Cisco Networking Academy

CCNA R&S: Introduction to Networks

Chapter 4:

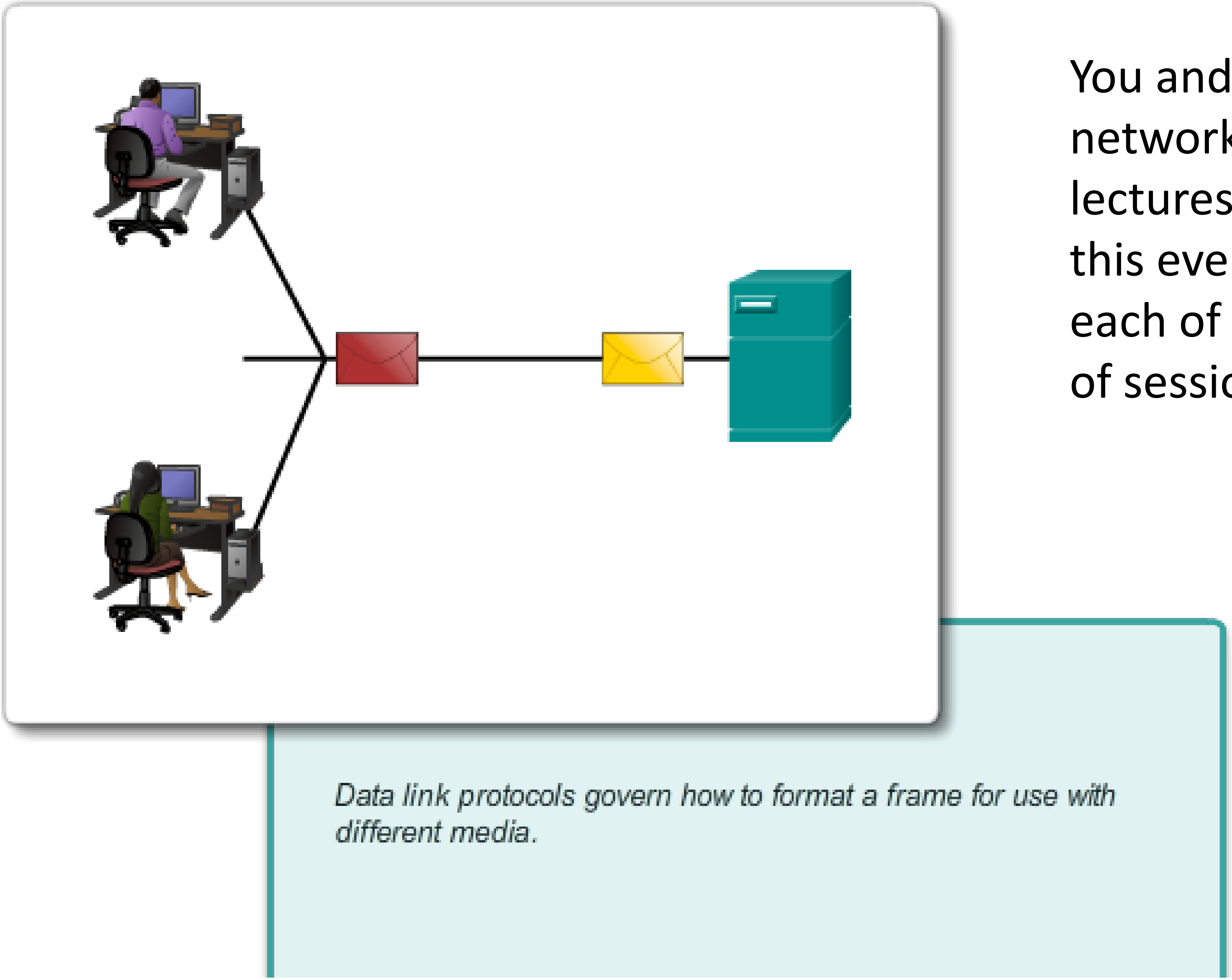
Network Access

4.0.1.1 Introduction

Upon completion of this chapter you will be able to:

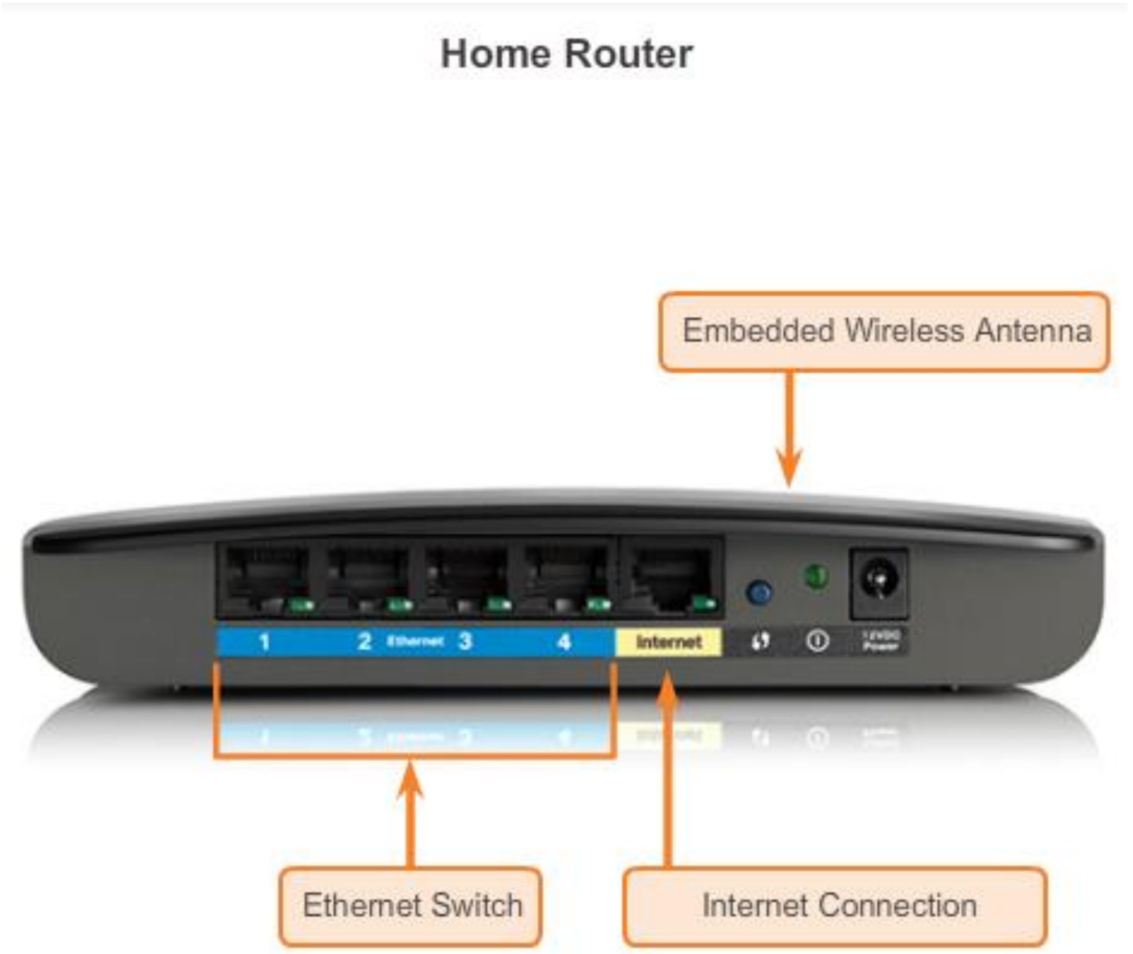
- Identify device connectivity options.
- Describe the purpose and functions of the physical layer in the network.
- Describe basic principles of the physical layer standards.
- Identify the basic characteristics of copper cabling.
- Build a UTP cable used in Ethernet networks.
- Describe fiber-optic cabling and its main advantages over other media.
- Describe wireless media.
- Select the appropriate media for a given requirement and connect devices.
- Describe the purpose and function of the data link layer in preparing communication for transmission on specific media.
- Describe the Layer 2 frame structure and identify generic fields.
- Identify several sources for the protocols and standards used by the data link layer.
- 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.

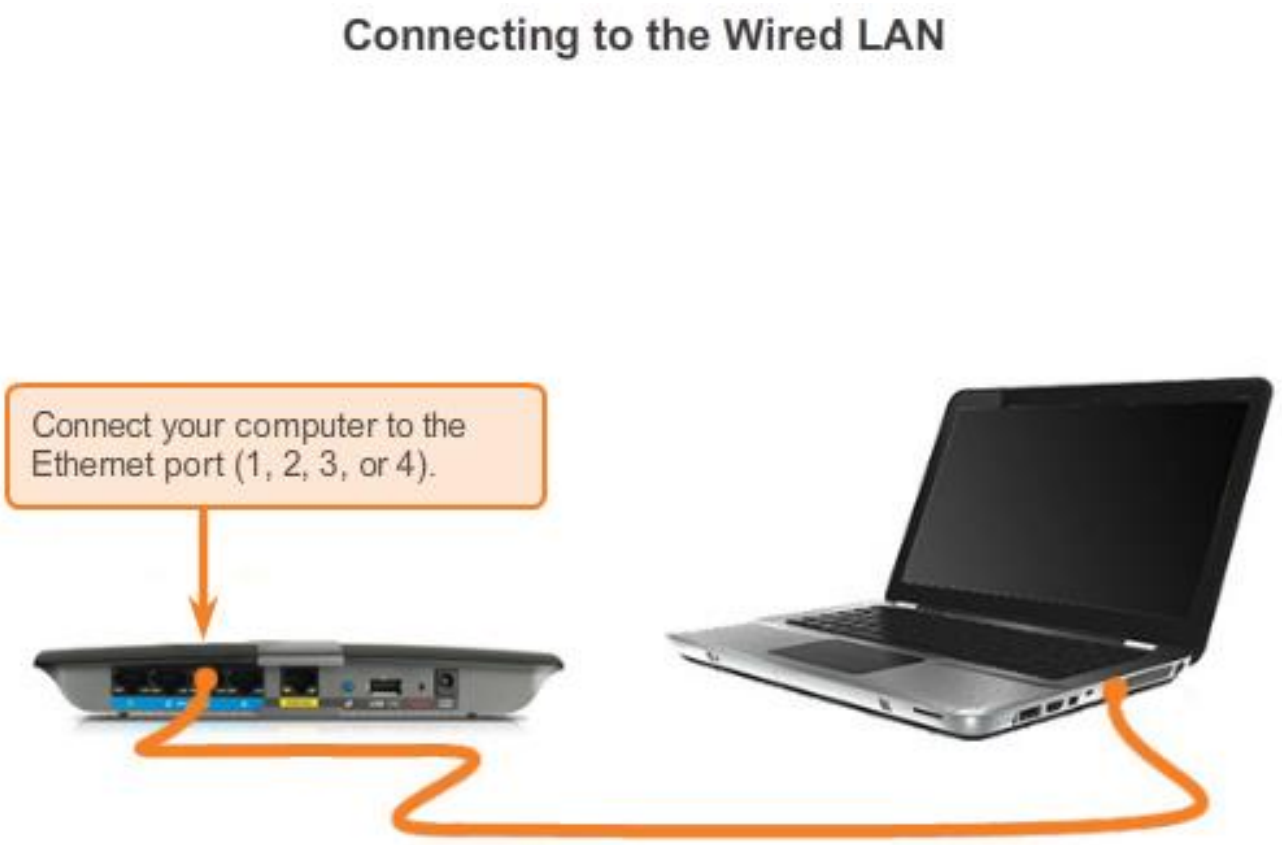
4.0.1.2 Activity – Managing the Medium



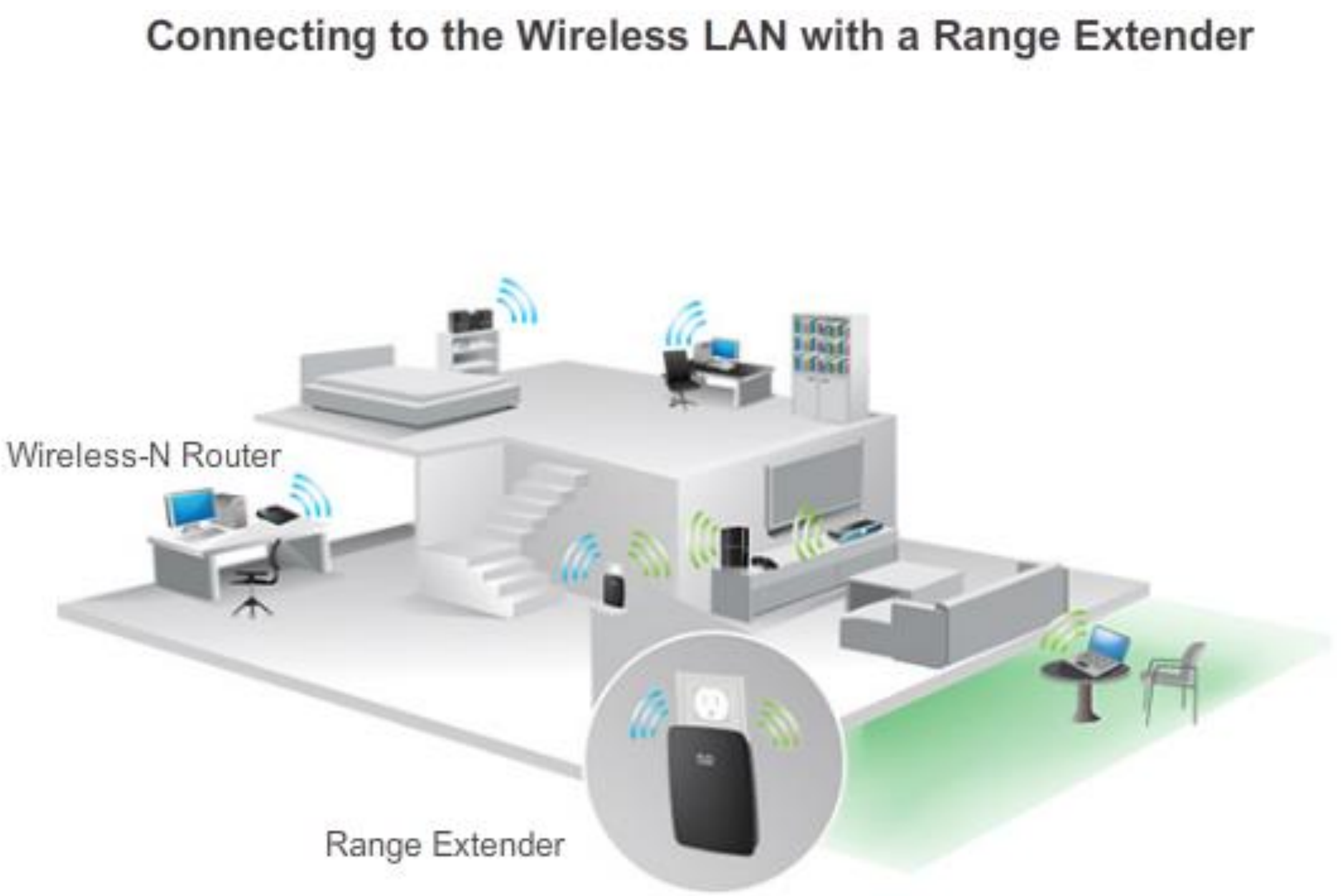
You and your colleague are attending a networking conference. There are many lectures and presentations held during this event, and because they overlap, each of you can only choose a limited set of sessions to attend.

4.1.1.1 Connecting to the Network



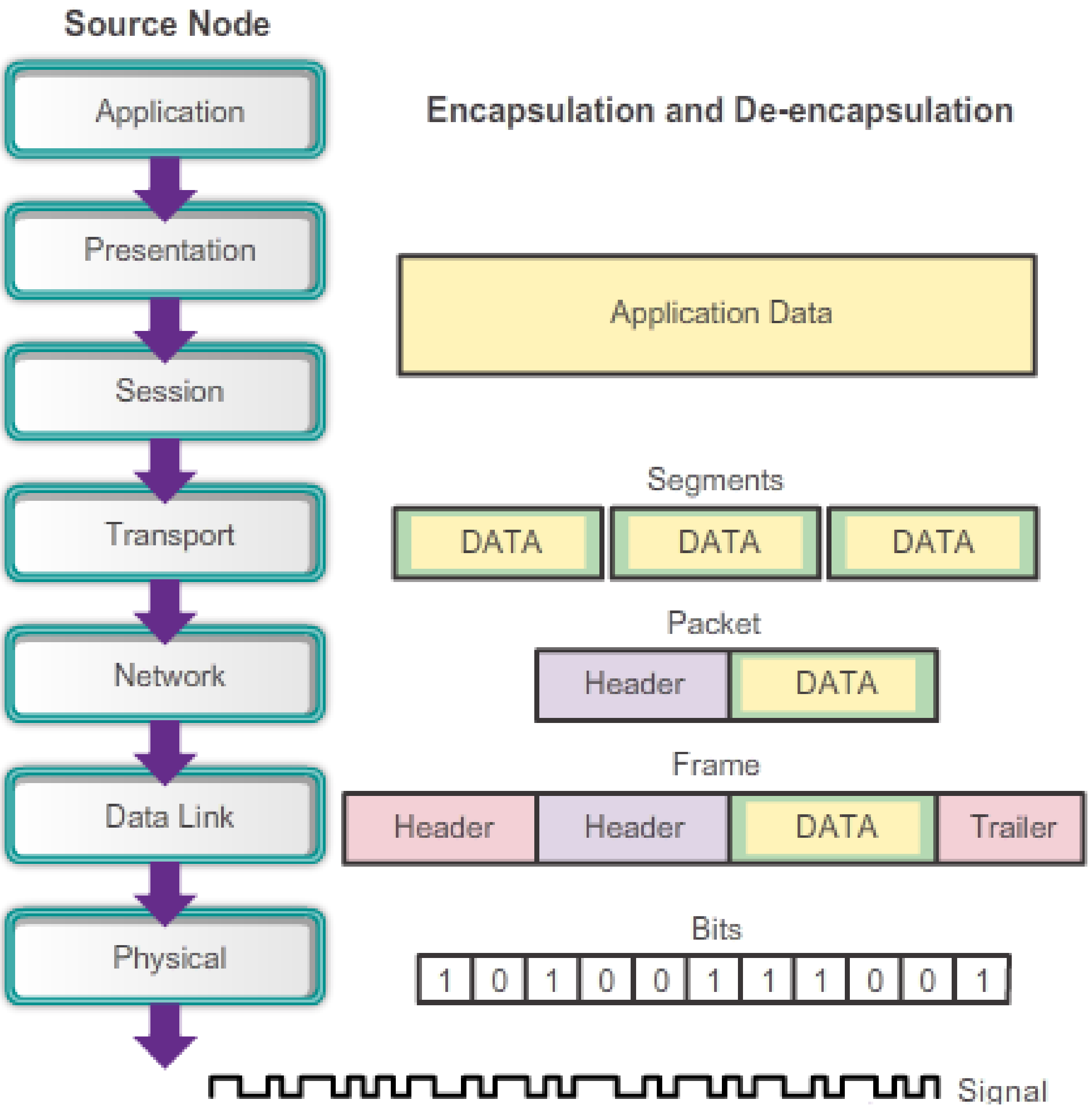


4.1.1.2 Network Interface Cards



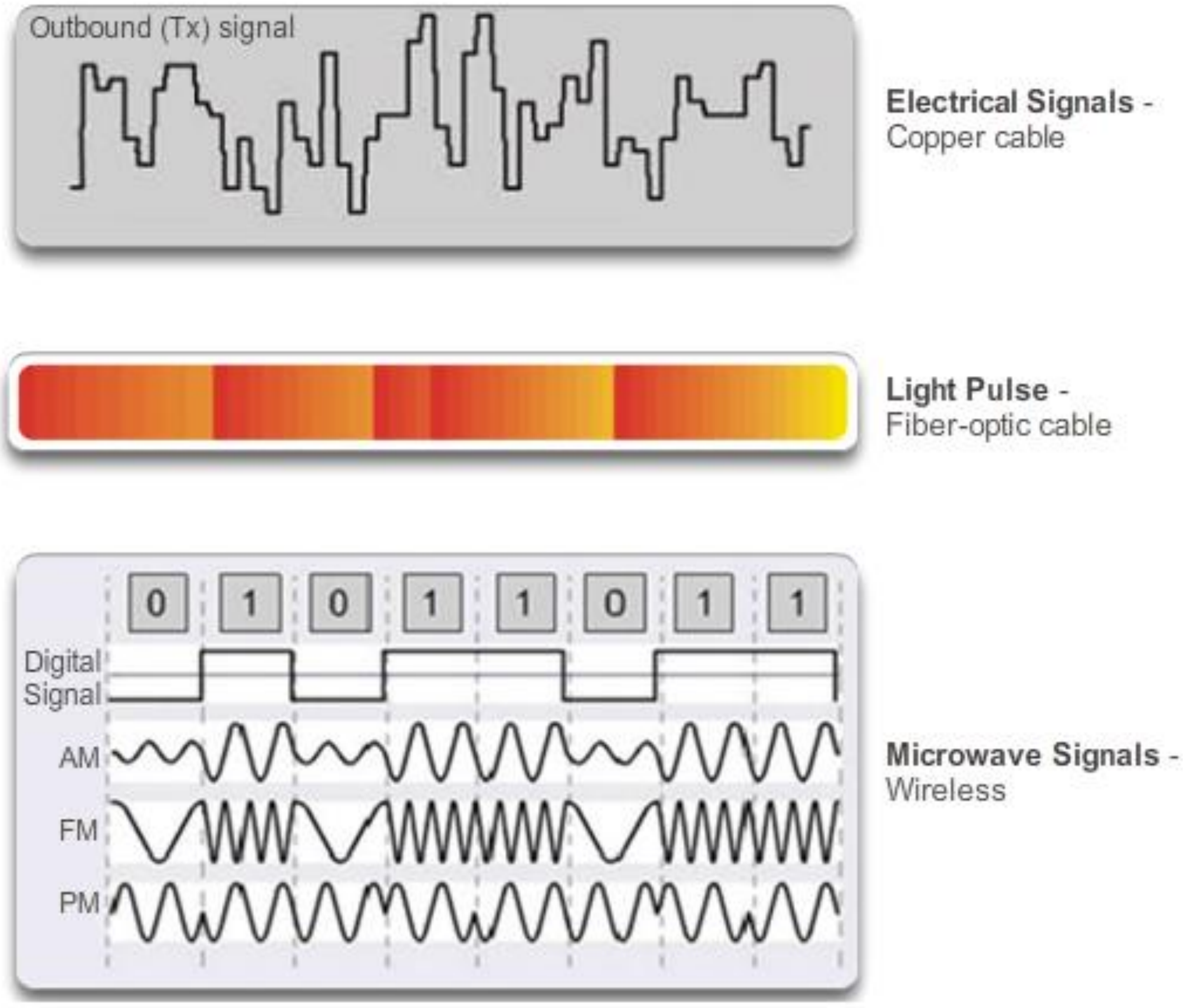
All wireless devices must share access to the airwaves connecting to the wireless access point. This means slower network performance may occur as more wireless devices access the network simultaneously. A wired device does not need to share its access to the network with other devices. Each wired device has a separate communications channel over its own Ethernet cable. This is important when considering some applications, like online gaming, streaming video, and video conferencing, which require more dedicated bandwidth than other applications.

4.1.2.1 The Physical Layer



The OSI physical layer provides the means to transport the bits that make up a data link layer frame across the network media. This layer accepts a complete frame from the data link layer and encodes it as a series of signals that are transmitted onto the local media. The encoded bits that comprise a frame are received by either an end device or an intermediate device.

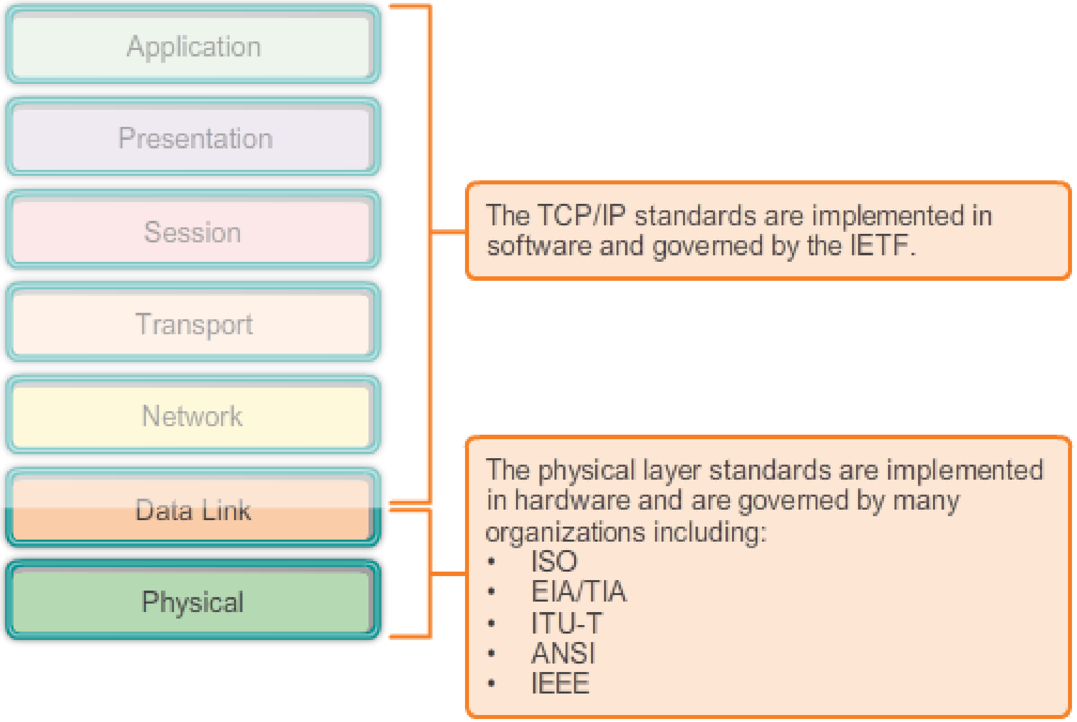
4.1.2.2 Physical Layer Media



There are three basic forms of network media.

