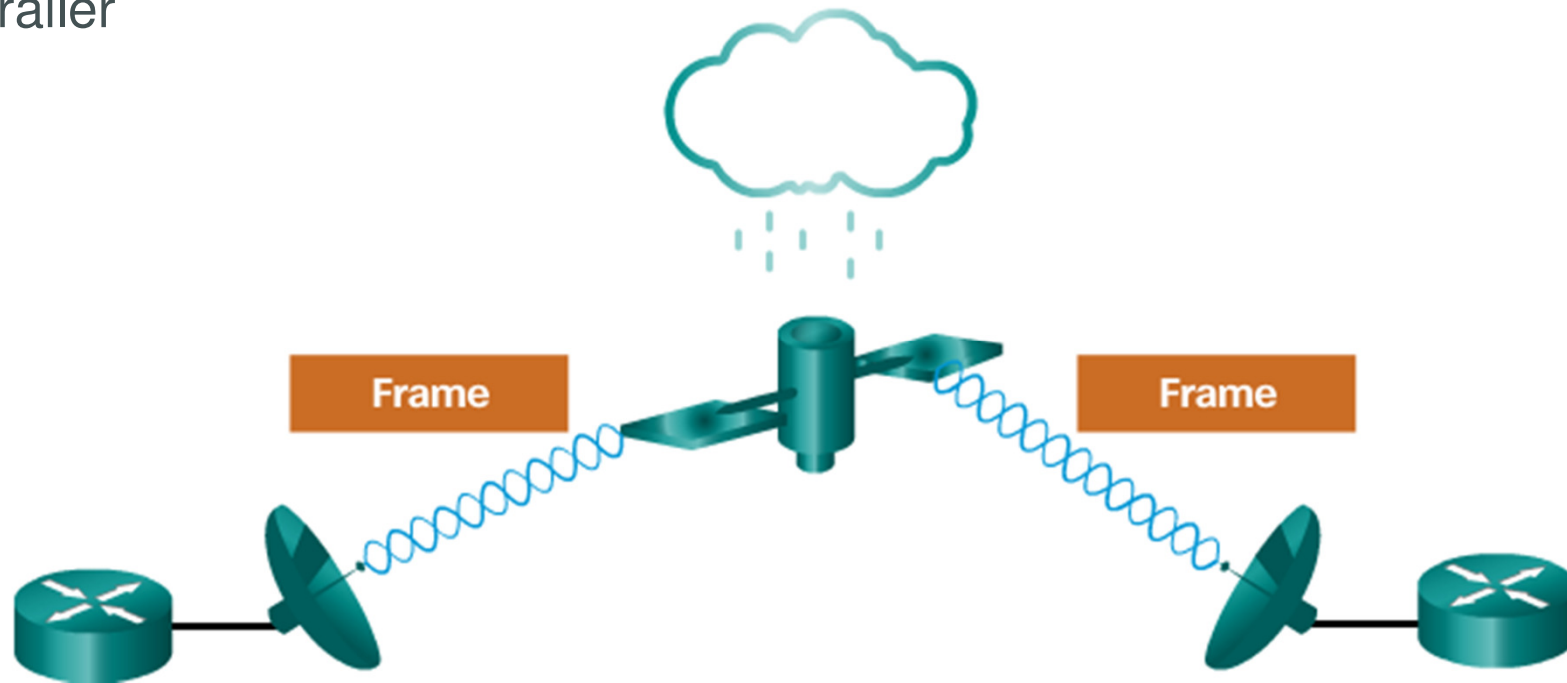
Topic 4.4.4: Data Link Frame



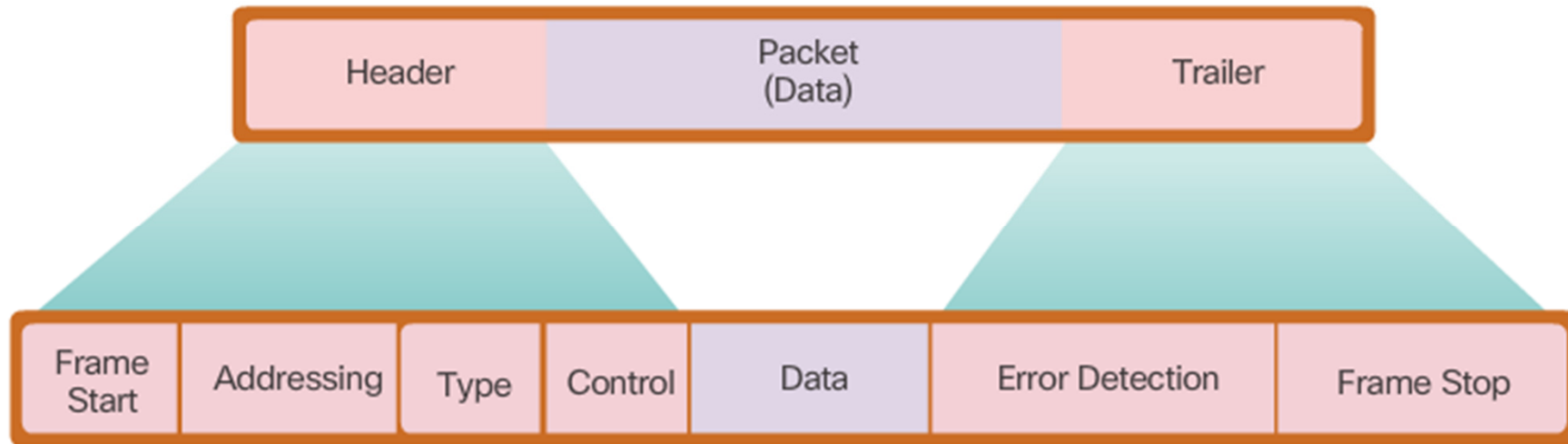
The Frame

Frames have three basic parts:

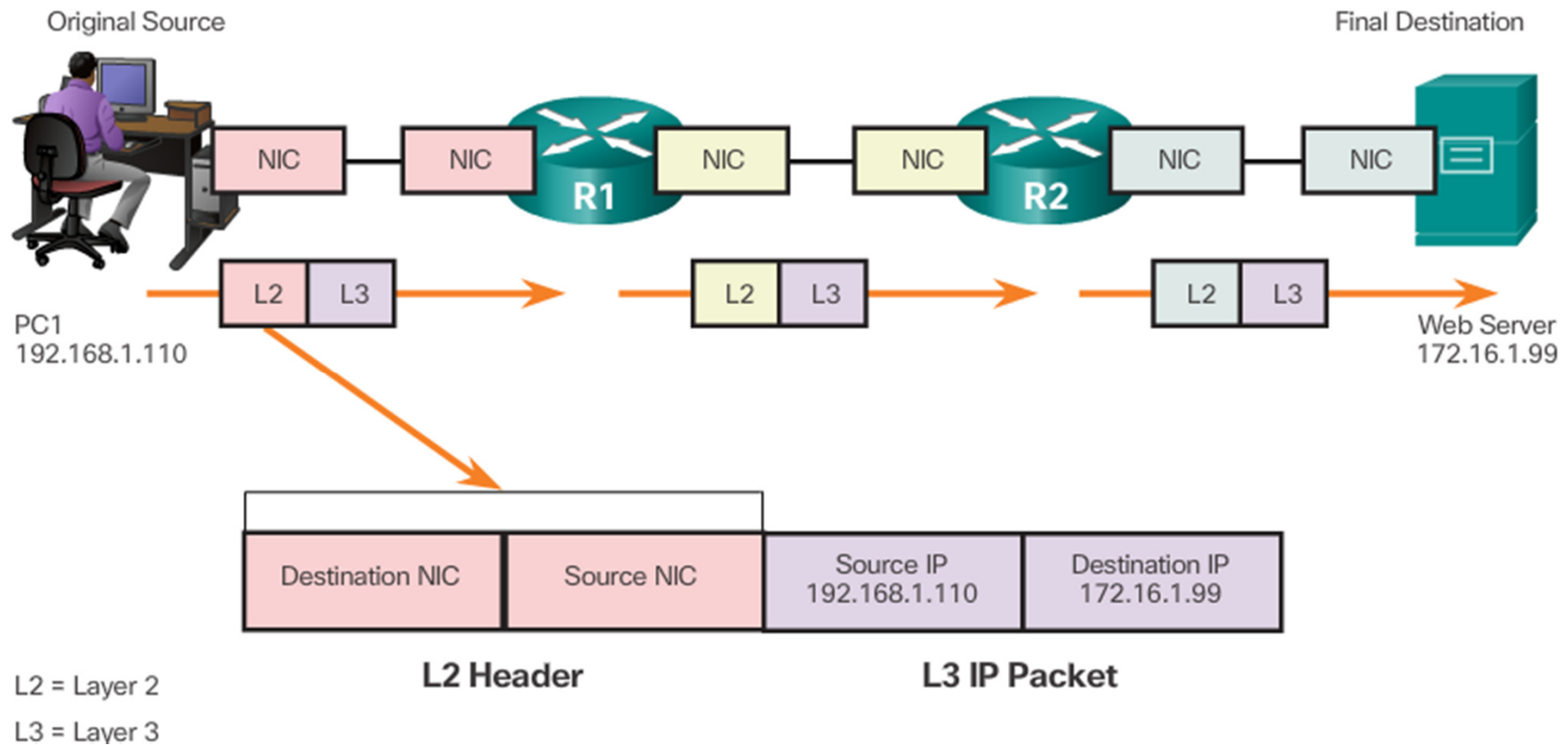
- Header
- Data
- Trailer



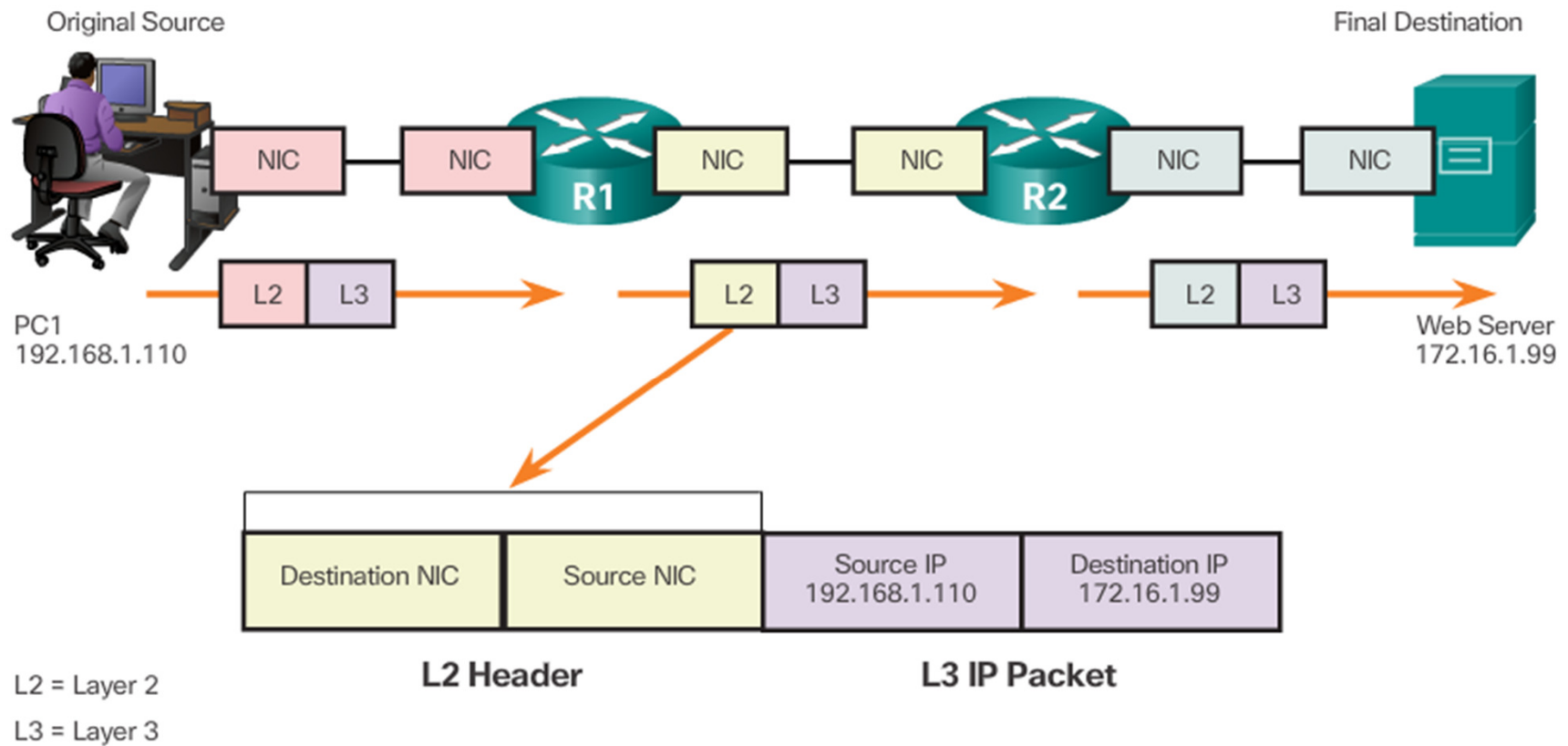