- Copper cable: The signals are patterns of electrical pulses.
- Fiber-optic cable: The signals are patterns of light.
- Wireless: The signals are patterns of microwave transmissions

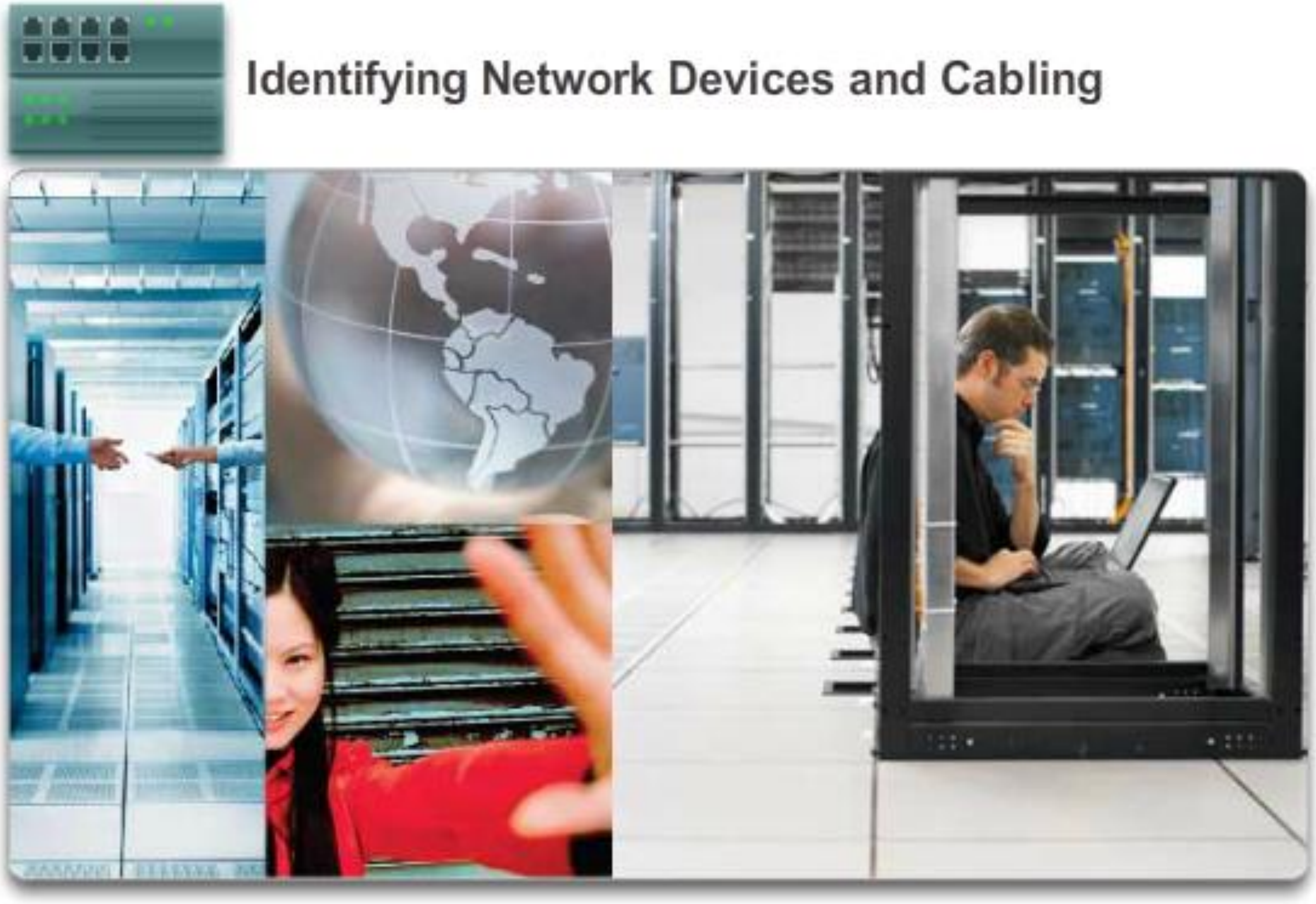
4.1.2.3 Physical Layer Standards



The protocols and operations of the upper OSI layers are performed in software designed by software engineers and computer scientists.

Standard Organization	Networking Standards
ISO	• ISO 8877: Officially adopted the RJ connectors (e.g., RJ-11, RJ-45). • ISO 11801: Network cabling standard similar to EIA/TIA 568.
EIA/TIA	• TIA-568-C: Telecommunications cabling standards, used by nearly all voice, video, and data networks. • TIA-569-B: Commercial Building Standards for Telecommunications Pathways and Spaces. • TIA-598-C: Fiber optic color coding. • TIA-942: Telecommunications Infrastructure Standard for Data Centers.
ANSI	568-C: RJ-45 pinouts. Co-developed with EIA/TIA.
ITU-T	G.992: ADSL
IEEE	• 802.3: Ethernet • 802.11: Wireless LAN (WLAN) & Mesh (Wi-Fi certification) • 802.15: Bluetooth

4.1.2.4 Lab - Identifying Network Devices and Cabling



In this lab, you will complete the following objectives:

- Part 1: Identify Network Devices
- Part 2: Identify Network Media

4.1.3.1 Physical Layer Fundamental Principles

Media	Physical Components	Frame Encoding Technique	Signalling Method
Copper cable	• UTP • Coaxial • Connectors • NICs • Ports • Interfaces	• Manchester Encoding • Non-Return to Zero (NRZ) techniques • 4B/5B codes are used with Multi-Level Transition Level 3 (MLT-3) signaling • 8B/10B • PAM5	• Changes in the electromagnetic field • Intensity of the electromagnetic field • Phase of the electromagnetic wave

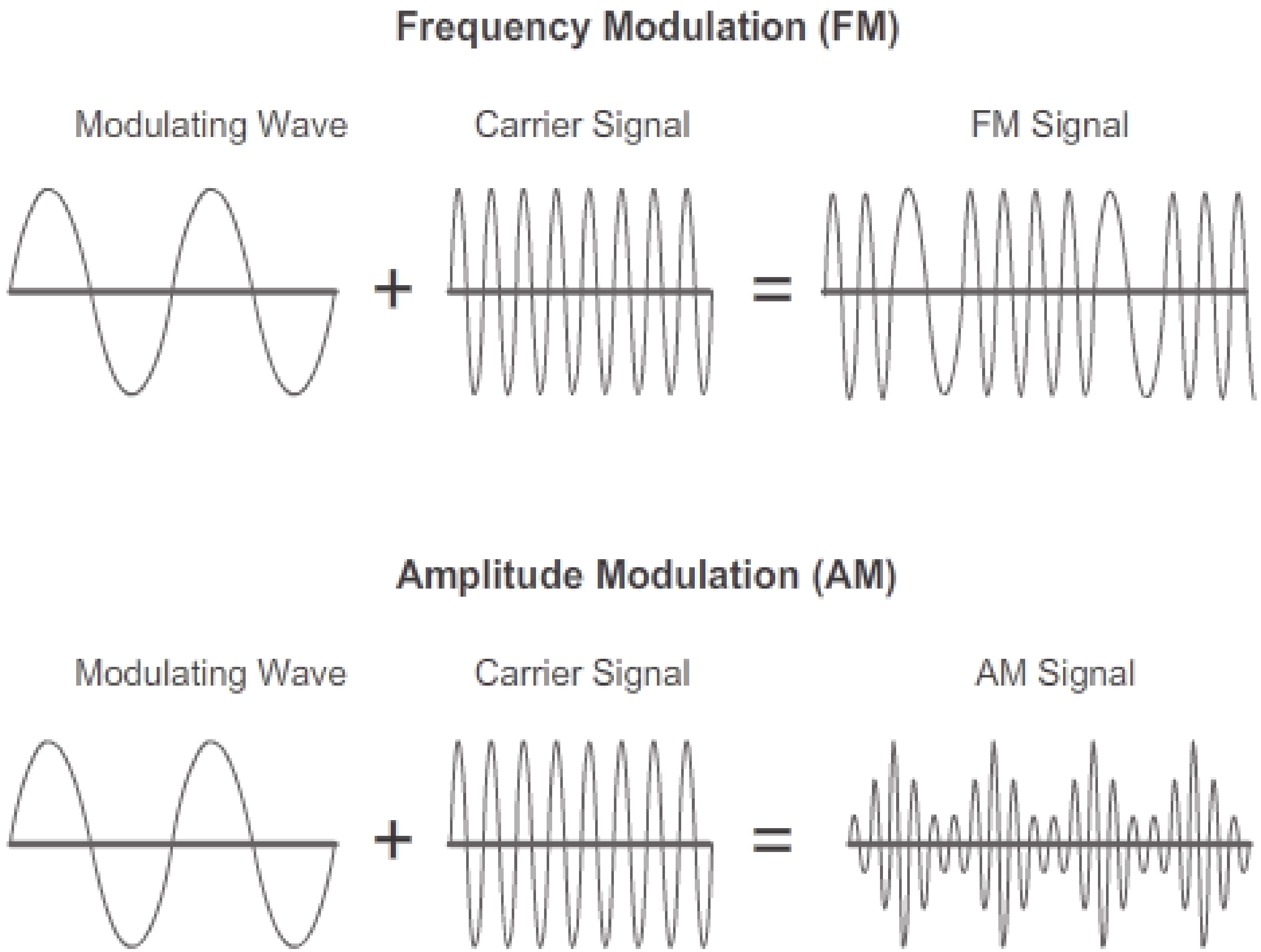
Encoding or line encoding is a method of converting a stream of data bits into a predefined "code".

Codes are groupings of bits used to provide a predictable pattern that can be recognized by both the sender and the received.

In the case of networking, encoding is a **pattern of voltage or current** used to represent bits; the 0s and 1s.

In addition to creating codes for data, encoding methods at the physical layer may also provide codes for **control purposes** such as identifying the beginning and end of a frame.

4.1.3.1 Physical Layer Fundamental Principles



Signals can be transmitted in one of two ways:

- **Asynchronous**: Data signals are transmitted without an associated clock signal. The time spacing between data characters or blocks may be of arbitrary duration, meaning the spacing is not standardized. Therefore, frames require start and stop indicator flags.

- **Synchronous**: Data signals are sent along with a clock signal which occurs at evenly spaced time durations referred to as the bit time.

4.1.3.2 Bandwidth

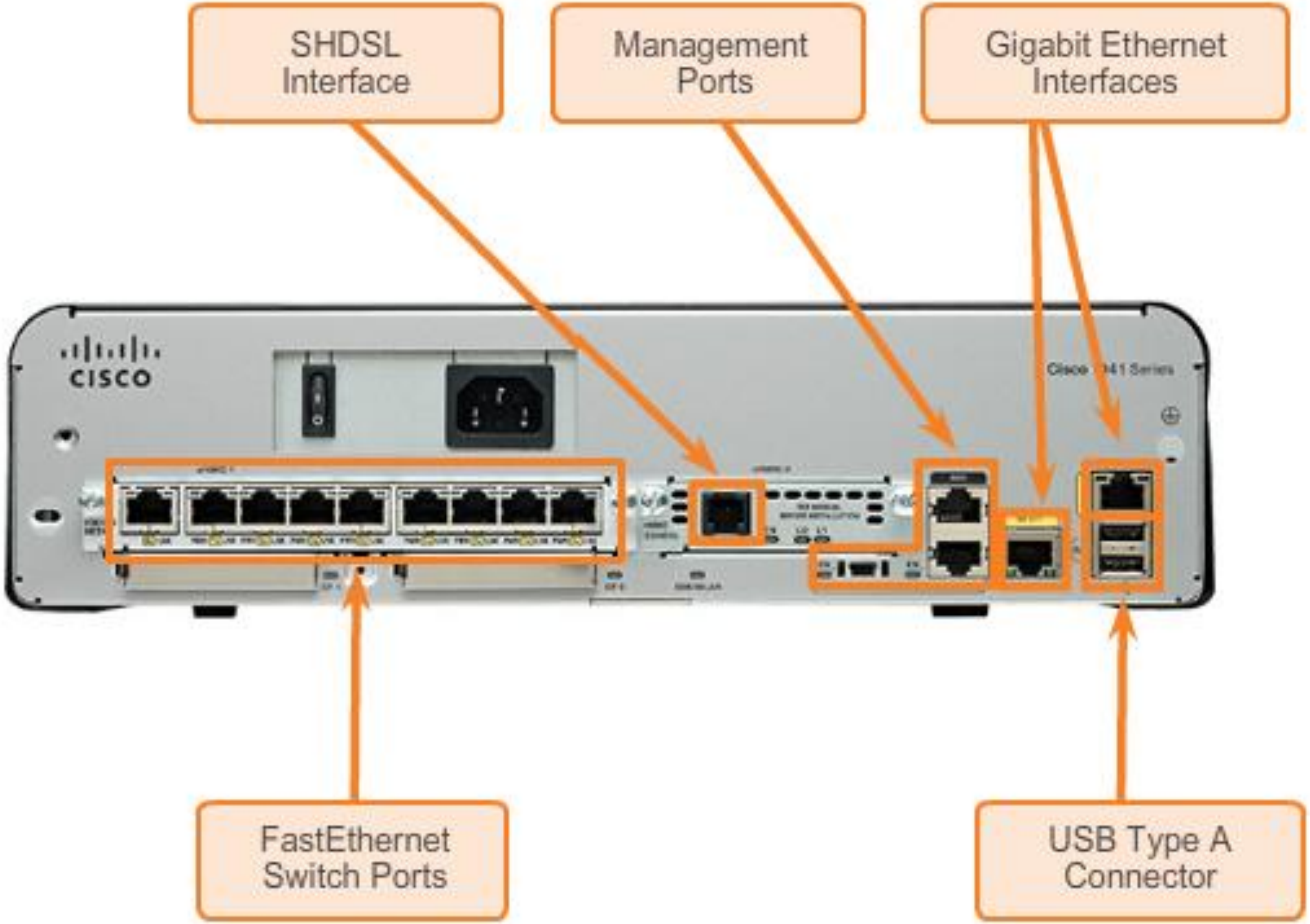
Unit of Bandwidth	Abbreviation	Equivalence
Bits per second	b/s	1 b/s = fundamental unit of bandwidth
Kilobits per second	kb/s	1 kb/s = 1,000 b/s = 10^3 b/s
Megabits per second	Mb/s	1 Mb/s = 1,000,000 b/s = 10^6 b/s
Gigabits per second	Gb/s	1 Gb/s = 1,000,000,000 b/s = 10^9 b/s
Terabits per second	Tb/s	1 Tb/s = 1,000,000,000,000 b/s = 10^12 b/s

4.1.3.3 Throughput

In an internetwork or network with multiple segments, throughput cannot be faster than the slowest link of the path from source to destination. Even if all or most of the segments have high bandwidth, it will only take one segment in the path with low throughput to create a bottleneck to the throughput of the entire network.

Goodput is the amount of usable data that traverses the media over a given period of time

4.1.3.4 Types of Physical Media



As an example, standards for copper media are defined for the:

- Type of copper cabling used
- Bandwidth of the communication
- Type of connectors used
- Pinout and color codes of connections to the media
- Maximum distance of the media

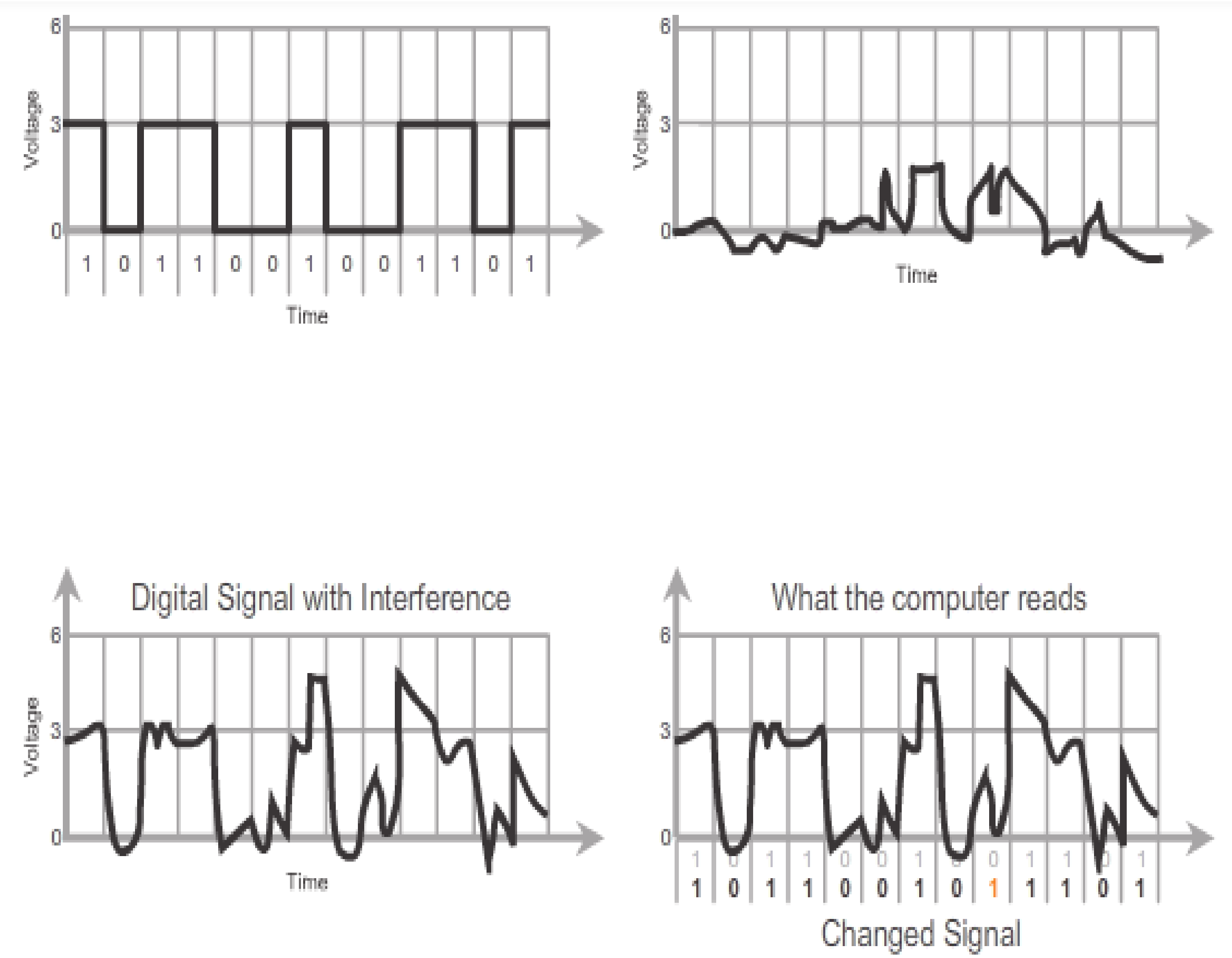
4.1.3.5 Activity - Physical Layer Terminology

Term	Physical Layer Description
Physical components	Hardware devices, media, and connectors which transmit and carry bit signals
Signaling method	How 1s and 0s are represented on the media – varies, depending on encoding scheme
Synchronous	Evenly spaced time duration for signals
Frame encoding	A method for converting streams of data bits into groupings of bits – predefined
Asynchronous	Arbitrarily spaced time duration for signals

4.1.3.5 Activity - Physical Layer Terminology

Goodput	How much useable data is transferred over a given amount of time
Bandwidth	Amount of data that is allowed by the medium to flow during a given set of time
Throughput	The actual measure of data bits over a given period of time
Pulse-coded modulation	A technique to convert voice analog to digital signals
Frequency modulation	Transmission method where the carrier frequency varies according to the signals sent

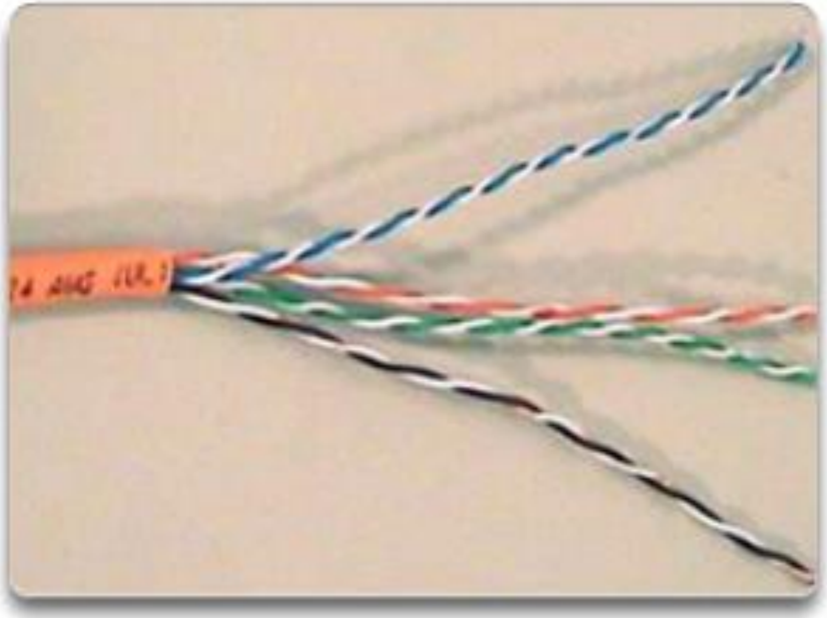
4.2.1.1 Characteristics of Copper Media



The timing and voltage values of the electrical pulses are also susceptible to interference from two sources:

- **Electromagnetic interference (EMI)** or radio frequency interference (RFI) - EMI and RFI signals can distort and corrupt the data signals being carried by copper media..
- **Crosstalk** - Crosstalk is a disturbance caused by the electric or magnetic fields of a signal on one wire to the signal in an adjacent wire.

4.2.1.2 Copper Media

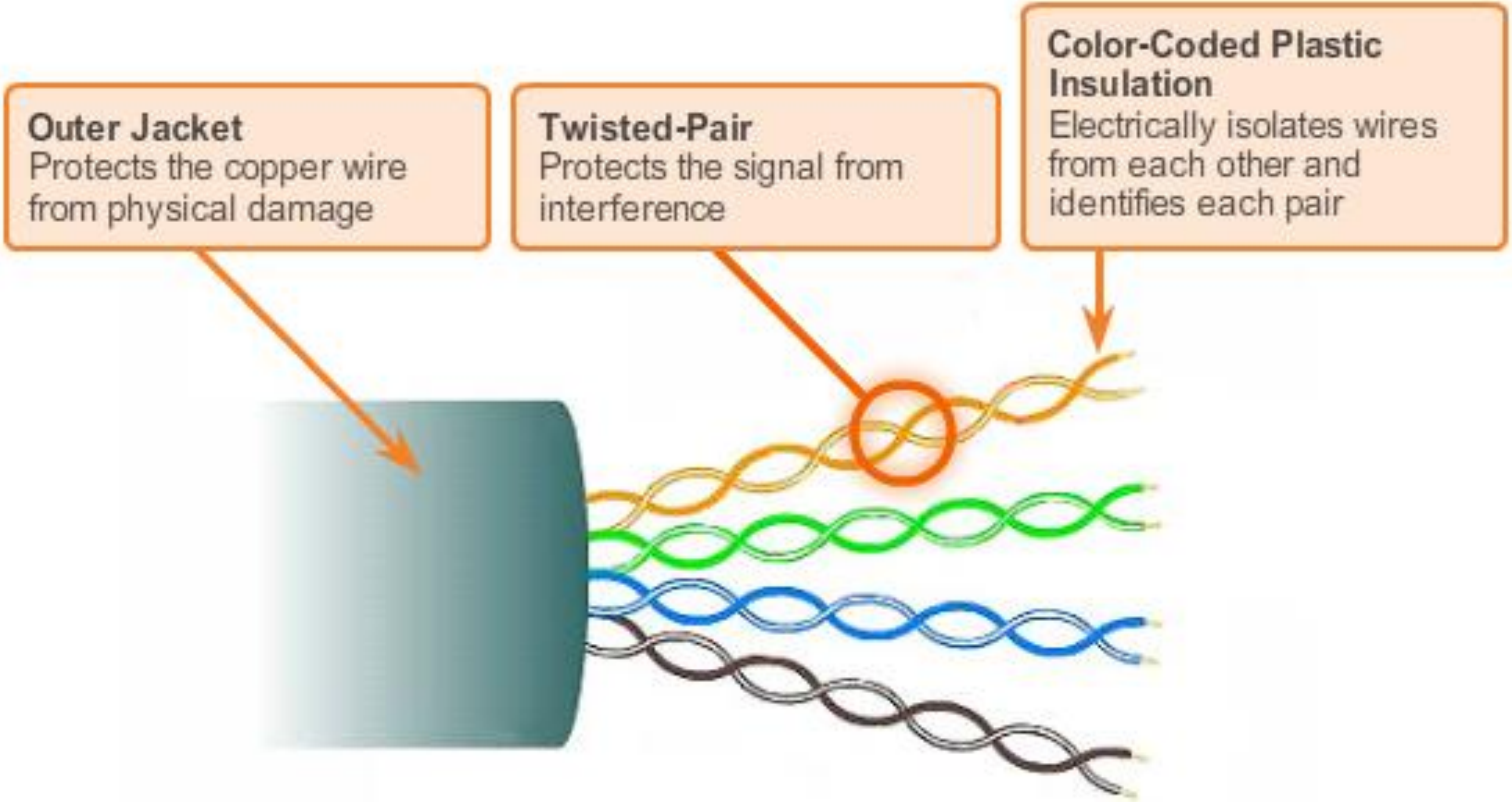


Unshielded Twisted-Pair (UTP) cable

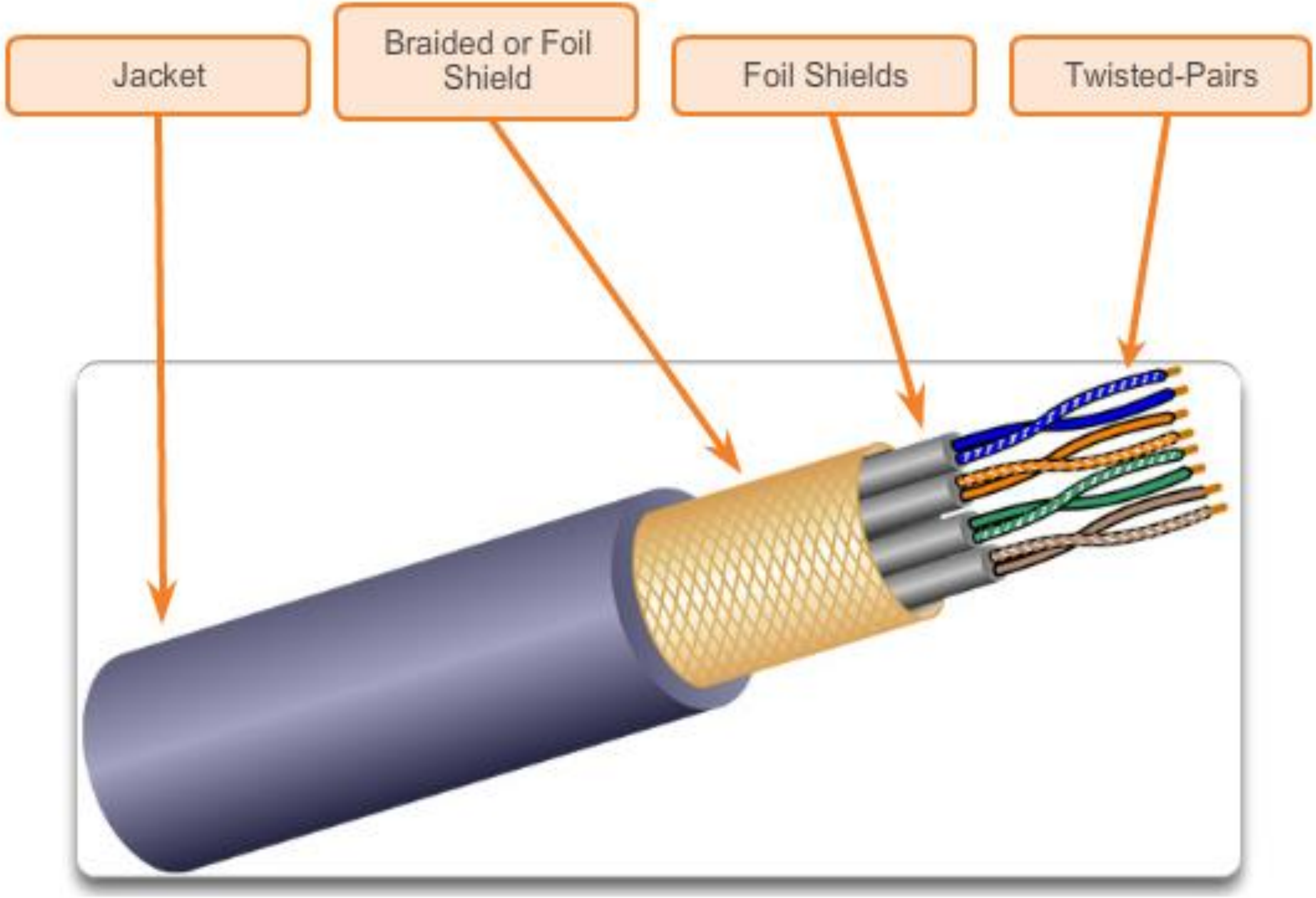
Shielded Twisted-Pair
(STP) cable

Coaxial cable

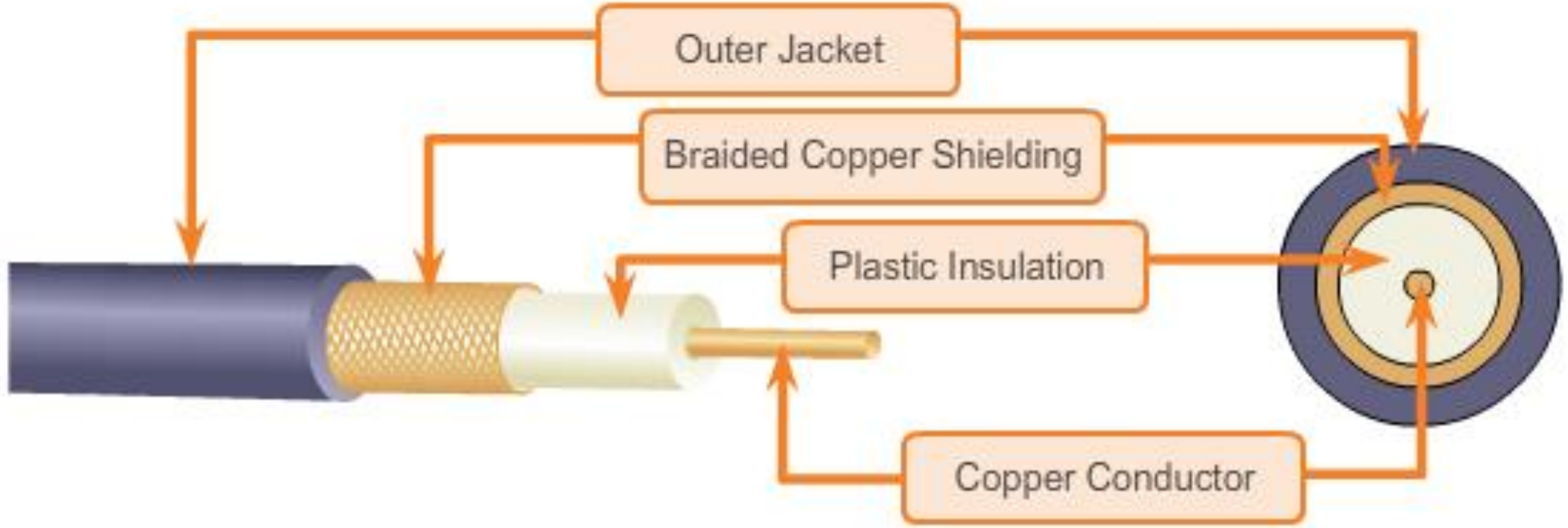
4.2.1.3 Unshielded Twisted-Pair Cable



4.2.1.4 Shielded Twisted-Pair (STP) Cable



4.2.1.5 Coaxial Cable



4.2.1.6 Copper Media Safety

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

Cables must be connected correctly.

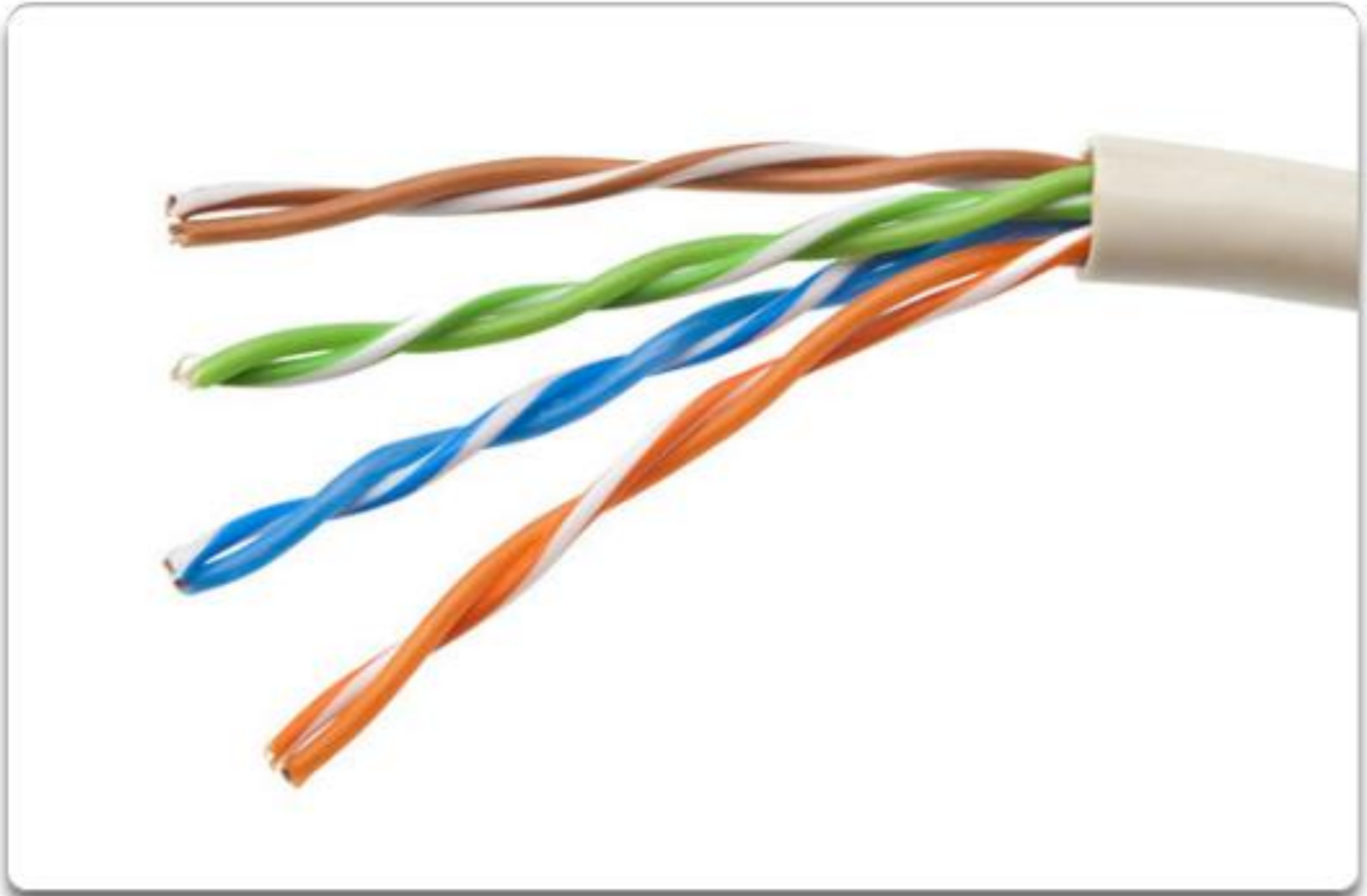
Installations must be inspected for damage.

Equipment must be grounded correctly.

4.2.1.7 Activity - Copper Media Characteristics

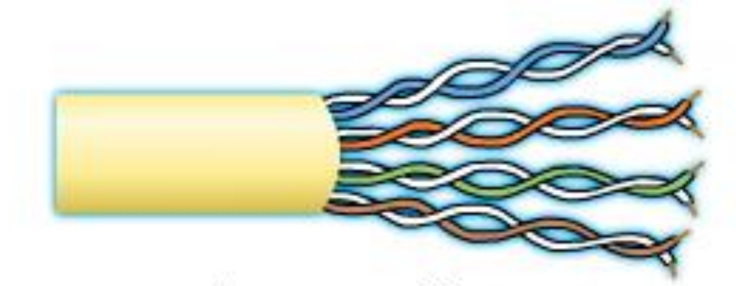
	UTP	STP	Coaxial
1. The new Ethernet 10GB standard uses this form of copper media		✓	
2. Attaches antennas to wireless devices – can be bundled with fiber optic cabling for two-way data transmission			✓
3. Counters EMI and RFI by using shielding techniques and special connectors		✓	
4. Most common network media	✓		
5. Terminates with BNC, N type and F type connectors			✓

4.2.2.1 Properties of UTP Cabling

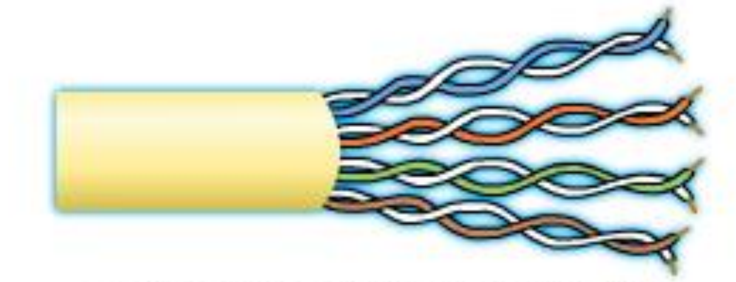


- Cancellation: Designers now pair wires in a circuit. When two wires in an electrical circuit are placed close together, their magnetic fields are the exact opposite of each other. Therefore, the two magnetic fields cancel each other out and also cancel out any outside EMI and RFI signals.

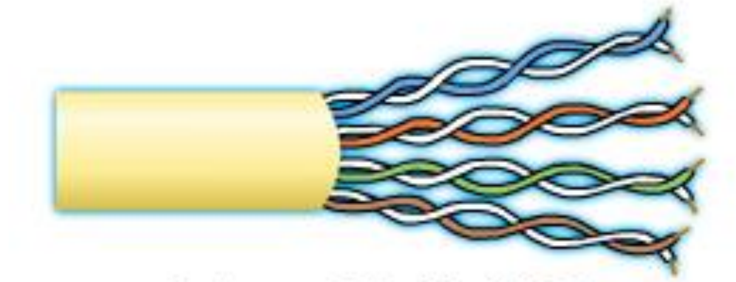
4.2.2.2 UTP Cabling Standards



Category 3 Cable (UTP)



Category 5 and 5e Cable (UTP)



Category 6 Cable (UTP)

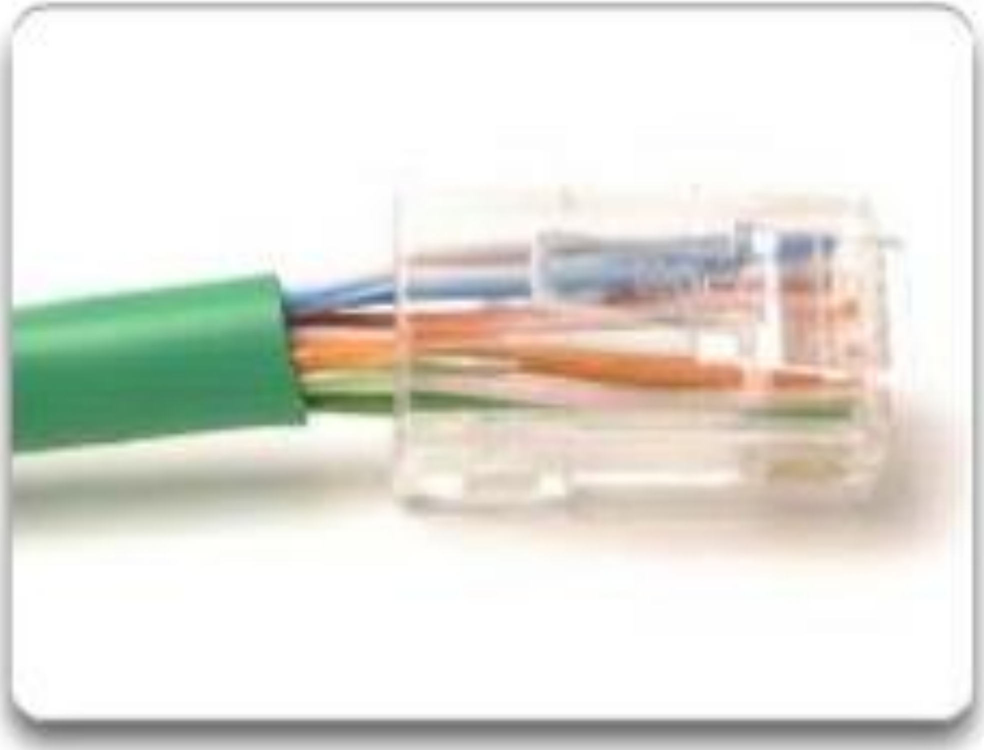
Cables are placed into categories according to their ability to carry higher bandwidth rates. For example, Category 5 (Cat5) cable is used commonly in 100BASE-TX FastEthernet installations. Other categories include Enhanced Category 5 (Cat5e) cable, Category 6 (Cat6), and Category 6a.

4.2.2.3 UTP Connectors

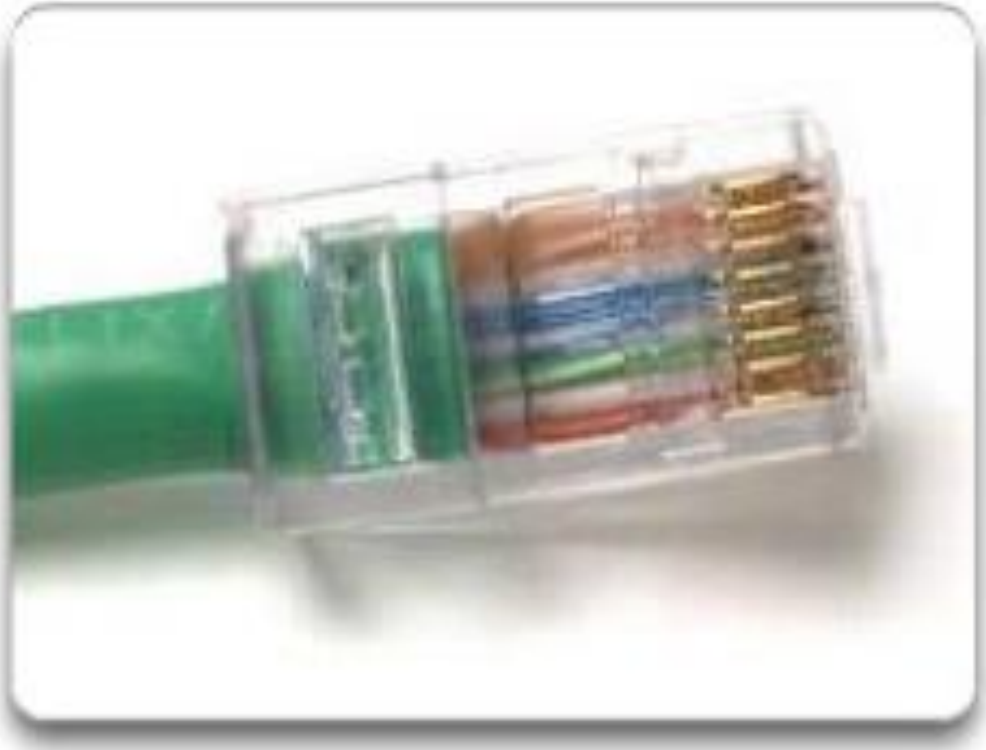
RJ-45 UTP Plugs

RJ-45 UTP Socket

4.2.2.3 UTP Connectors

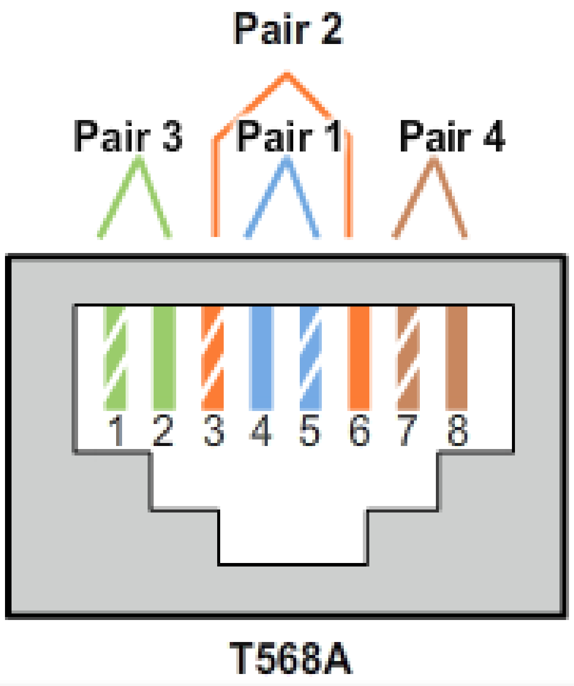


Bad connector - Wires are exposed, untwisted, and not entirely covered by the sheath.



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

4.2.2.4 Types of UTP Cable



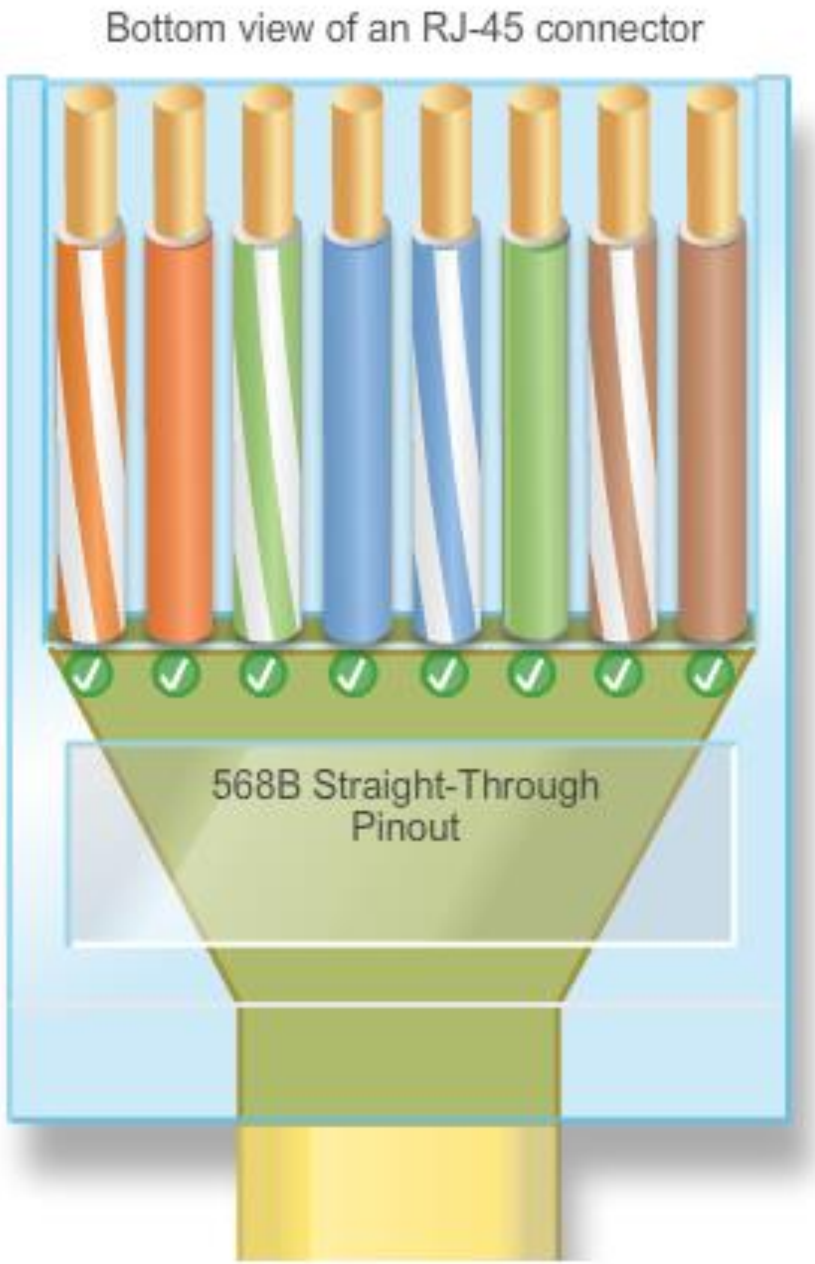
Cable Type	Standard	Application
Ethernet Straight-through	Both ends T568A or both ends T568B	Connects a network host to a network device such as a switch or hub.
Ethernet Crossover	One end T568A, other end T568B	• Connects two network hosts • Connects two network intermediary devices (switch to switch,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