Frame Fields



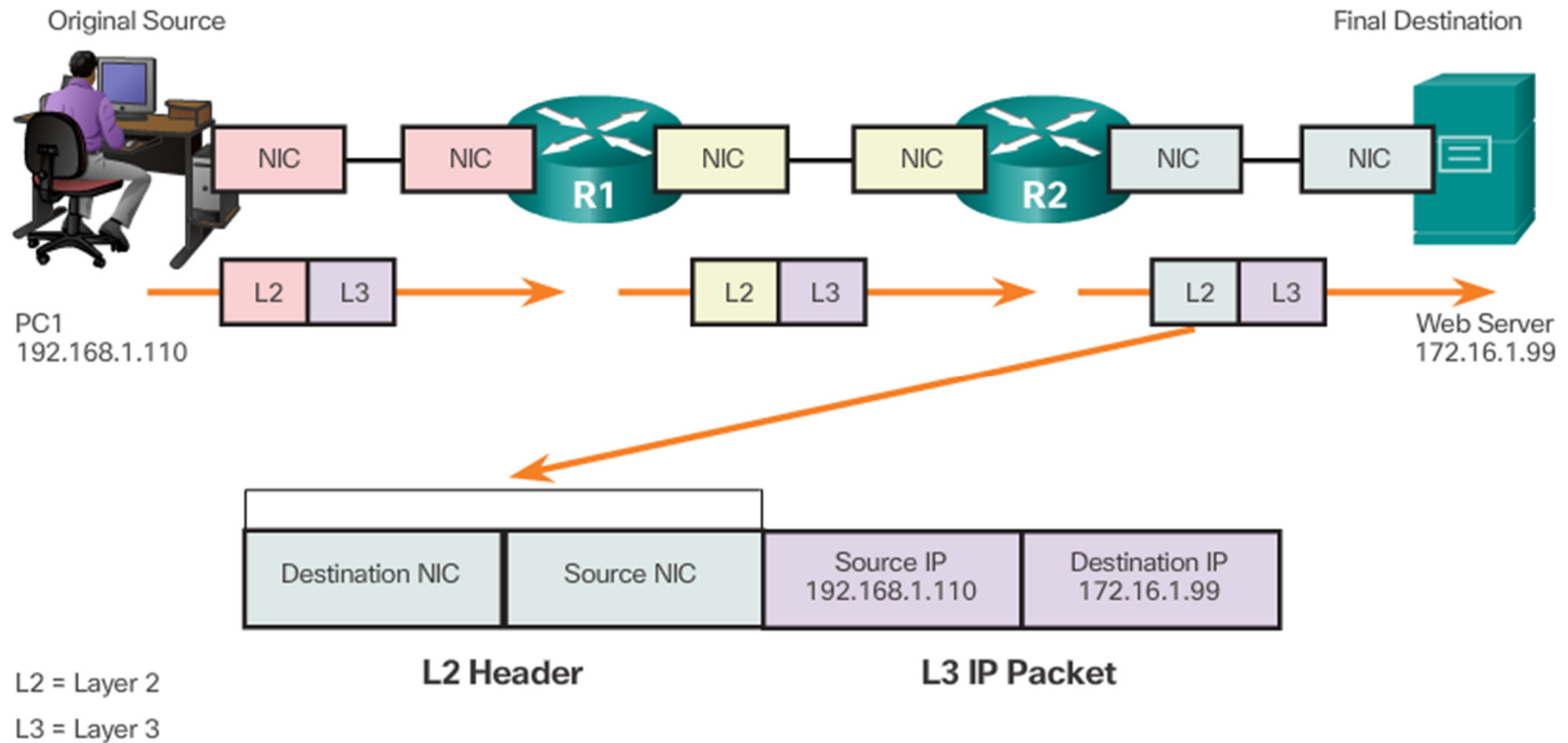
Layer 2 Address



Layer 2 Address (cont.)



Layer 2 Address (cont.)



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.



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