4.2.2.5 Testing UTP Cables

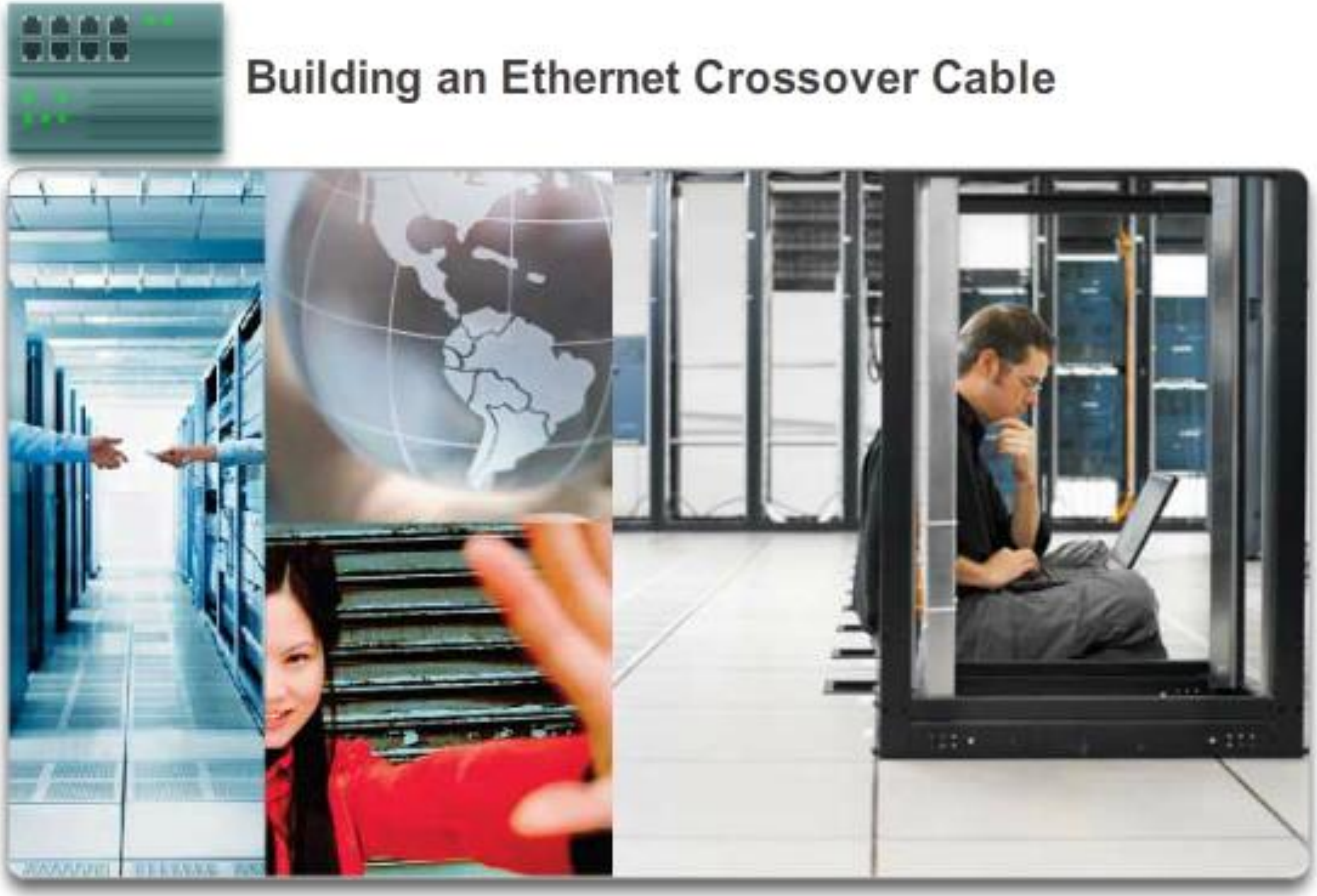
After installation, a UTP cable tester should be used to test for the following parameters:

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

4.2.2.6 Activity - Cable Pinouts



4.2.2.7 Lab - Building an Ethernet Crossover Cable

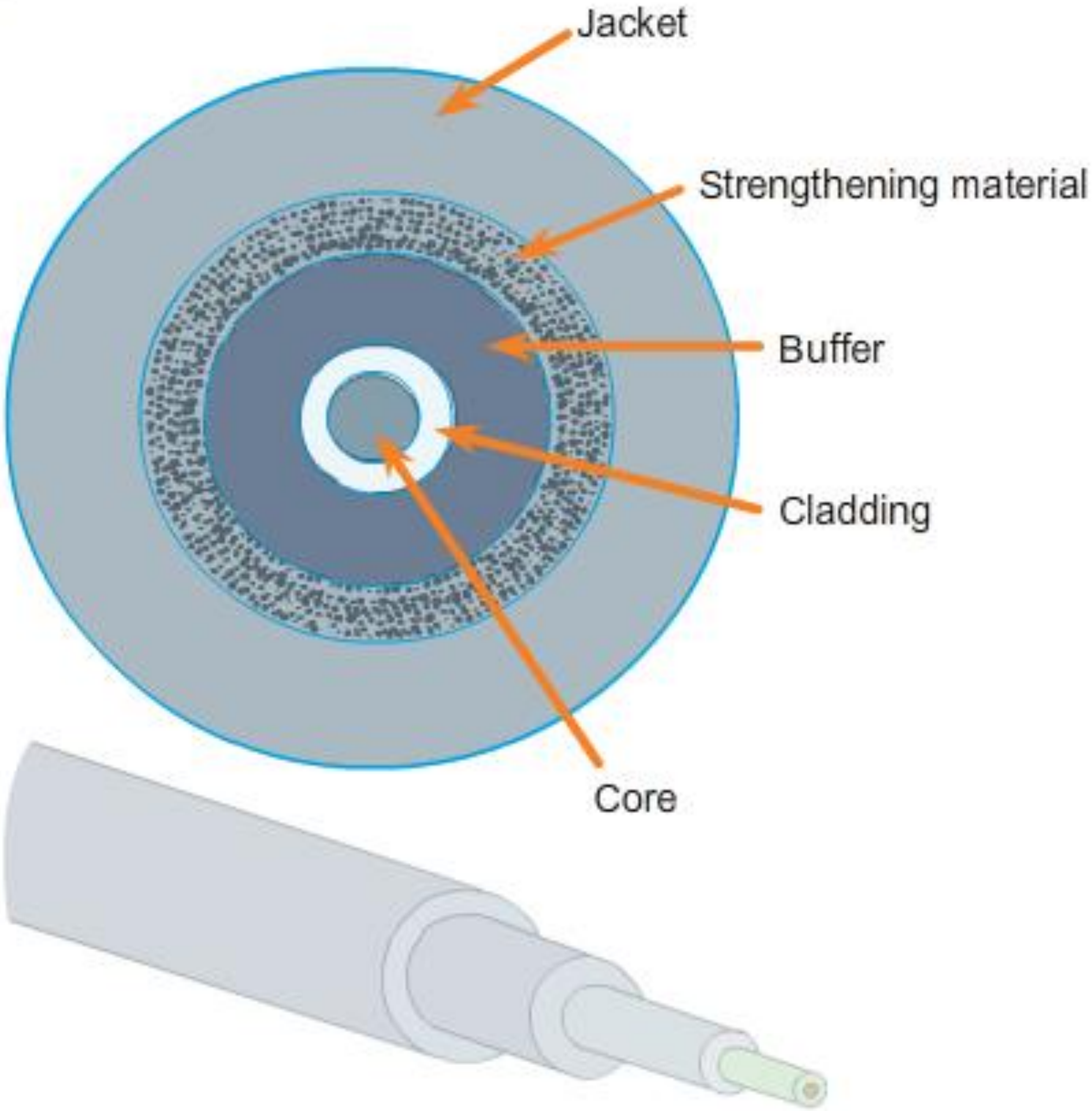


4.2.3.1 Properties of Fiber Optic Cabling

Optical fiber cable has become very popular for interconnecting infrastructure network devices. It permits the transmission of data over longer distances and at higher bandwidths (data rates) than any other networking media.

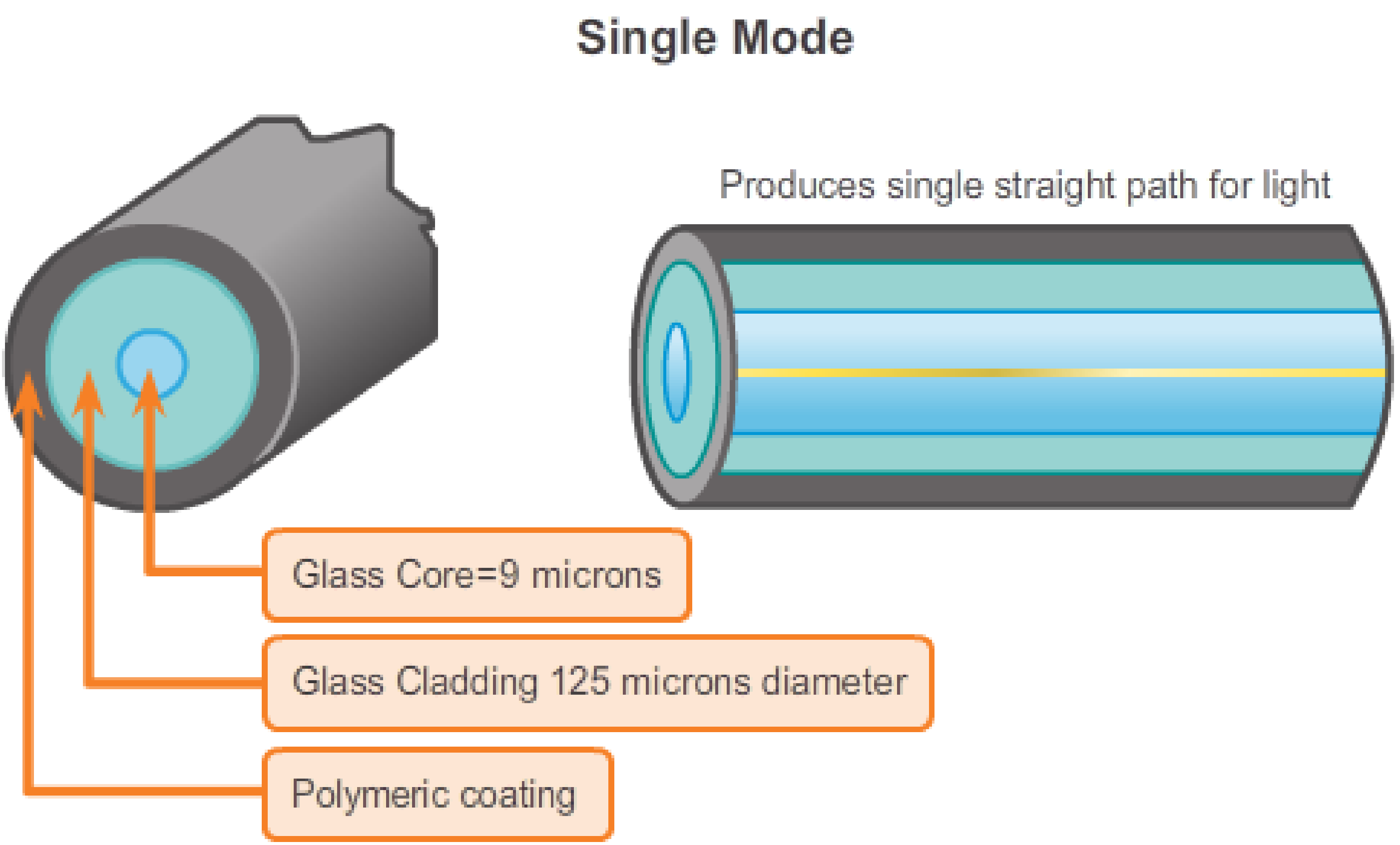
Unlike copper wires, fiber-optic cable can transmit signals with less attenuation and is completely immune to EMI and RFI.

4.2.3.2 Fiber Media Cable Design



- **Core**: Consists of pure glass and is the part of the fiber where light is carried.
- **Cladding**: The glass that surrounds the core and acts as a mirror. The light pulses propagate down the core while the cladding reflects the light pulses. This keeps the light pulses contained in the fiber core in a phenomenon known as **total internal reflection**.

4.2.3.3 Types of Fiber Media

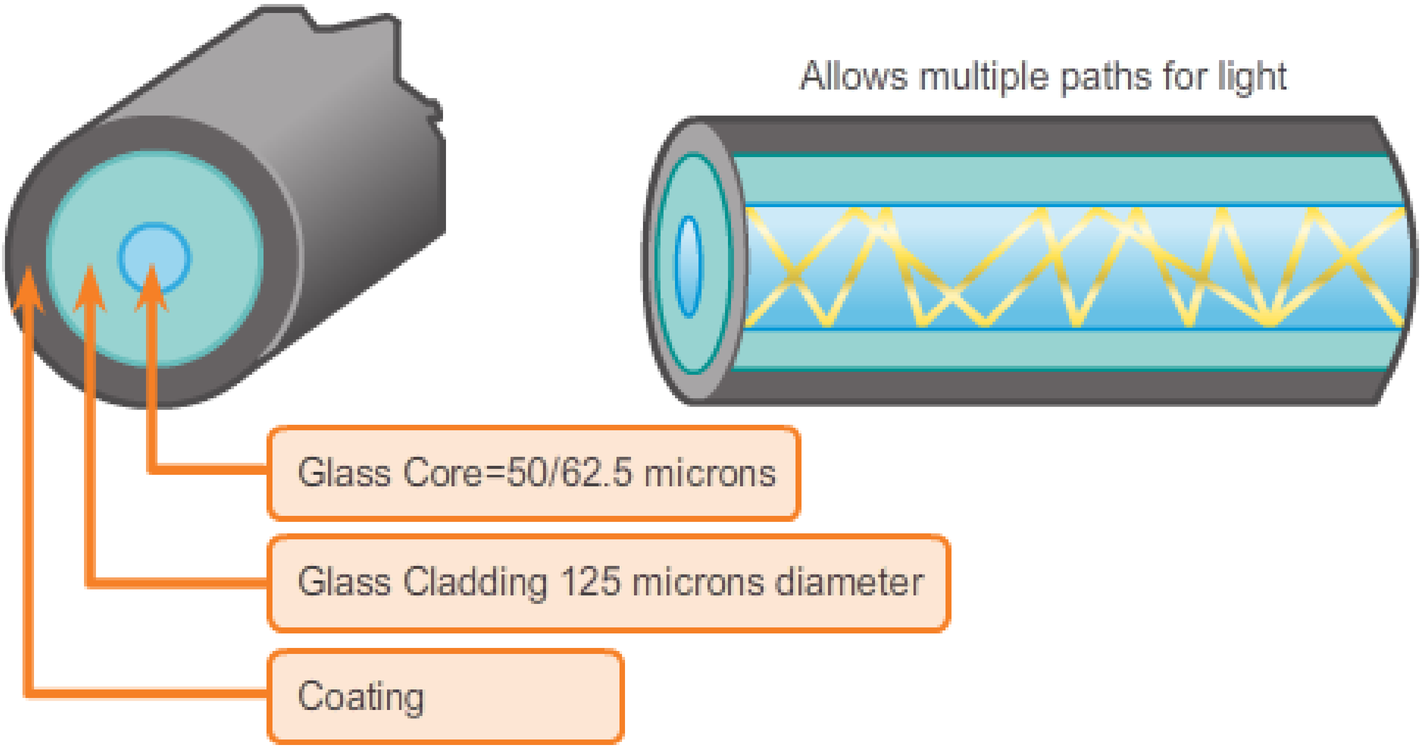


- Small core
- Less dispersion
- Suited for long distance applications
- Uses lasers as the light source
- Commonly used with campus backbones for distances of several thousand meters

Single-mode fiber (SMF): Consists of a very small core and uses expensive laser technology to send a single ray of light. Popular in long-distance situations spanning hundreds of kilometers such as required in long haul telephony and cable TV applications.

4.2.3.3 Types of Fiber Media

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

Multimode fiber (MMF): Consists of a larger core and uses LED emitters to send light pulses. Specifically, light from an LED enters the multimode fiber at different angles. Popular in LANs because they can be powered by low cost LEDs. It provides bandwidth up to 10 Gb/s over link lengths of up to 550 meters.

4.2.3.4 Network Fiber Connectors

Fiber Optic Connectors

ST Connectors

SC Connectors

LC Connector

Duplex Multimode LC Connectors

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

4.2.3.5 Testing Fiber Cables

Optical Time Domain Reflectometer (OTDR)

Three common types of fiber-optic termination and splicing errors are:

- Misalignment: The fiber-optic media are not precisely aligned to one another when joined.
- End gap: The media does not completely touch at the splice or connection.
- End finish: The media ends are not well polished or dirt is present at the termination.

A quick and easy field test can be performed by shining a bright flashlight into one end of the fiber while observing the other end of the fiber. If light is visible, then the fiber is capable of passing light. Although this does not ensure the performance of the fiber, it is a quick and inexpensive way to find a broken fiber

4.2.3.6 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

4.2.3.7 Activity - Fiber Optics Terminology

	Multimode	Single-mode
1. Can help data travel approximately 1.24 miles or 2 km/2000 m	✓	
2. Uses light emitting diodes (LEDs) as a data light source transmitter	✓	
3. Uses lasers in a single stream as a data light source transmitter		✓
4. Used to connect long-distance telephony and cable TV applications		✓
5. Can travel approximately 62.5 miles or 100 km/100000 m		✓
6. Used within a campus network	✓	

4.2.4.1 Properties of Wireless Media

Wireless does have some areas of concern including:

- Coverage area: Wireless data communication technologies work well in open environments..
- Interference: Wireless is susceptible to interference and can be disrupted by such common devices as household cordless phones, some types of fluorescent lights, microwave ovens, and other wireless communications.
- Security: Wireless communication coverage requires no access to a physical strand of media.

4.2.4.2 Types of Wireless Media

- Commonly referred to as Wi-Fi
- Uses CSMA/CA
- Variations include:
  - 802.11a: 54 Mb/s, 5 GHz
  - 802.11b: 11 Mb/s, 2.4 GHz
  - 802.11g: 54 Mb/s, 2.4 GHz
  - 802.11n: 600 Mb/s, 2.4, and 5 GHz
  - 802.11ac: 1 Gb/s, 5 GHz
  - 802.11ad: 7 Gb/s, 2.4 GHz, 5 GHz, and 60 GHz

- IEEE 802.15 standard
- Supports speeds up to 3 Mb/s
- Provides device pairing over distances from 1 to 100 meters

- IEEE 802.16 standard
- Provides speeds up to 1 Gb/s
- Uses a point-to-multipoint topology to provide wireless broadband access

4.2.4.3 Wireless LAN

Cisco Linksys EA6500 802.11ac Wireless Router

To use multiple Wireless Router Access points:

- Turn off DHCP and NAT except on the primary router
- Give each router a different **Channel Number**

4.2.4.4 802.11 Wi-Fi Standards

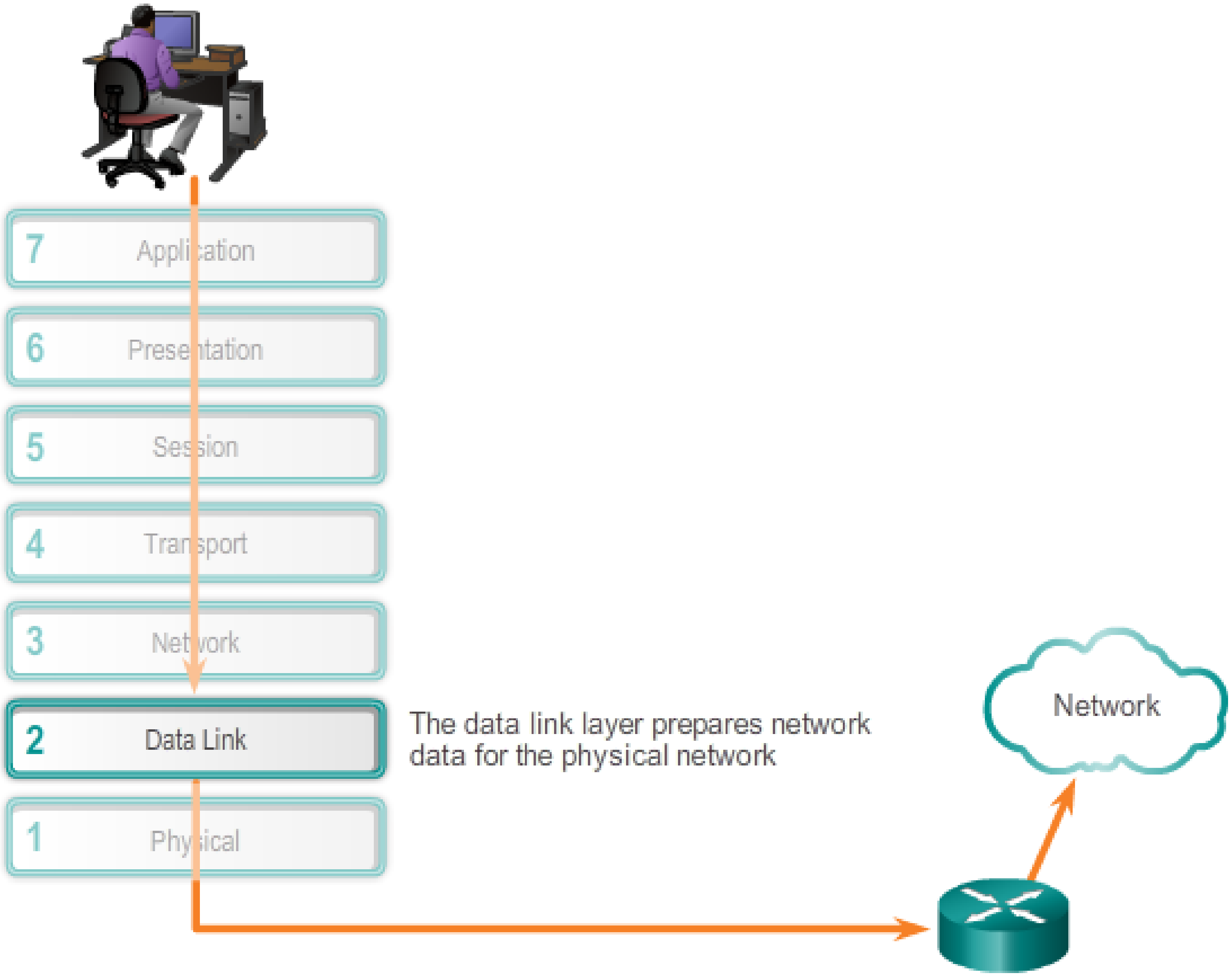
Standard	Maximum Speed	Frequency	Backward Compatible
802.11a	54 Mb/s	5 GHz	No
802.11b	11 Mb/s	2.4 GHz	No
802.11g	54 Mb/s	2.4 GHz	802.11b
802.11n	600 Mb/s	2.4 GHz and 5 GHz	802.11a/b/g
802.11ac	1.3 Gb/s (1300 Mb/s)	5 GHz	802.11a/n
802.11ad	7 Gb/s (7000 Mb/s)	2.4 GHz, 5 GHz, and 60 GHz	802.11a/b/g/n/ac

4.2.4.5 Packet Tracer - Connecting a Wired and Wireless LAN

Connecting a Wired and Wireless LAN

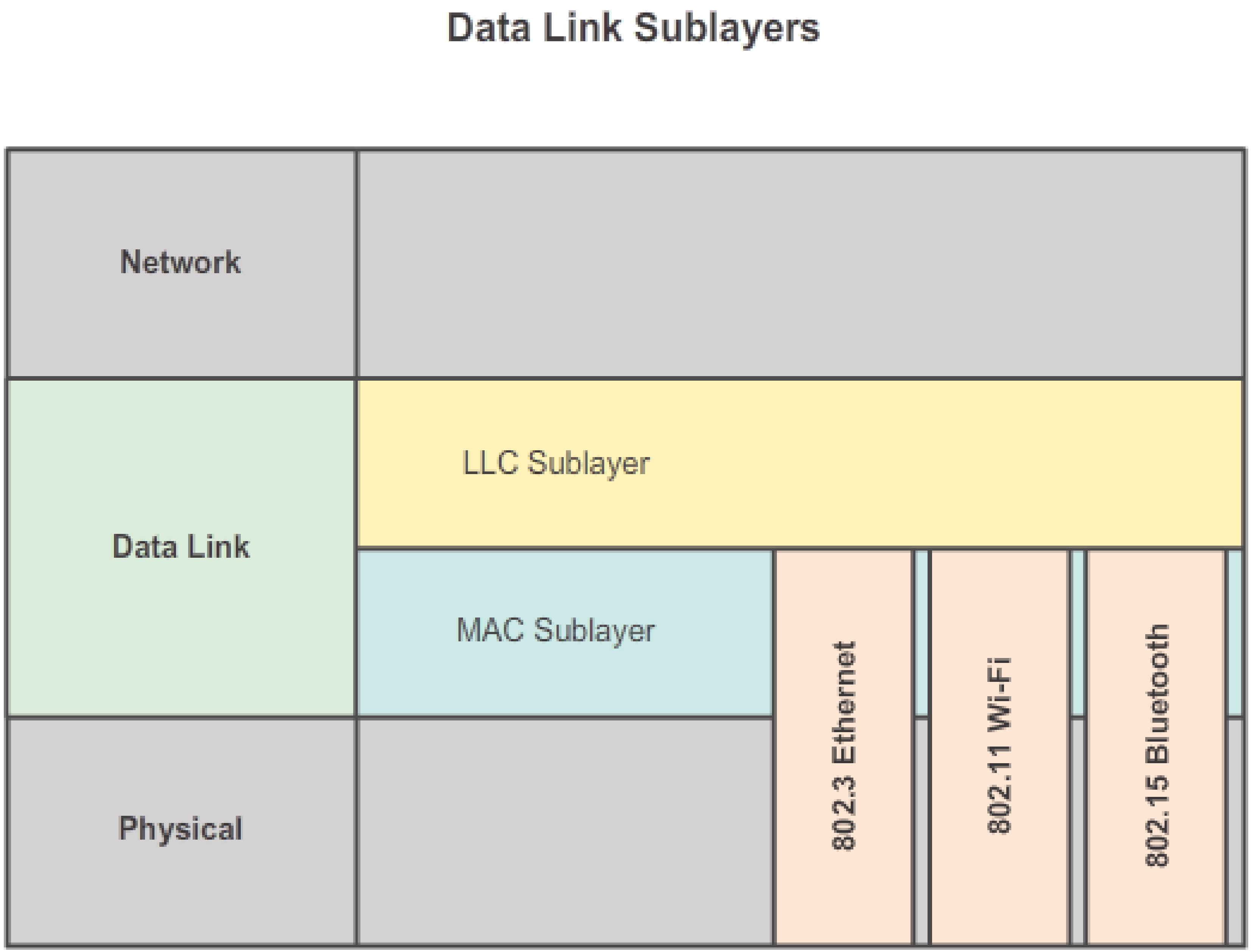
4.2.4.6 Lab - Viewing Wired and Wireless NIC Information

4.3.1.1 The Data Link Layer

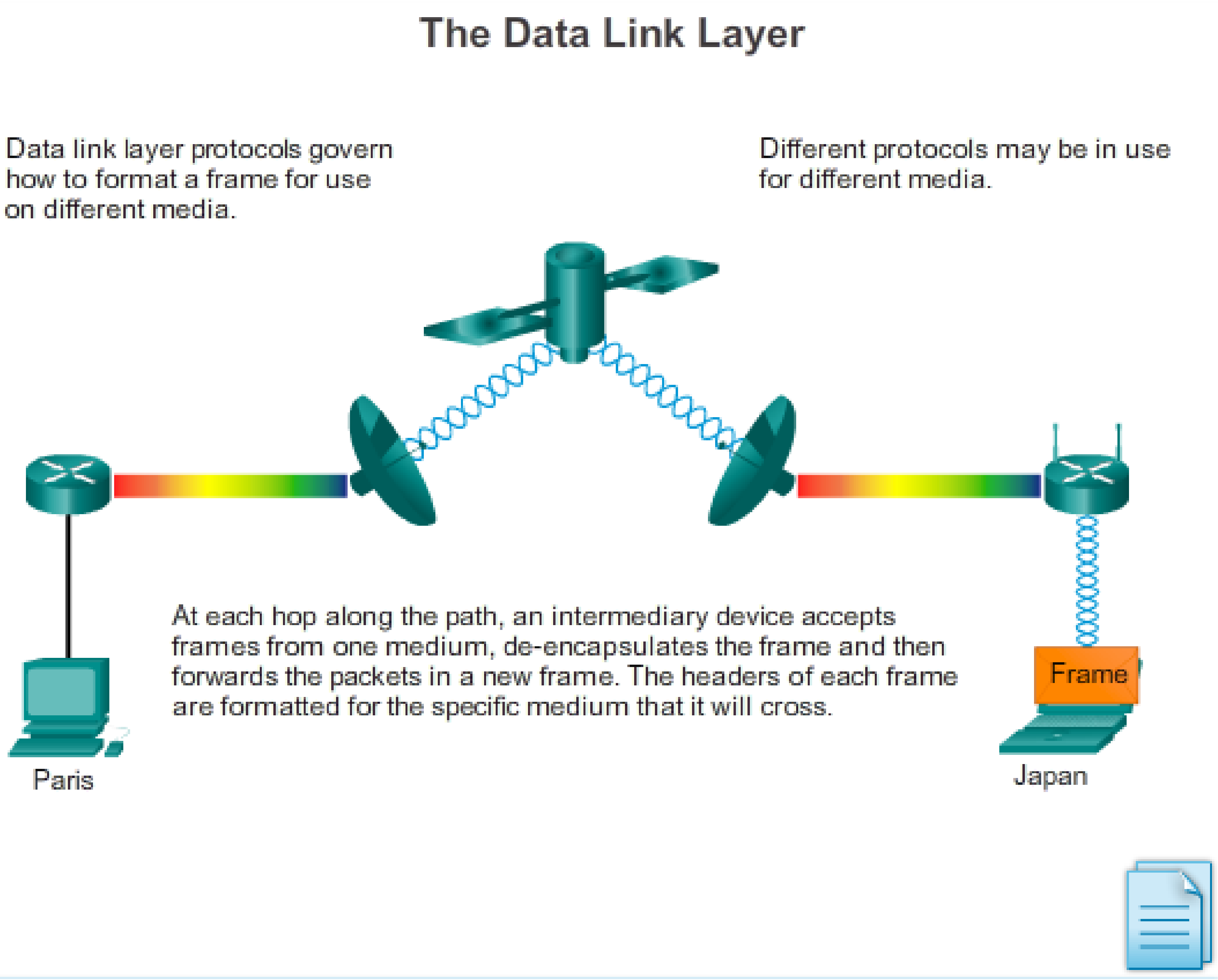


As shown in the figure, the data link layer is responsible for the exchange of frames between nodes over a physical network media. It allows the upper layers to access the media and controls how data is placed and received on the media.

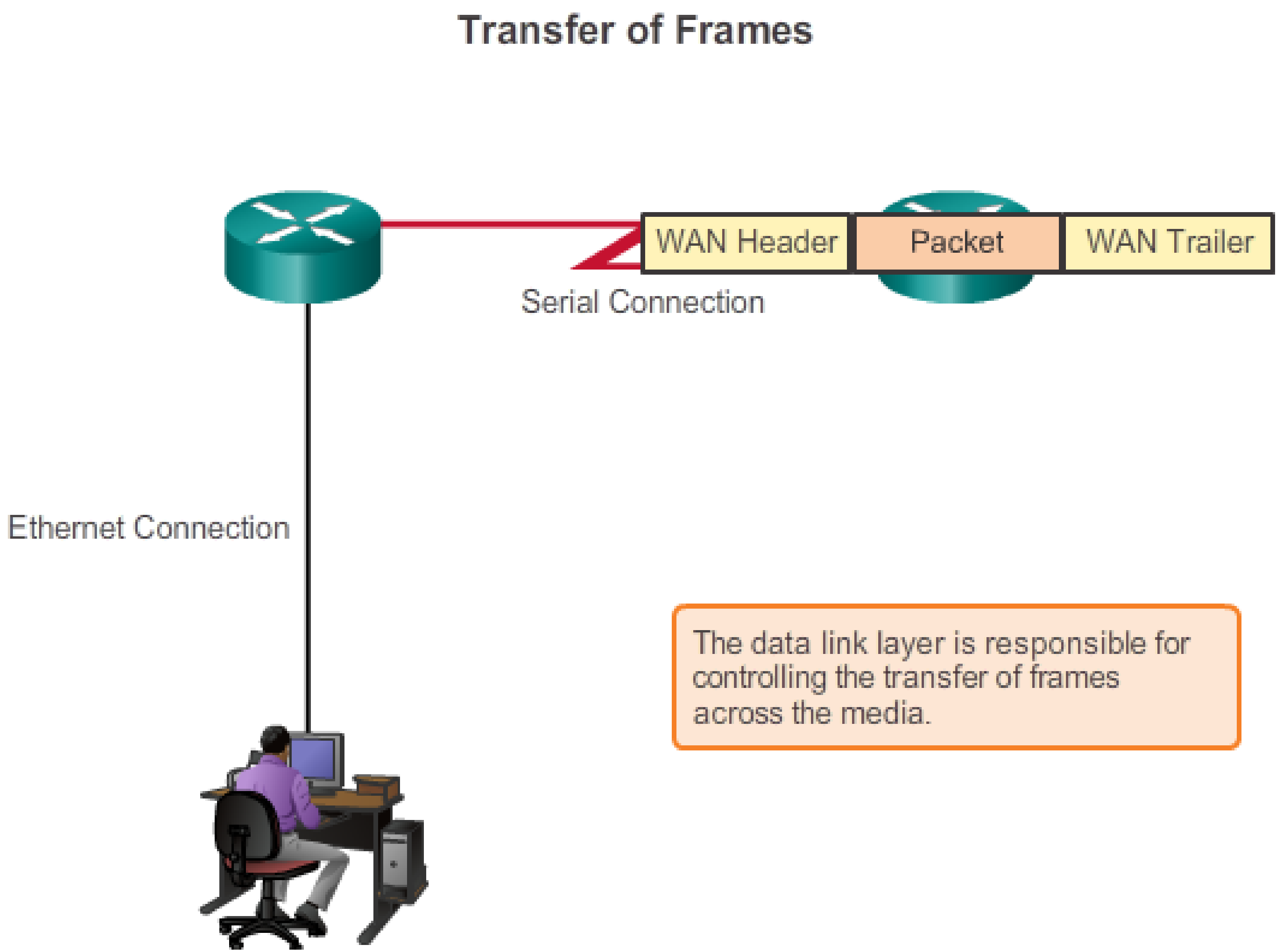
4.3.1.2 Data Link Sublayers



4.3.1.3 Media Access Control



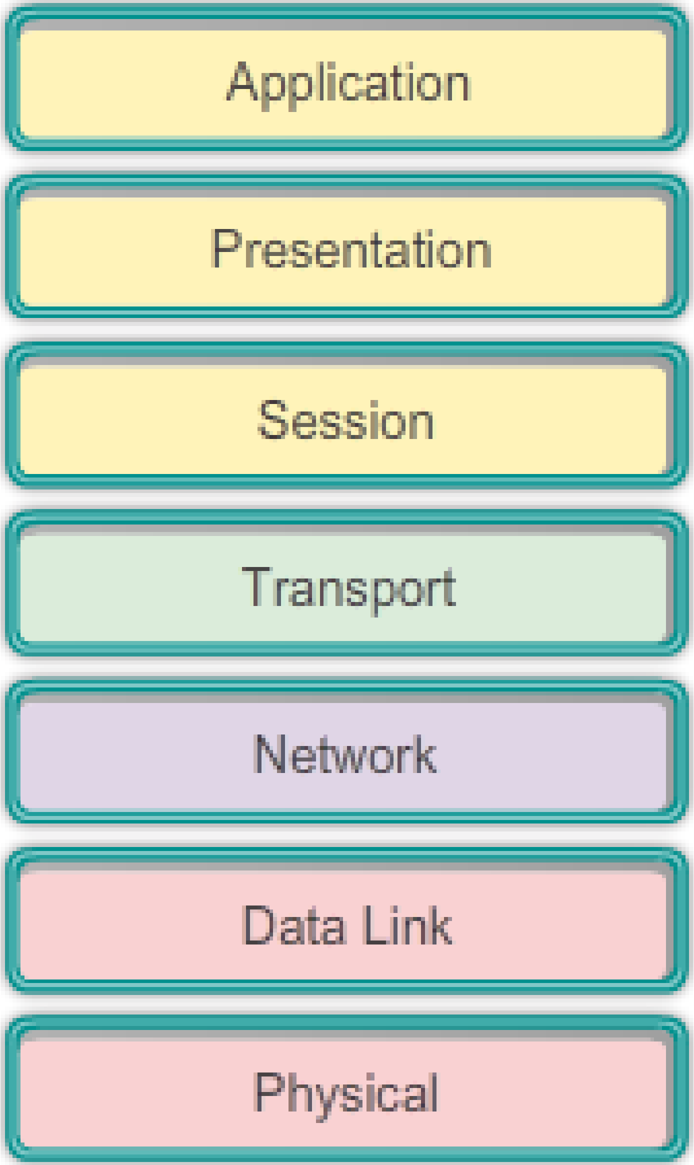
4.3.1.4 Providing Access to Media



Router interfaces encapsulate the packet into the appropriate frame, and a suitable media access control method is used to access each link.

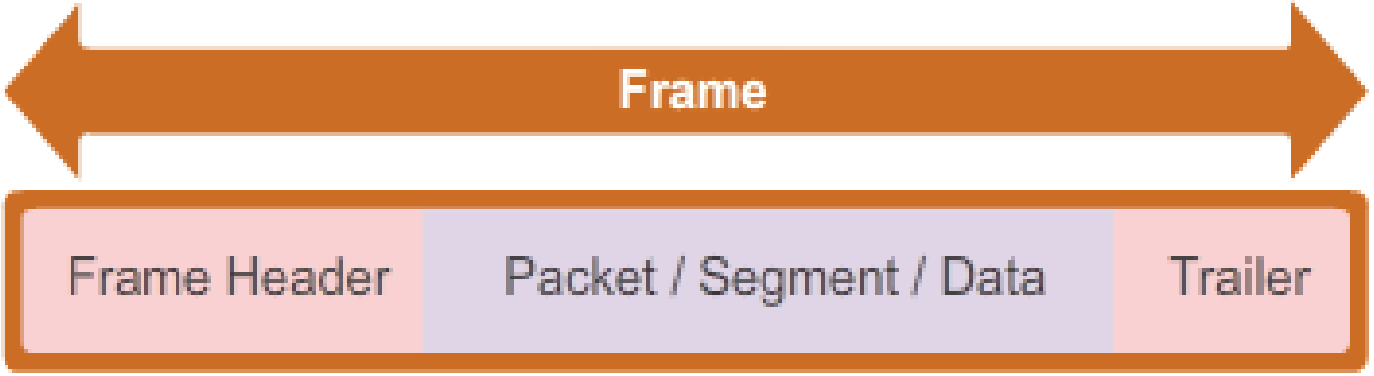
In any given exchange of network layer packets, there may be numerous data link layer and media transitions.

4.3.2.1 Formatting Data for Transmission

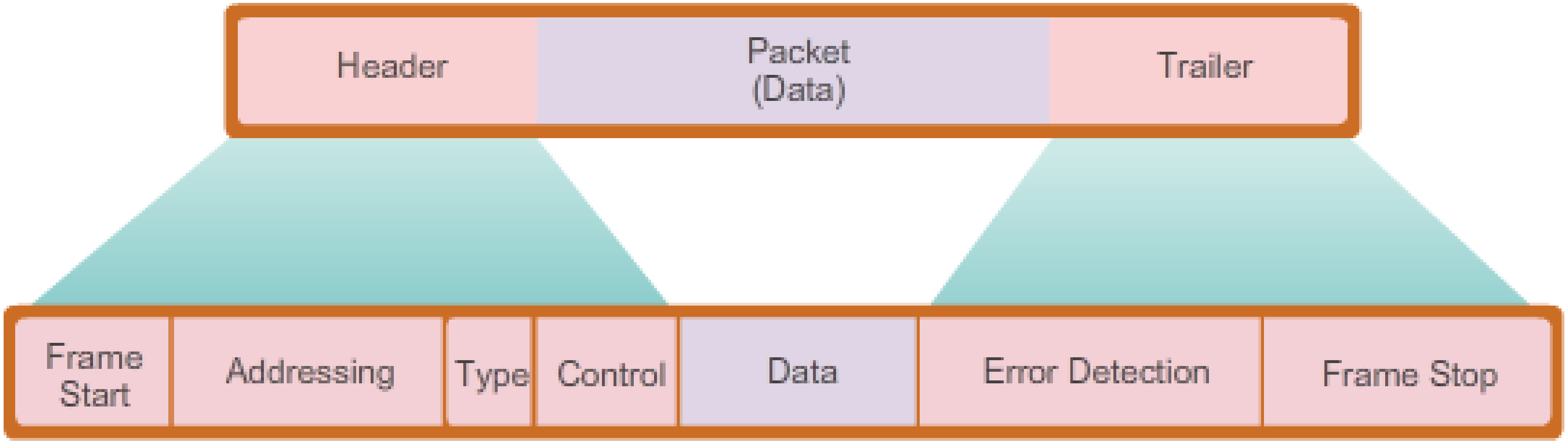


Data link layer protocols require control information to enable the protocols to function. Control information typically answers:

- Which nodes are in communication with each other?
- When does communication between individual nodes begin and when does it end?
- Which errors occurred while the nodes communicated?
- Which nodes will communicate next?



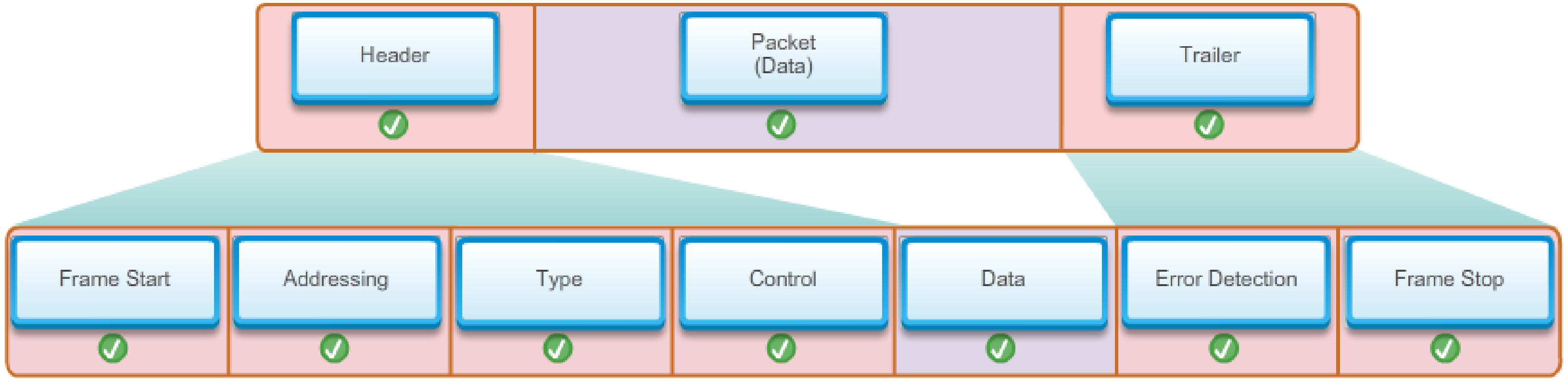
4.3.2.2 Creating a Frame



As shown in the figure, generic frame field types include:

- Frame start and stop indicator flags:
- Addressing: Used by the MAC sublayer to identify the source and destination nodes.
- Type: Used by the LLC to identify the Layer 3 protocol.
- Control: Identifies special flow control services.
- Data: Contains the frame payload (i.e., packet header, segment header, and the data).
- Error Detection: Included after the data to form the trailer

4.3.2.3 Activity - Generic Frame Fields

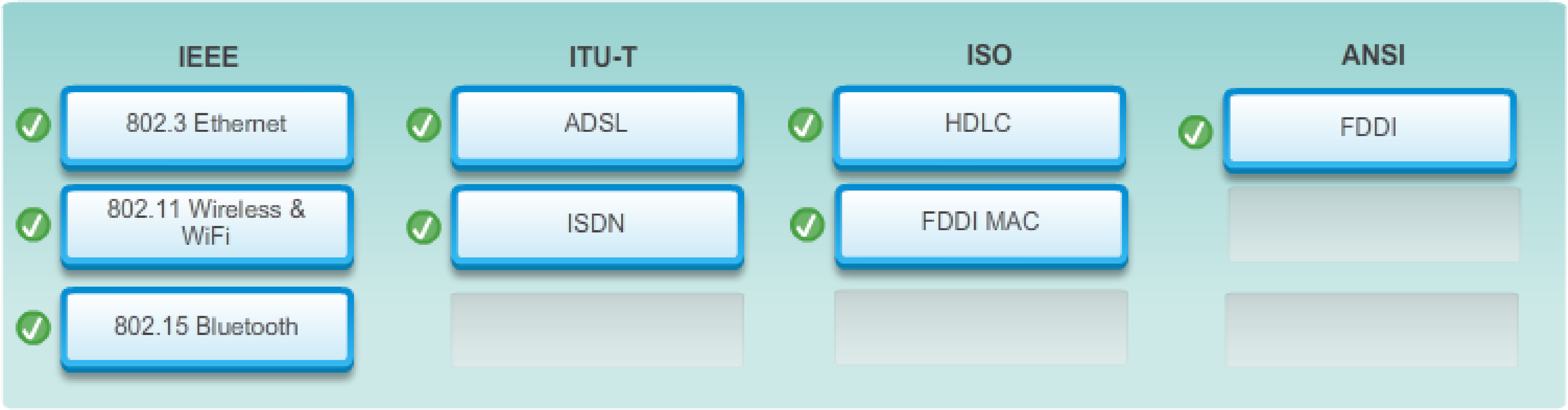


Data	Contains the IP header, transport layer PDU, and data
Type	Identifies the Layer 3 protocol used by the LLC
Frame stop indicator flag	Marks the end of the frame
Addressing	Identifies source and destination hosts by MAC address
Control	Specifies special flow control services

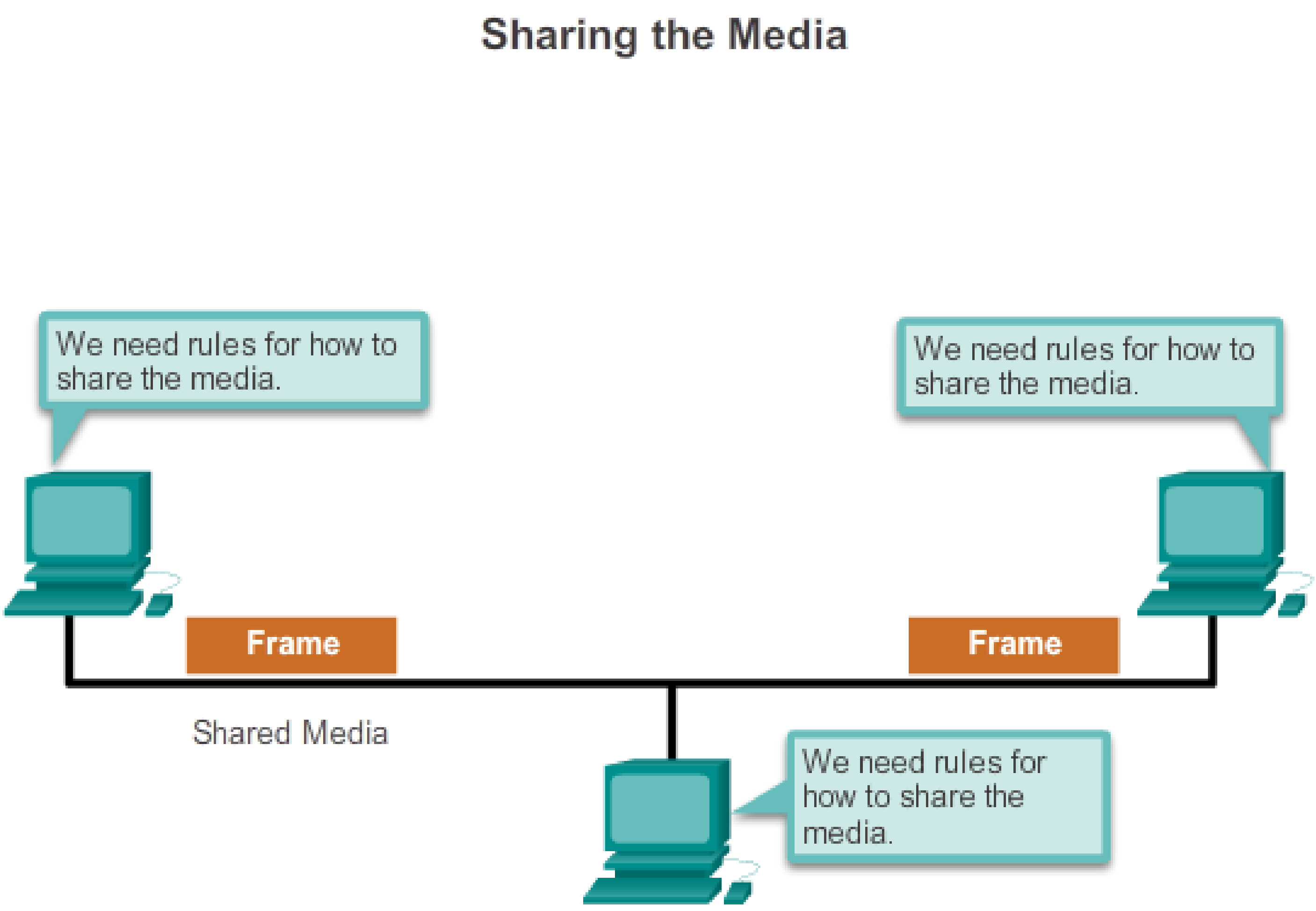
4.3.3.1 Data Link Layer Standards

Standard Organization	Networking Standards
IEEE	• 802.2: Logical Link Control (LLC) • 802.3: Ethernet • 802.4: Token bus • 802.5: Token ring • 802.11: Wireless LAN (WLAN) & Mesh (Wi-Fi certification) • 802.15: Bluetooth • 802.16: WiMax
ITU-T	• G.992: ADSL • G.8100 - G.8199: MPLS over Transport aspects • Q.921: ISDN • Q.922: Frame Relay
ISO	• HDLC (High Level Data Link Control) • ISO 9314: FDDI Media Access Control (MAC)
ANSI	• X3T9.5 and X3T12: Fiber Distributed Data Interface (FDDI)

4.3.3.2 Activity - Data Link Layer Standards Organizations



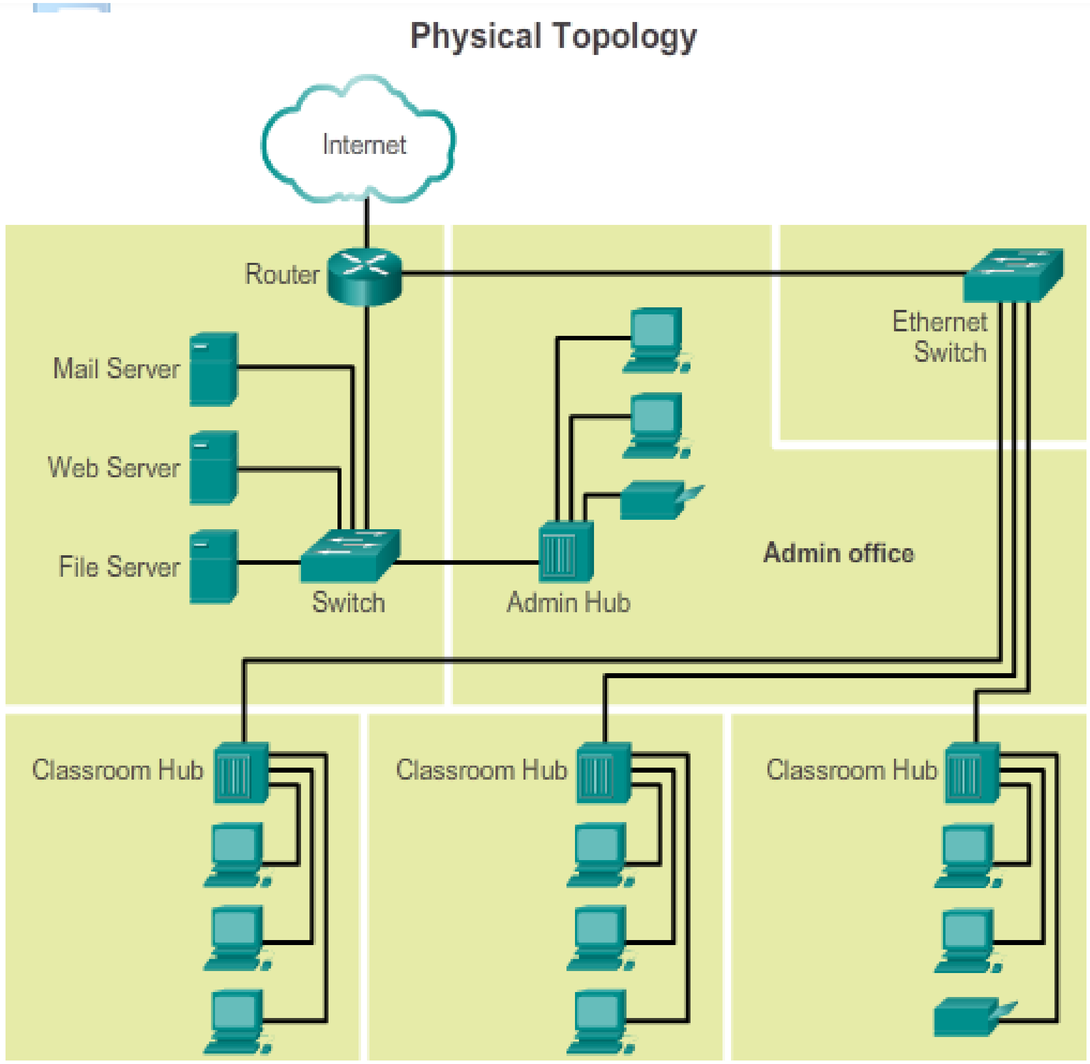
4.4.1.1 Controlling Access to the Media

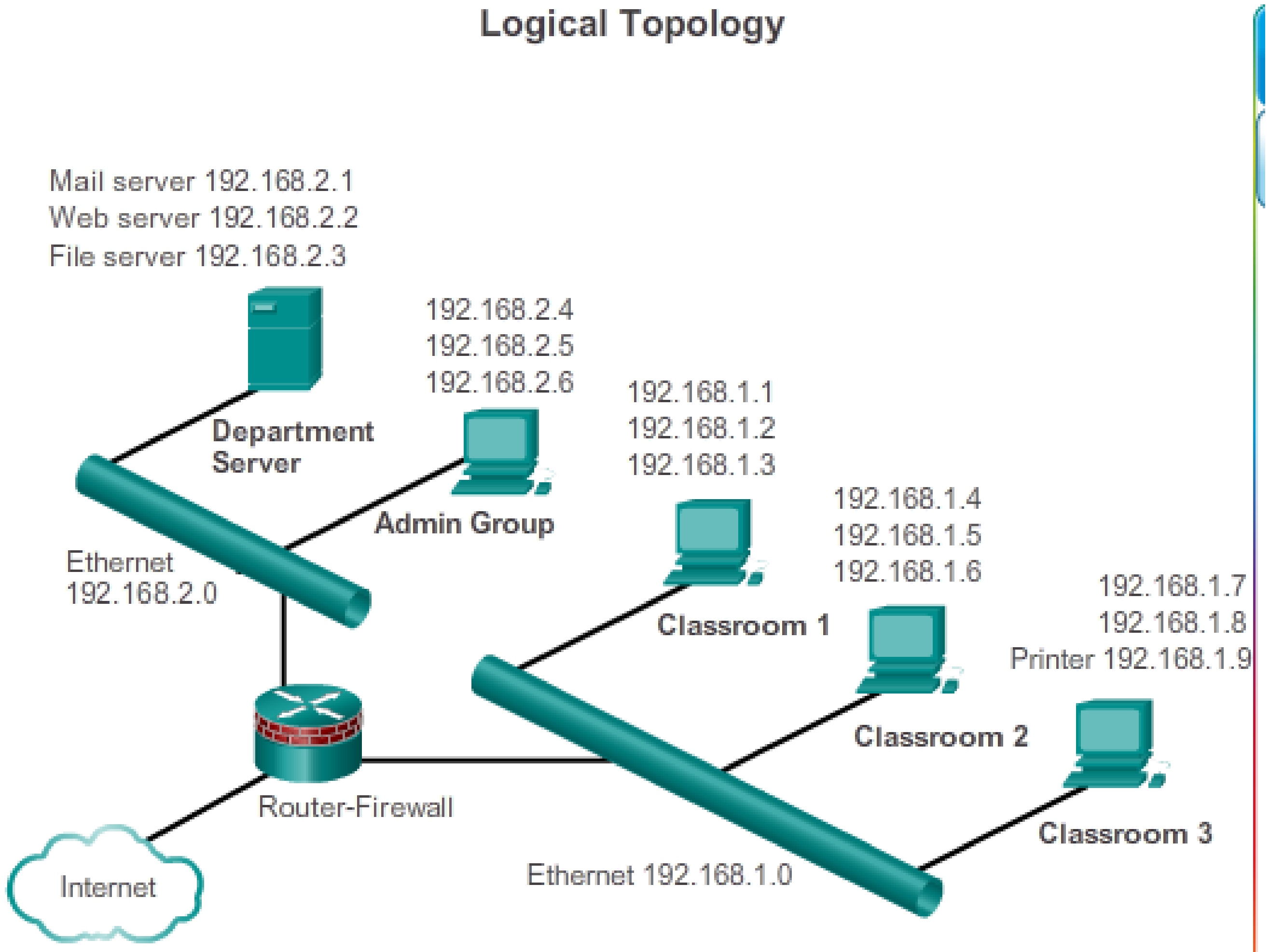


The actual media access control method used depends on:

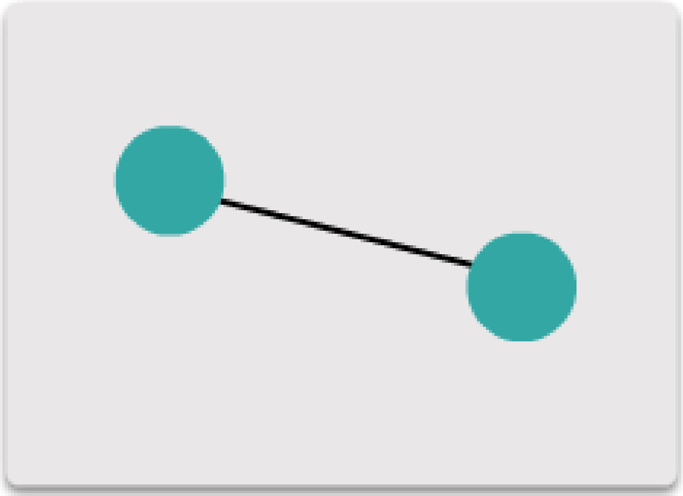
- **Topology**: How the connection between the nodes appears to the data link layer.
- **Media sharing**: How the nodes share the media. The media sharing can be point-to-point such as in WAN connections or shared such as in LAN networks

4.4.1.2 Physical and Logical Topologies

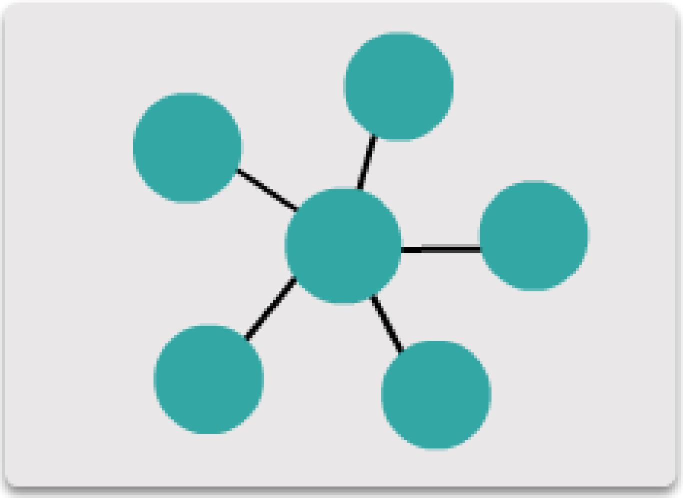




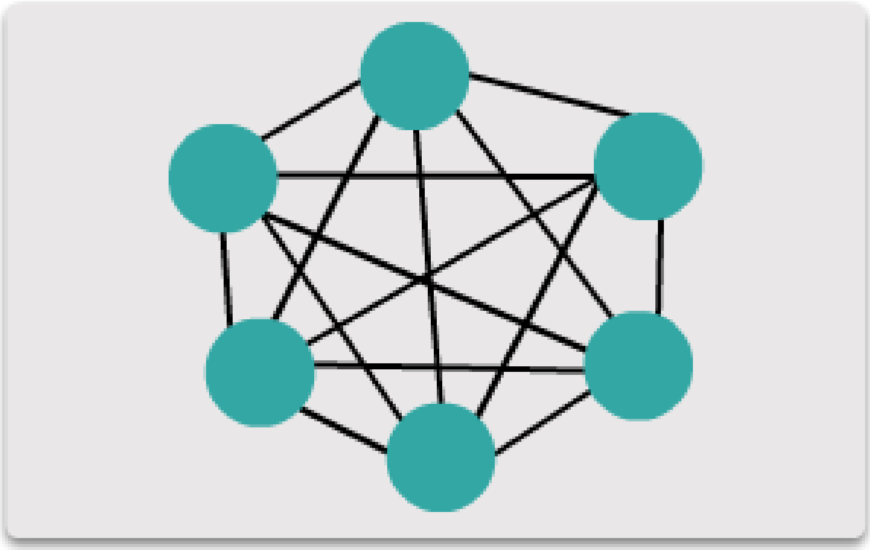
4.4.2.1 Common Physical WAN Topologies



Point-to-point topology

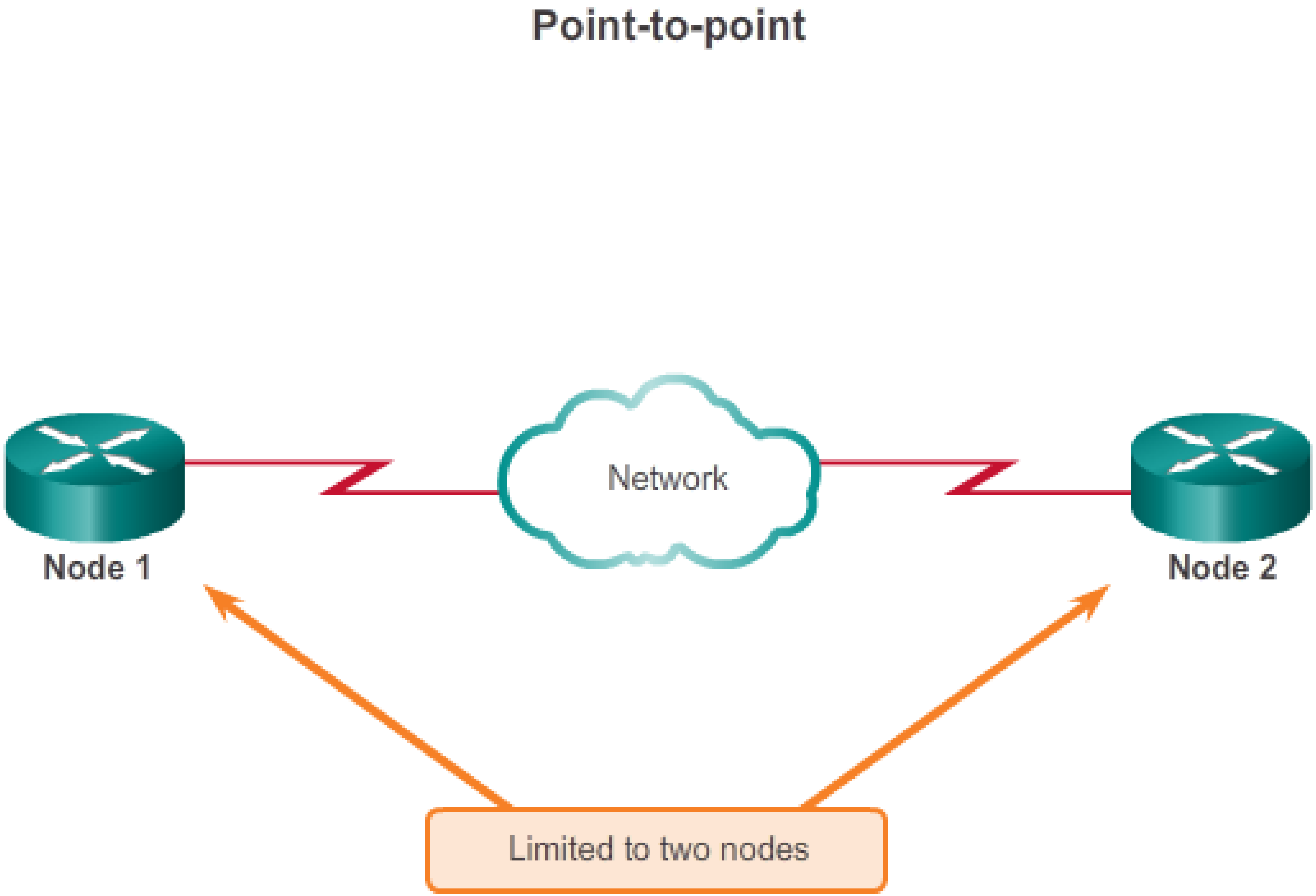


Hub and spoke topology



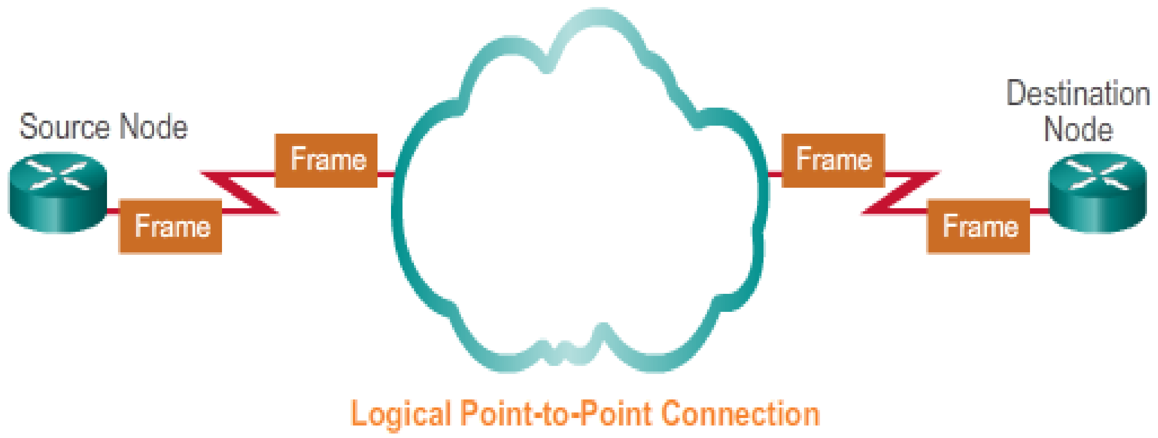
Full mesh topology

4.4.2.2 Physical Point-to-Point Topology

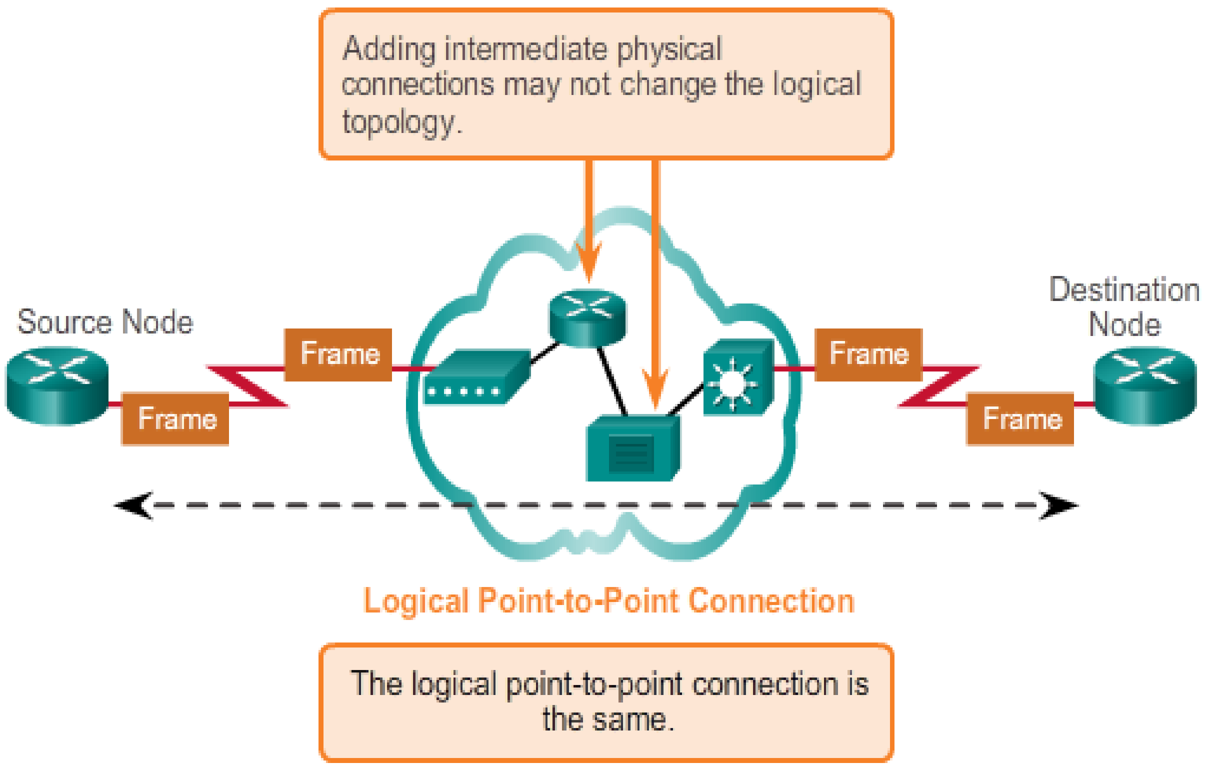


4.4.2.3 Logical Point-to-Point Topology

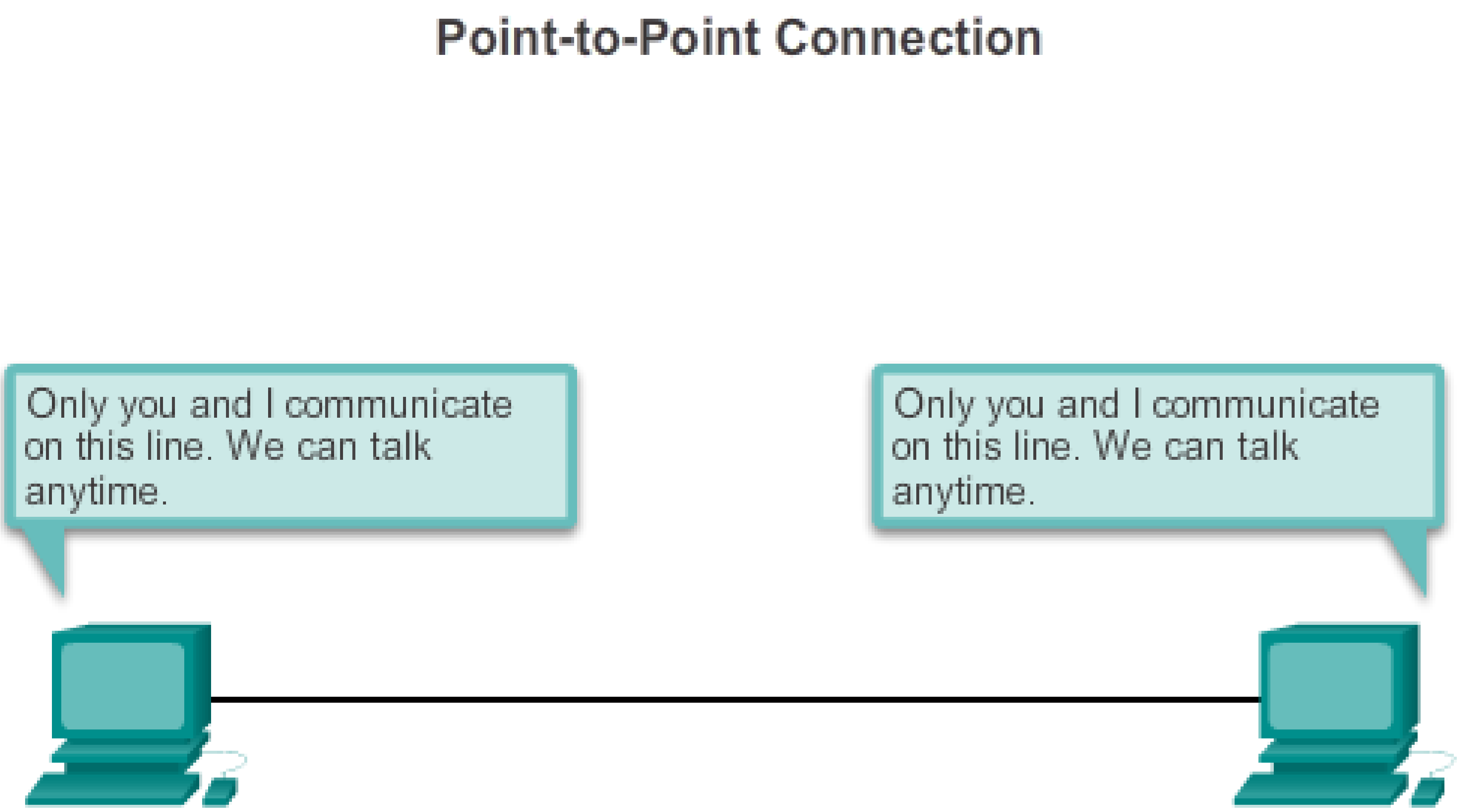
Logical Connection



Logical Point-to-Point Topology



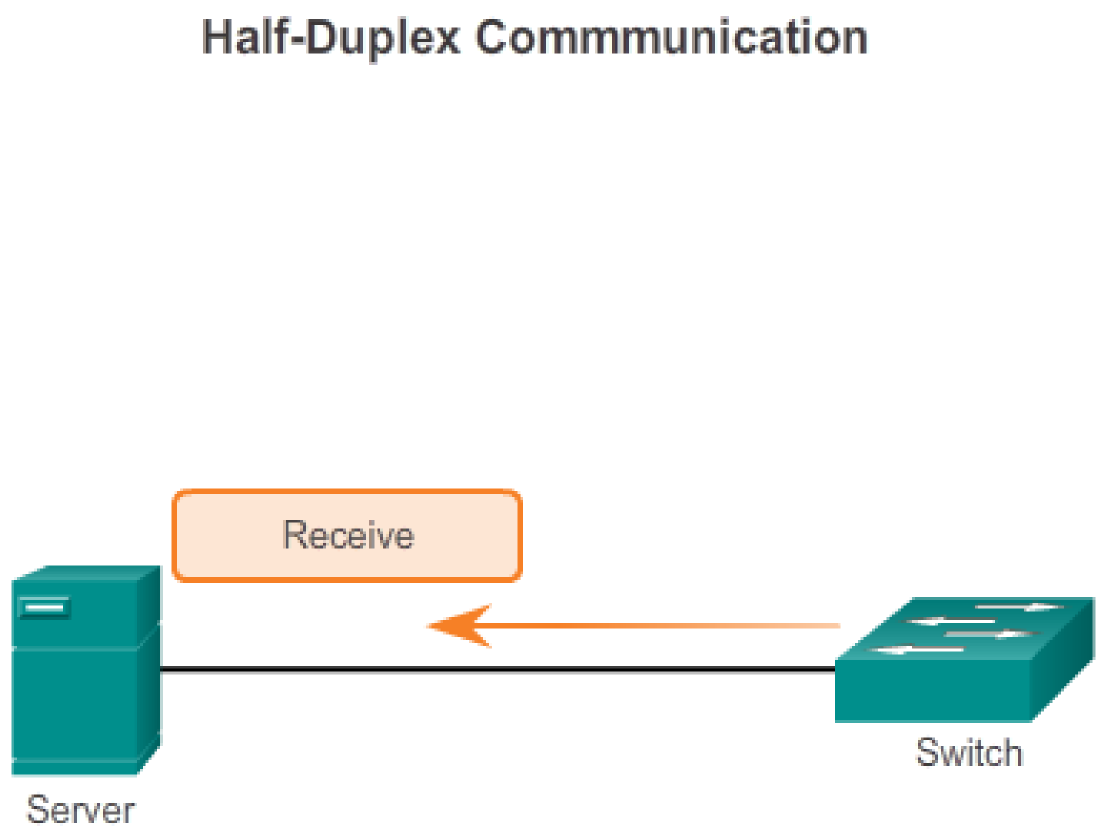
4.4.2.4 Half and Full Duplex

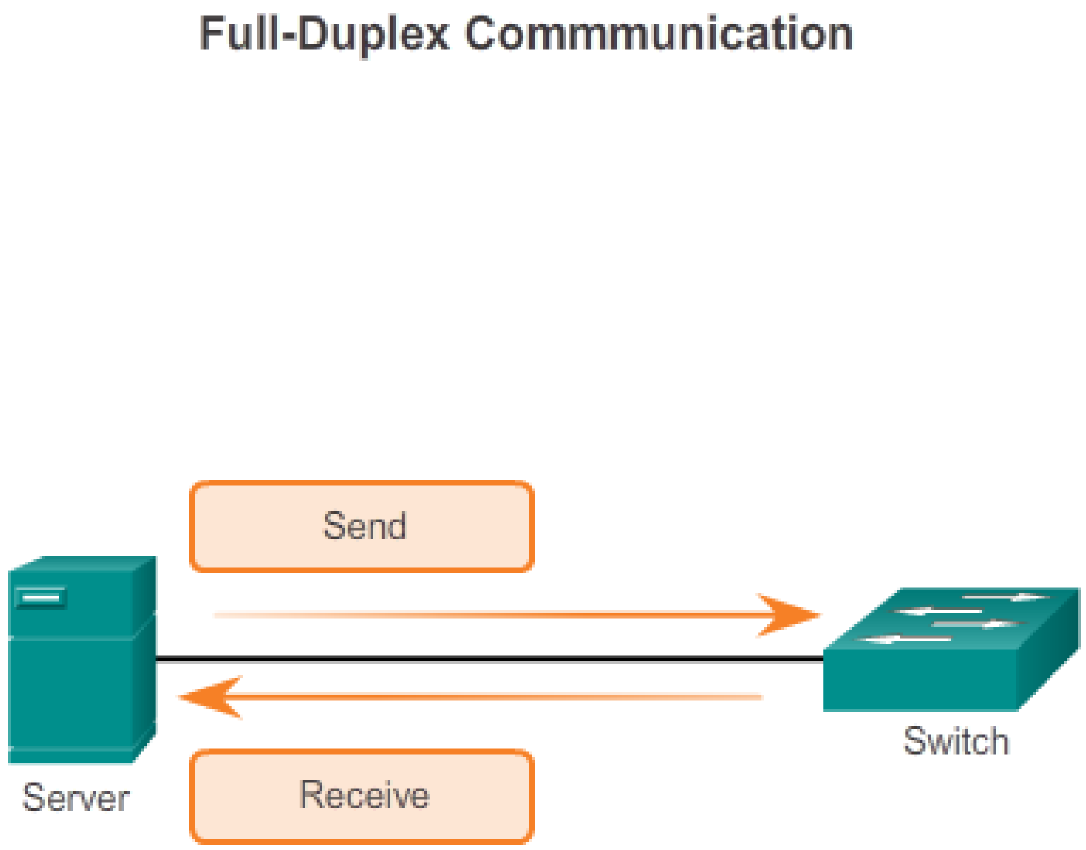


. In point-to-point networks, data can flow in one of two ways

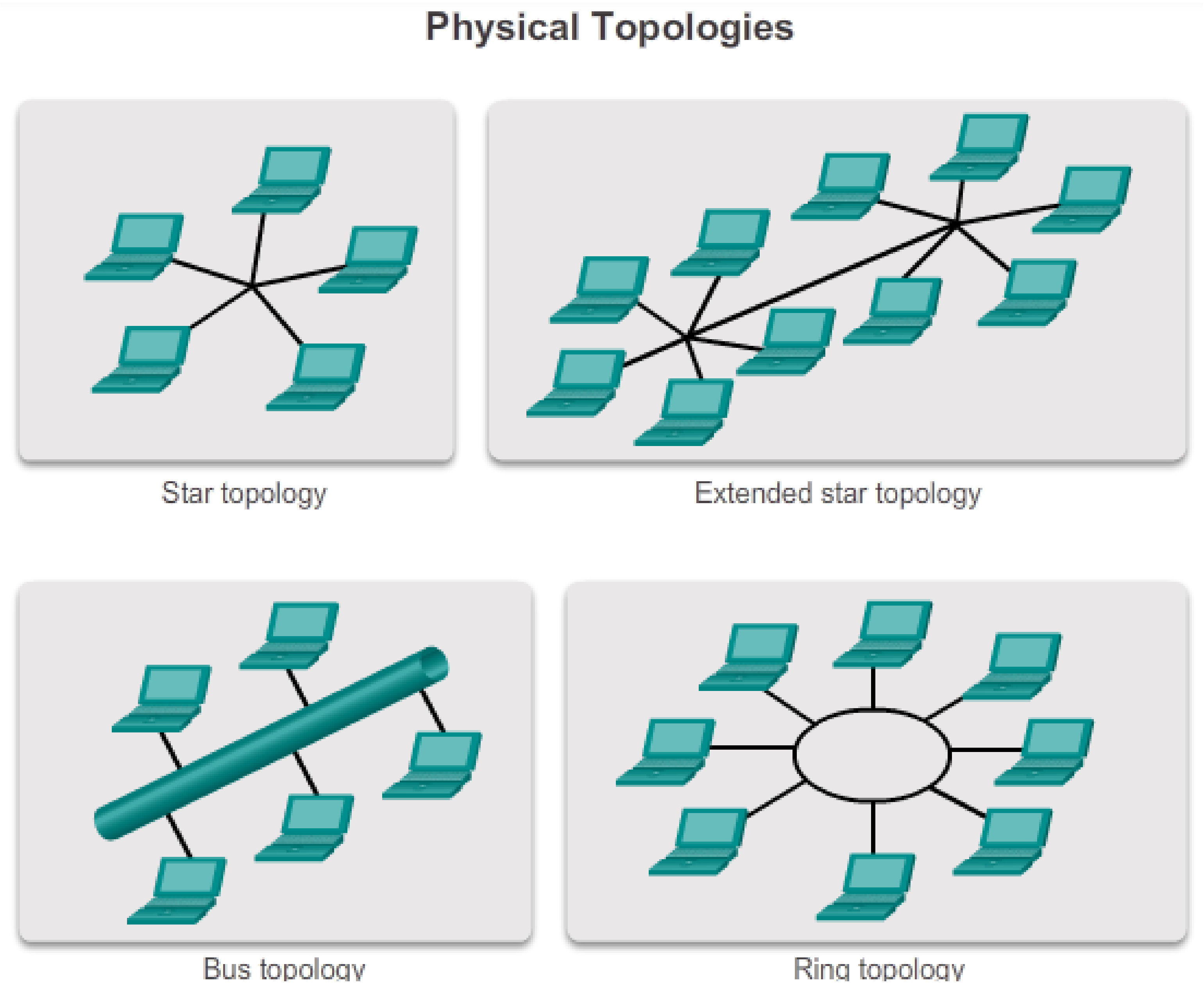
Half Duplex or Full Duplex

4.4.2.4 Half and Full Duplex

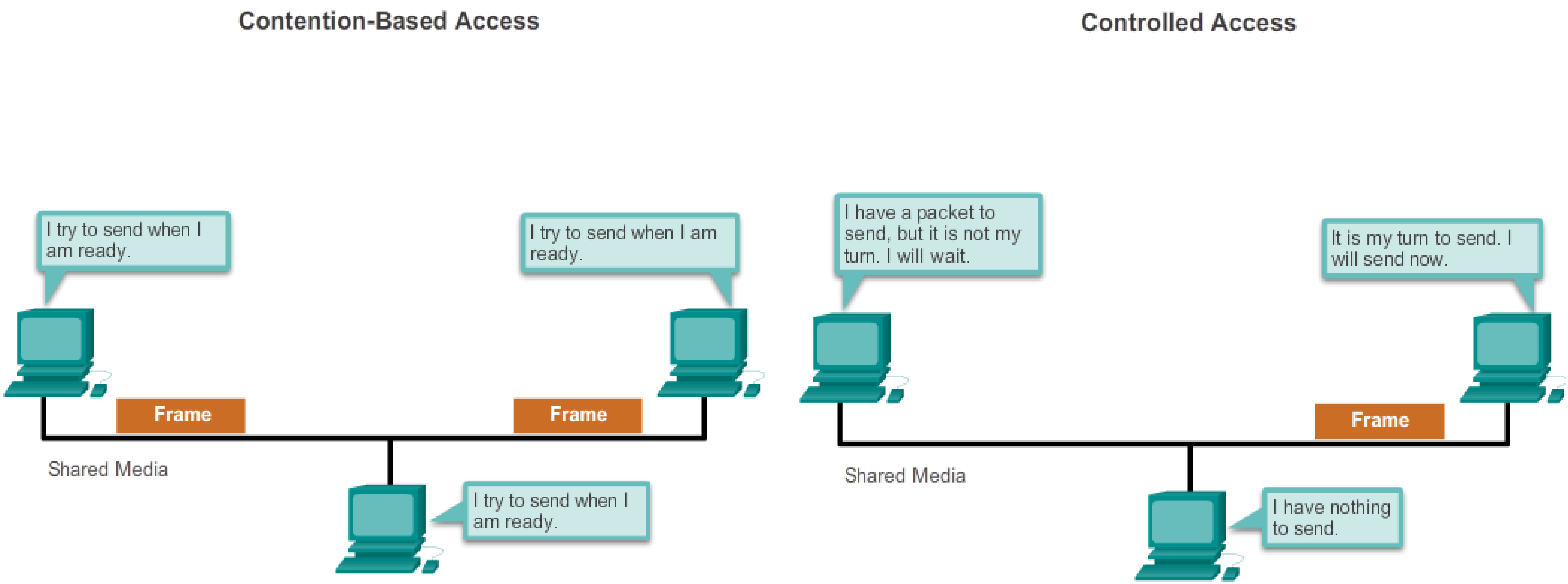




4.4.3.1 Physical LAN Topologies

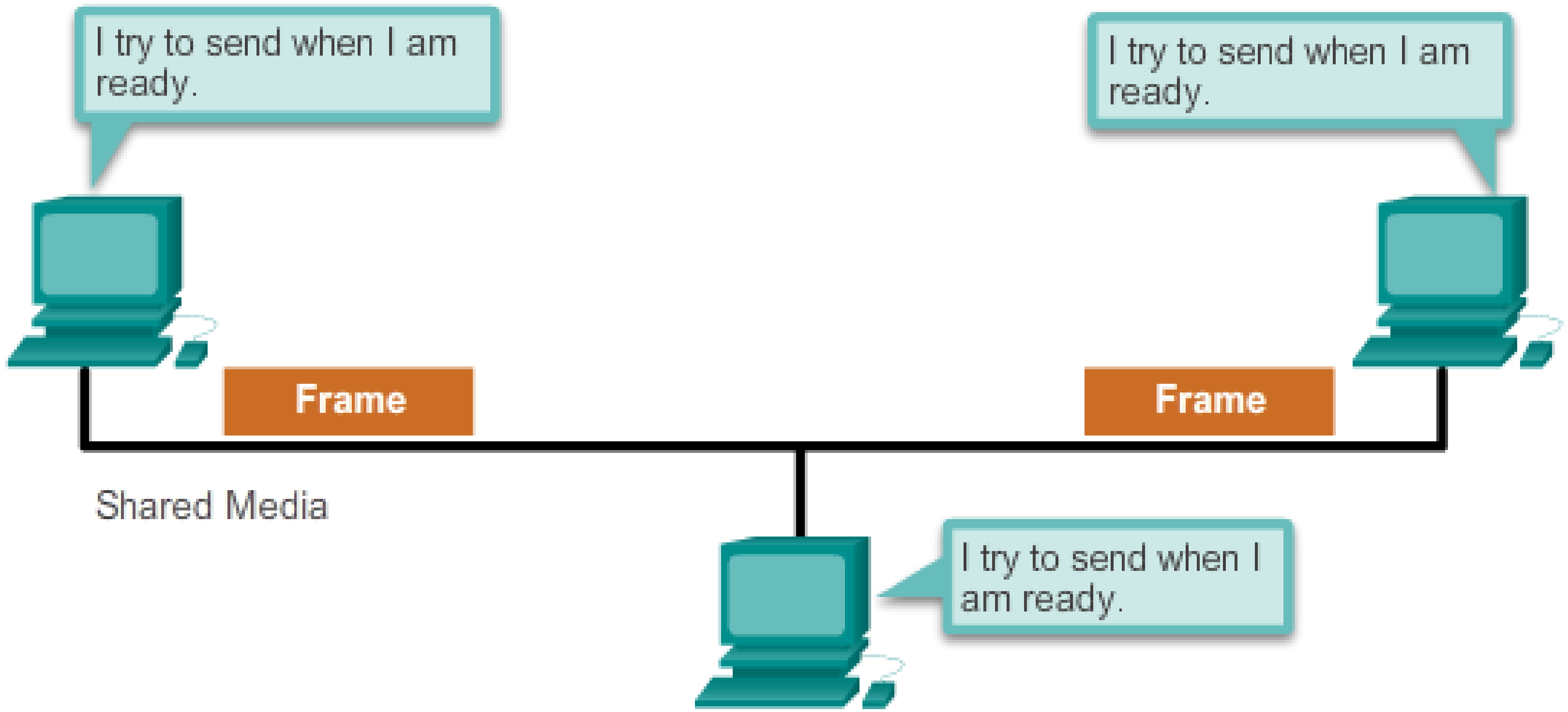


4.4.3.2 Logical Topology for Shared Media



4.4.3.3 Contention-Based Access

Contention-Based Access



Characteristics	Contention-Based Technologies
• Stations can transmit at any time • Collisions exist • There are mechanisms to resolve contention for the media	• CSMA/CD for 802.3 Ethernet networks • CSMA/CA for 802.11 wireless networks

4.4.3.4 Multi-Access Topology

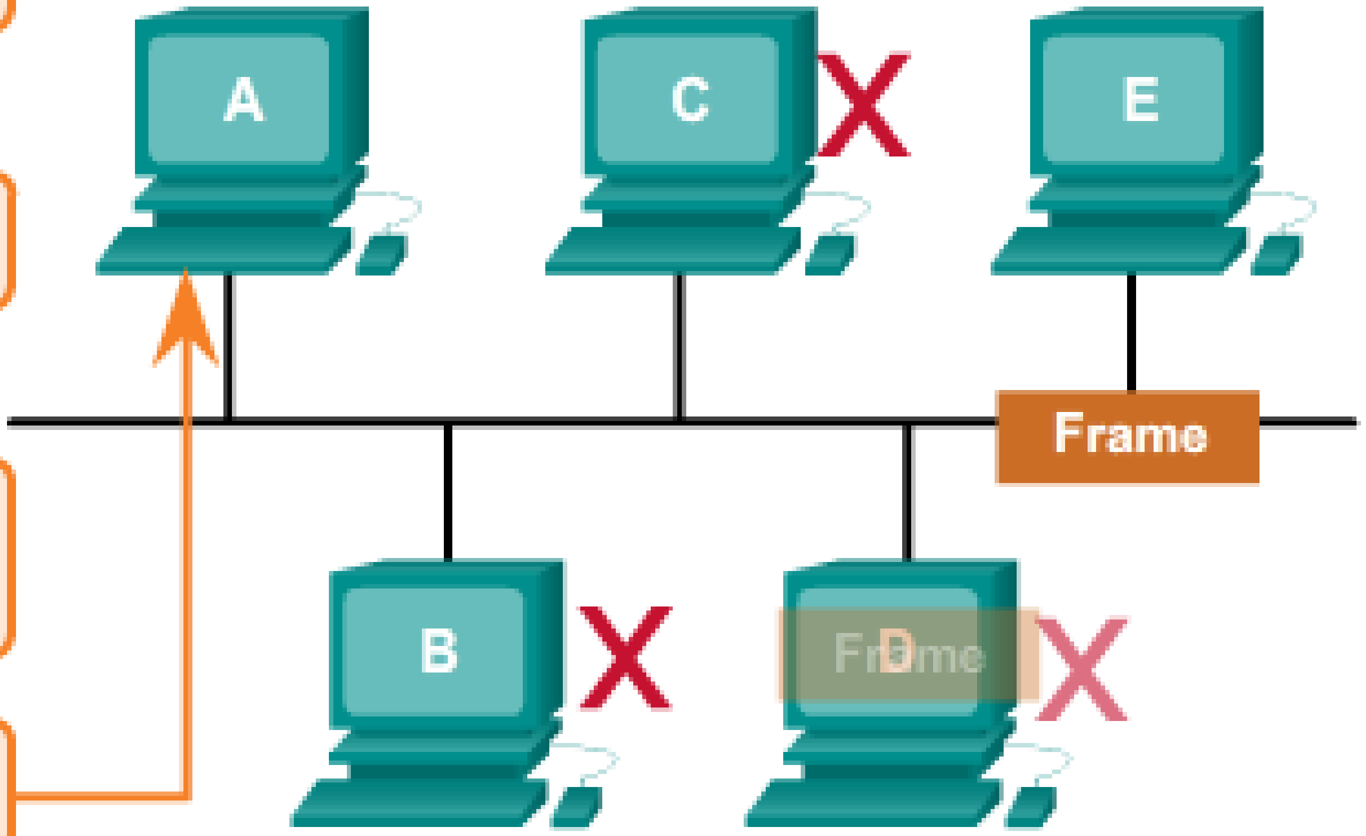
Logical Multi-Access Topology

I need to transmit to E.

I check for other transmissions.

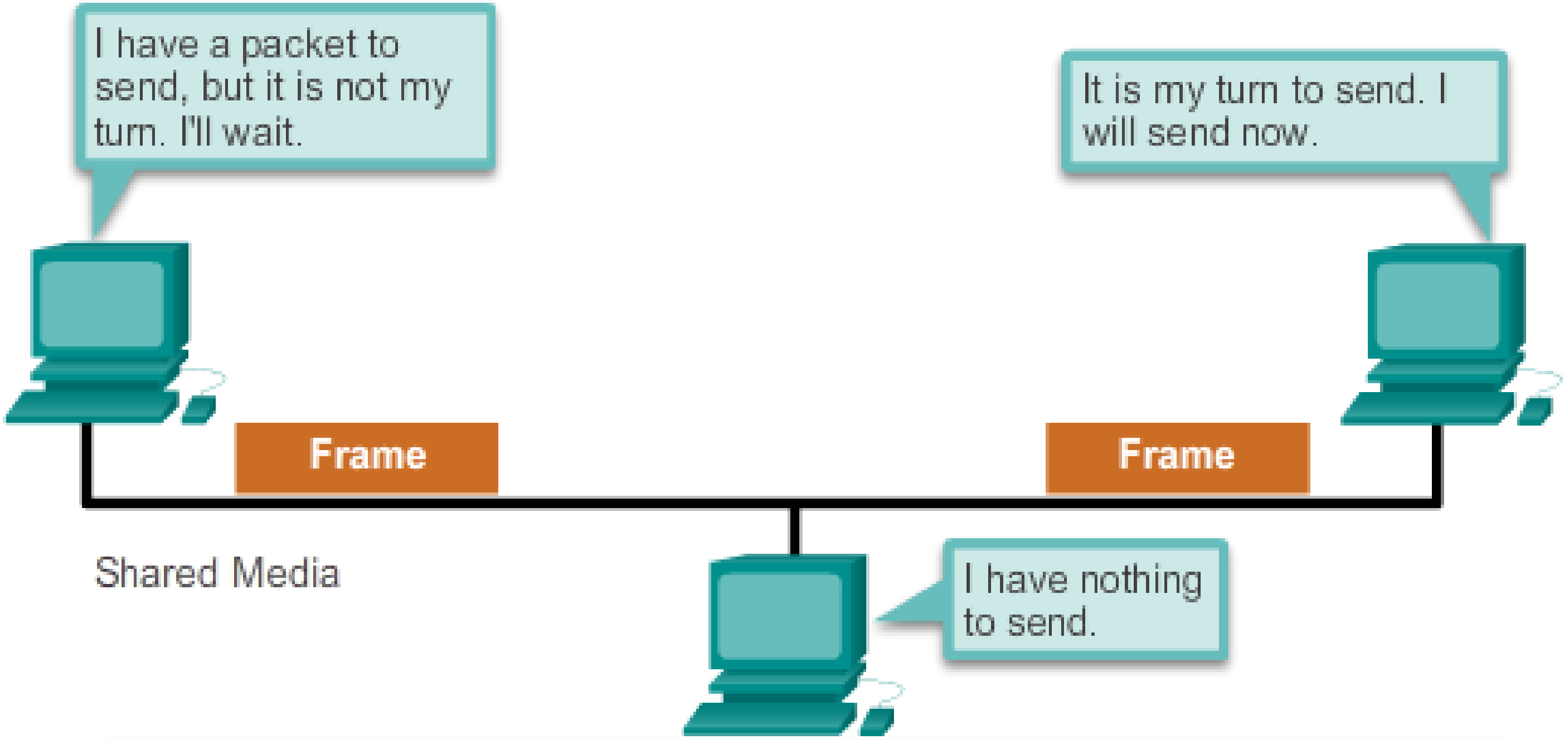
No other transmissions are detected.

Transmitting...



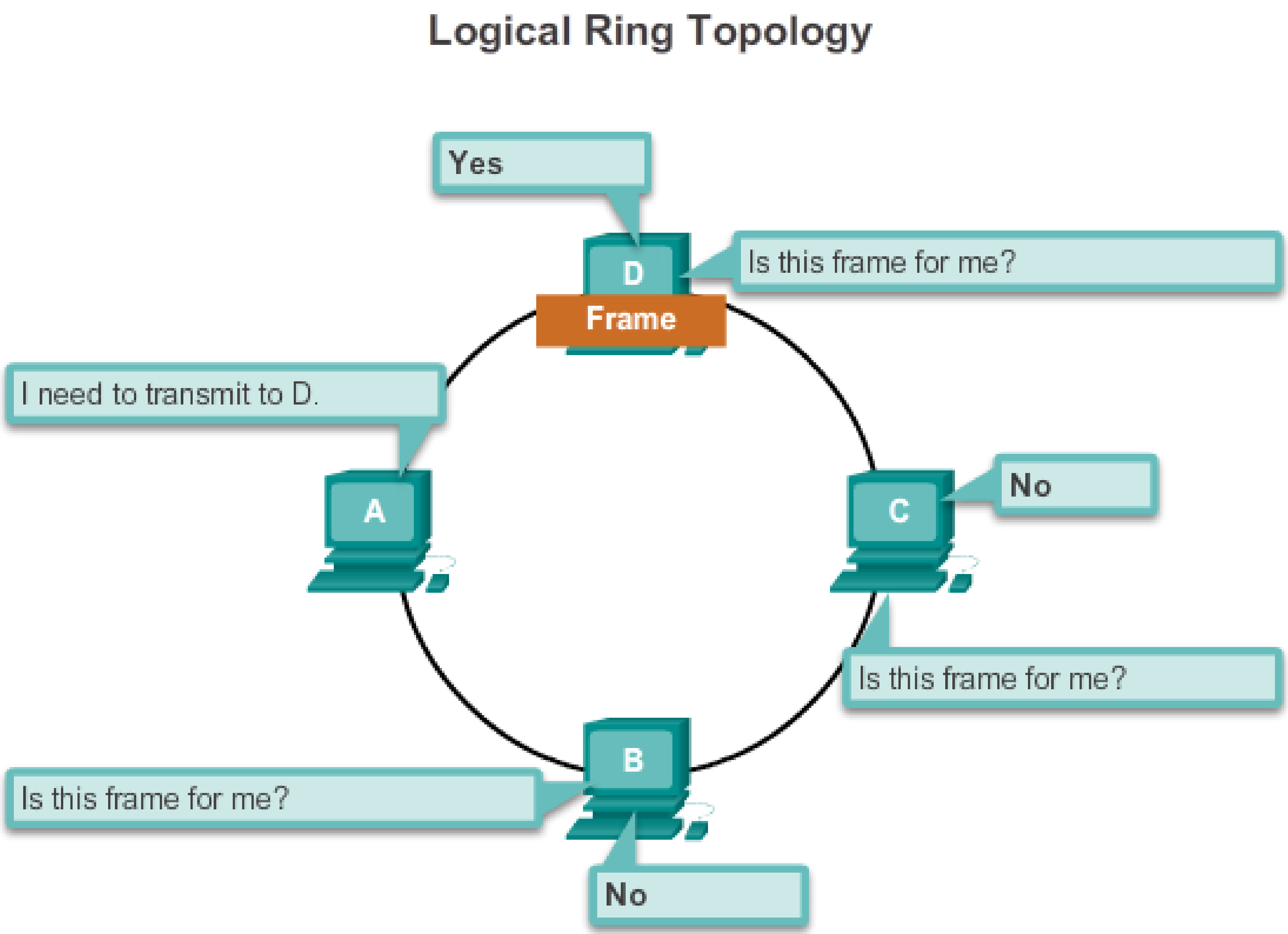
4.4.3.5 Controlled Access

Controlled Access



Characteristics	Controlled Access Technologies
• Only one station transmits at a time • Devices wishing to transmit must wait their turn • No collisions • May use a token passing method	• Token Ring (IEEE 802.5) • Fiber Distributed Data Interface (FDDI)

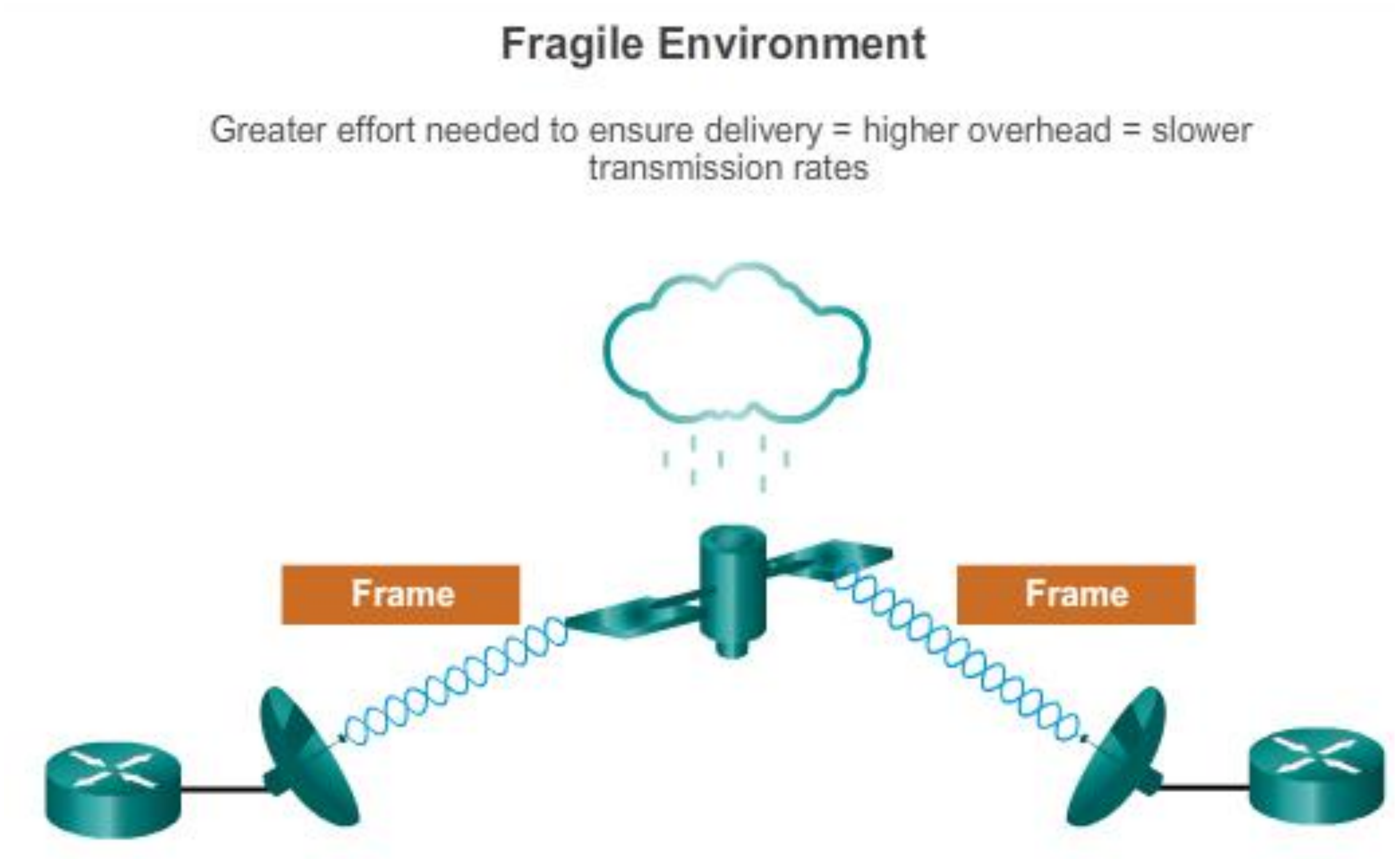
4.4.3.6 Ring Topology



4.4.3.7 Activity - Logical and Physical Topologies

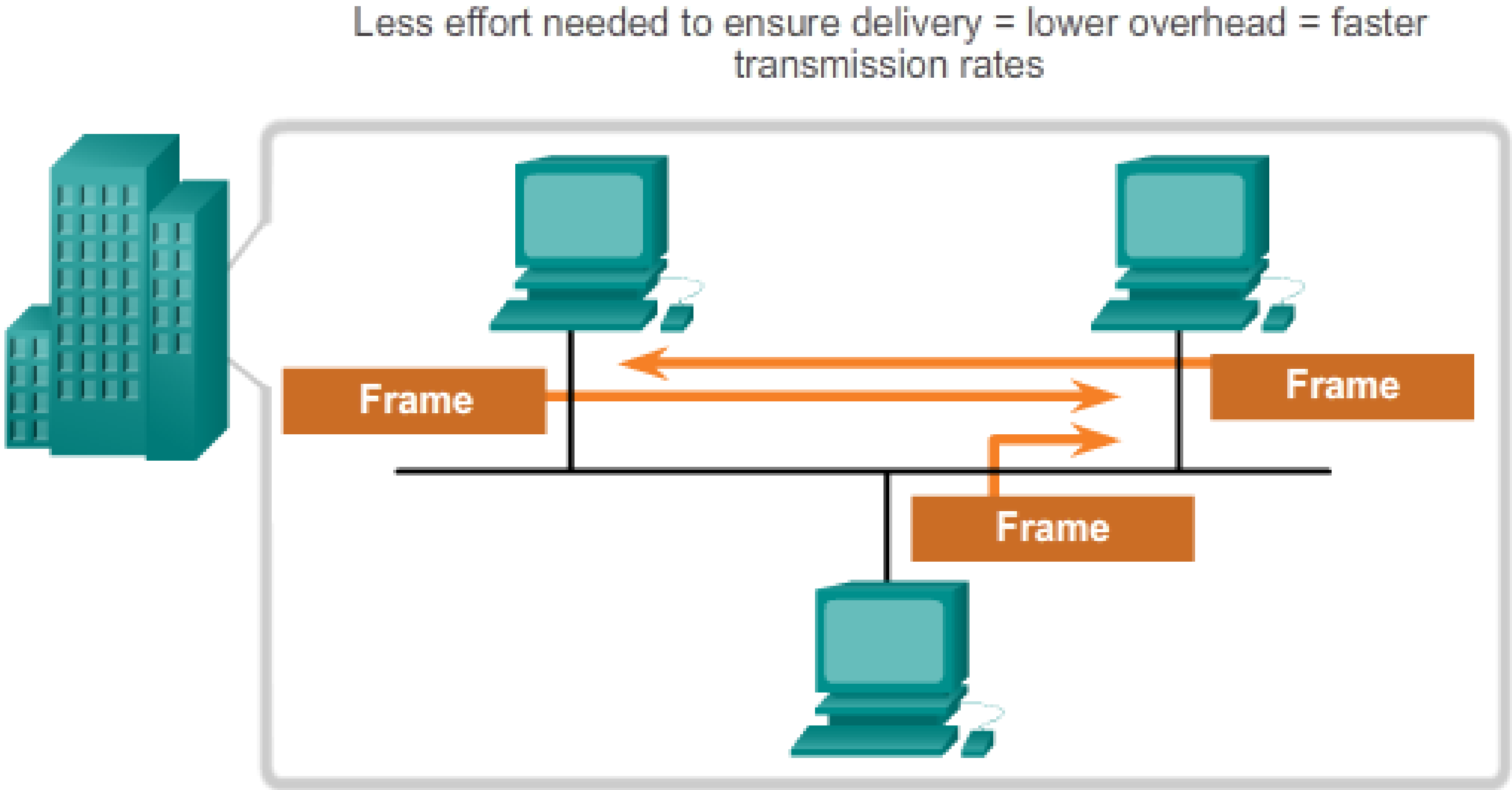
	Physical Topology	Logical Topology
1. CSMA/CD		✓
2. Star	✓	
3. Contention-based access		✓
4. Bus	✓	
5. CSMA/CA		✓
6. Controlled access		✓
7. Point-to-Point	✓	
8. Ring	✓	

4.4.4.1 The Frame



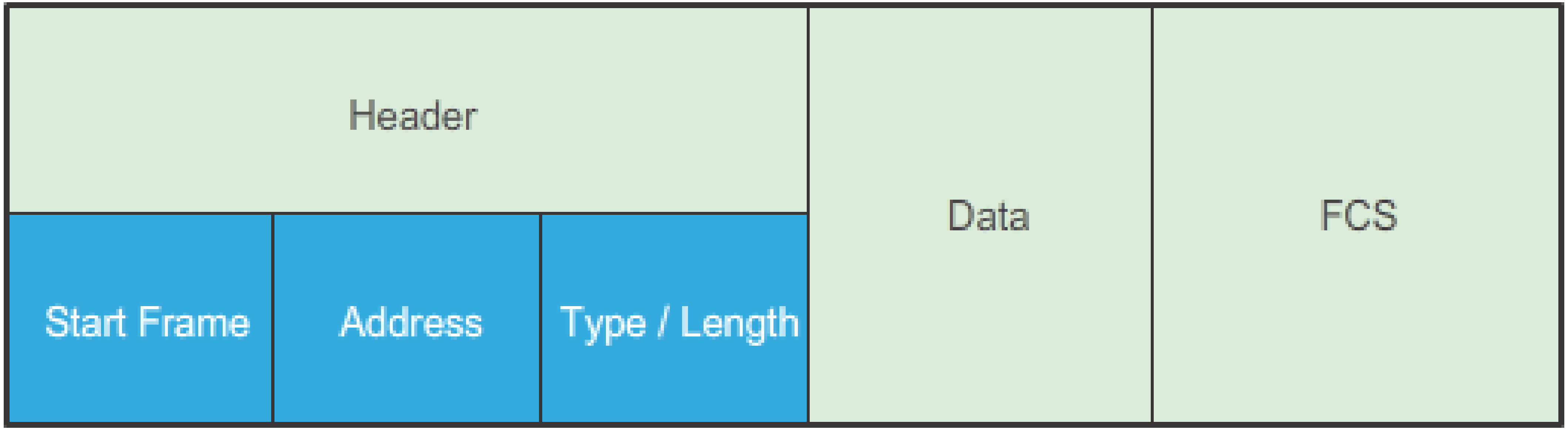
4.4.4.1 The Frame

Protected Environment



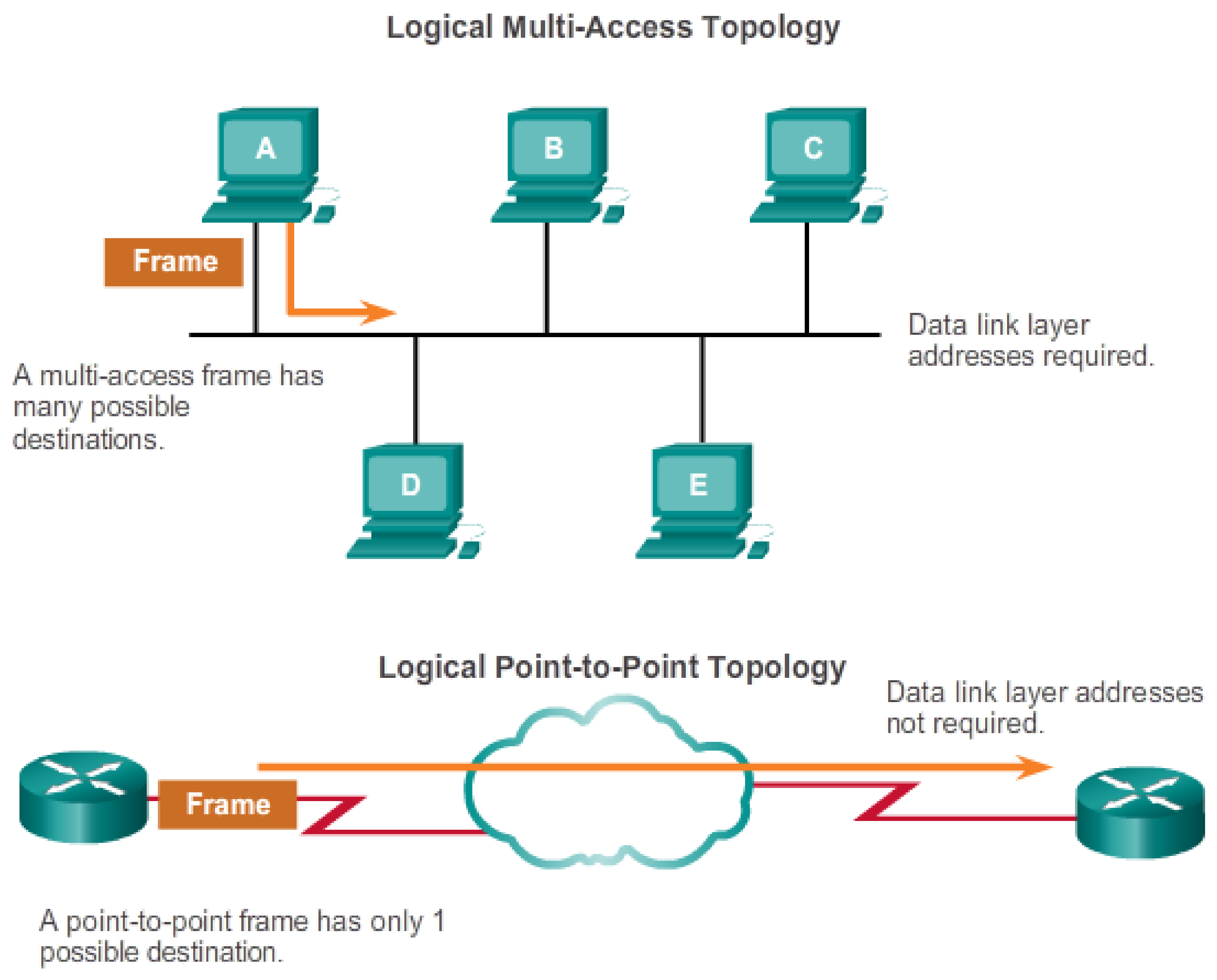
4.4.4.2 The Header

The Role of the Header



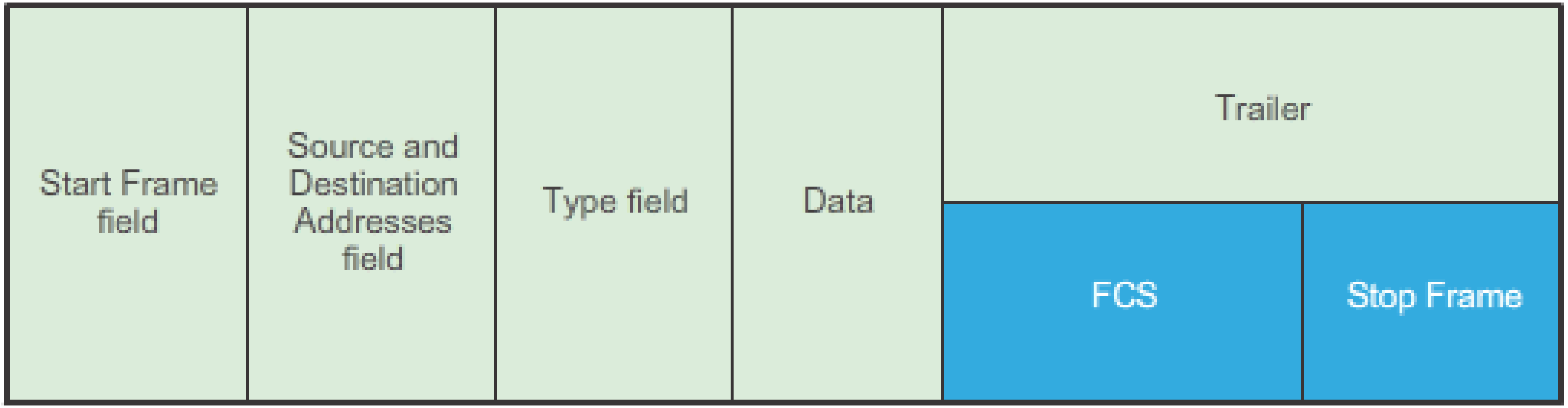
The frame header contains the control information specified by the data link layer protocol for the specific logical topology and media used.

4.4.4.3 Layer 2 Address

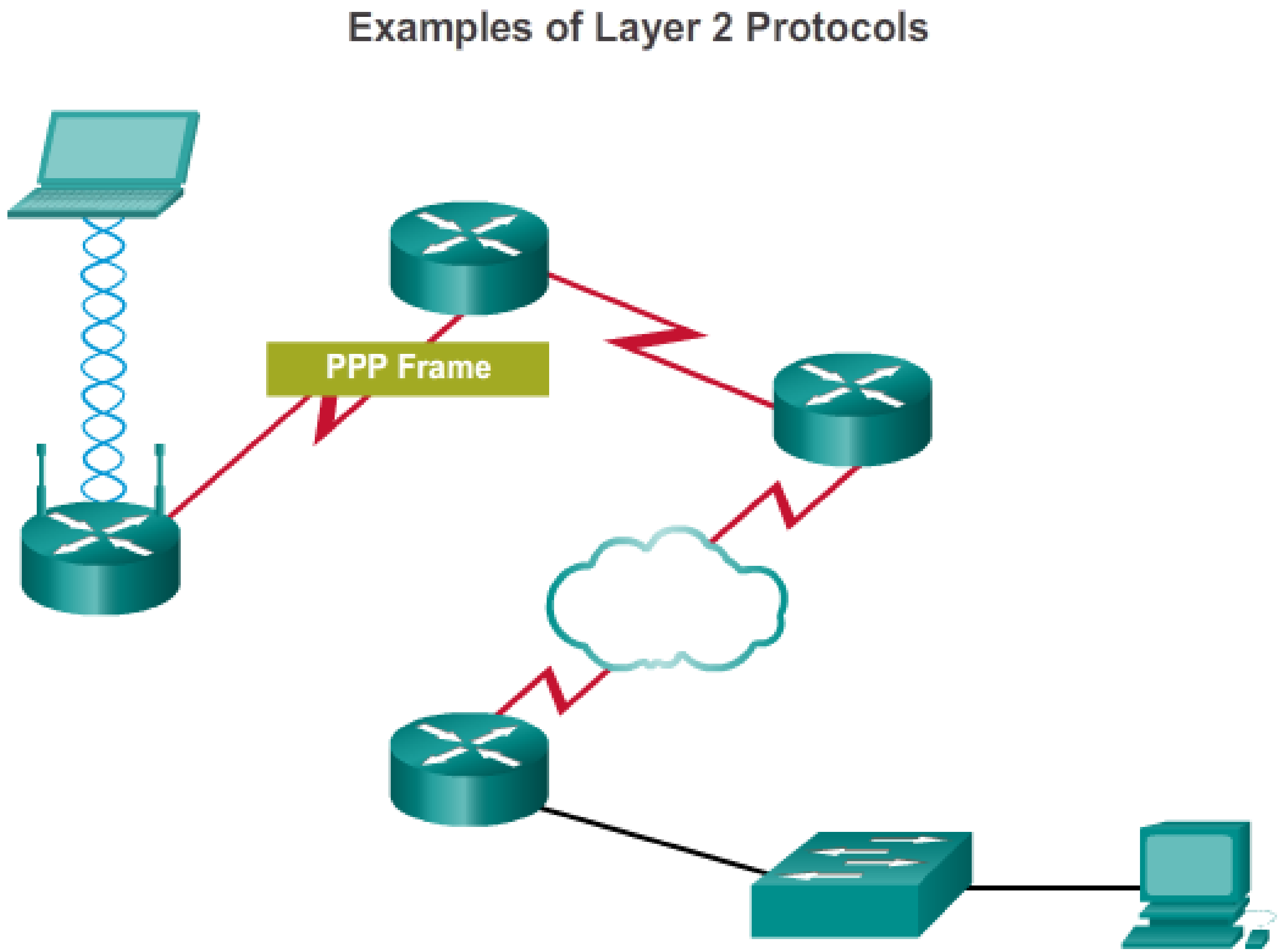


4.4.4.4 The Trailer

Frame Trailer



4.4.4.5 LAN and WAN Frames



The Layer 2 protocol used for a particular network topology is determined by the technology used to implement that topology. The technology is, in turn, determined by the size of the network - in terms of the number of hosts and the geographic scope - and the services to be provided over the network.

Common data link layer protocols include:

- Ethernet
- Point-to-Point Protocol (PPP)
- 802.11 Wireless

4.4.4.6 Ethernet Frame

Ethernet Protocol

A Common Data Link Layer Protocol for LANs

Frame

Field name	Preamble	Destination	Source	Type	Data	Frame Check Sequence
Size	8 bytes	6 bytes	6 bytes	2 bytes	46 - 1500 bytes	4 bytes

Preamble - Used for synchronization; also contains a delimiter to mark the end of the timing information
Destination Address - 48-bit MAC address for the destination node
Source Address - 48-bit MAC address for the source node
Type - Value to indicate which upper layer protocol will receive the data after the Ethernet process is complete
Data or payload - This is the PDU, typically an IPv4 packet, that is to be transported over the media.
Frame Check Sequence (FCS) - A value used to check for damaged frames

4.4.4.7 PPP Frame

Point-to-Point Protocol

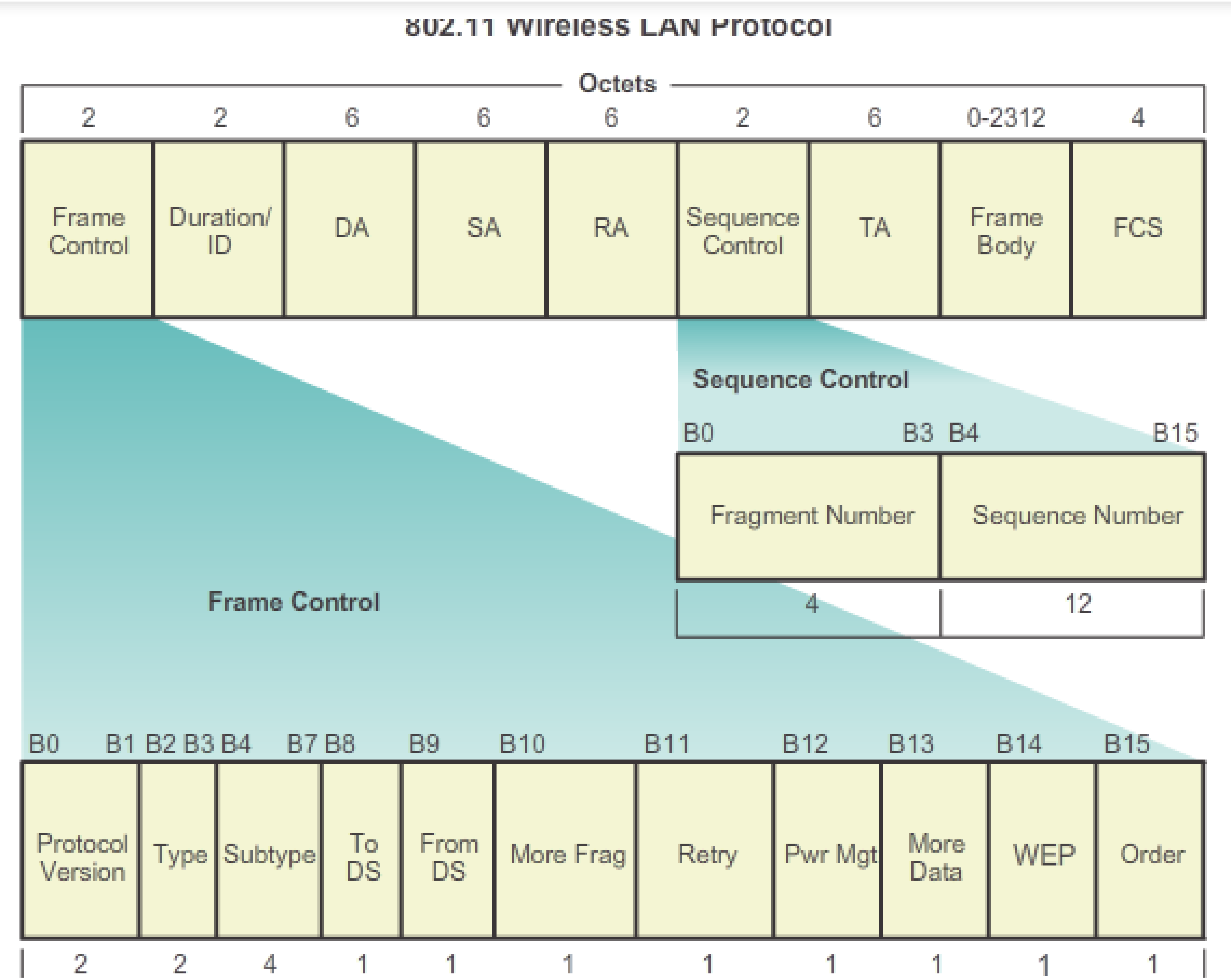
A Common Data Link Protocol for WANs

Frame

Field name	Flag	Address	Control	Protocol	Data	FCS
Size	1 byte	1 byte	1 byte	2 bytes	variable	2 or 4 bytes

Flag - A single byte that indicates the beginning or end of a frame. The flag field consists of the binary sequence 01111110.
Address - A single byte that contains the standard PPP broadcast address. PPP does not assign individual station addresses.
Control - A single byte that contains the binary sequence 00000011, which calls for transmission of user data in an unsequenced frame.
Protocol - Two bytes that identify the protocol encapsulated in the data field of the frame. The most up-to-date values of the protocol field are specified in the most recent Assigned Numbers Request For Comments (RFC).
Data - Zero or more bytes that contain the datagram for the protocol specified in the protocol field.
Frame Check Sequence (FCS) - Normally 16 bits (2 bytes). By prior agreement, consenting PPP implementations can use a 32-bit (4-byte) FCS for improved error detection.

4.4.4.8 802.11 Wireless Frame



4.4.4.9 Activity - Frame Fields

Ethernet Frame

Preamble	Destination	Source	Type	Data	Frame Check Sequence
8 bytes	6 bytes	6 bytes	2 bytes	46-1500 bytes	4 bytes

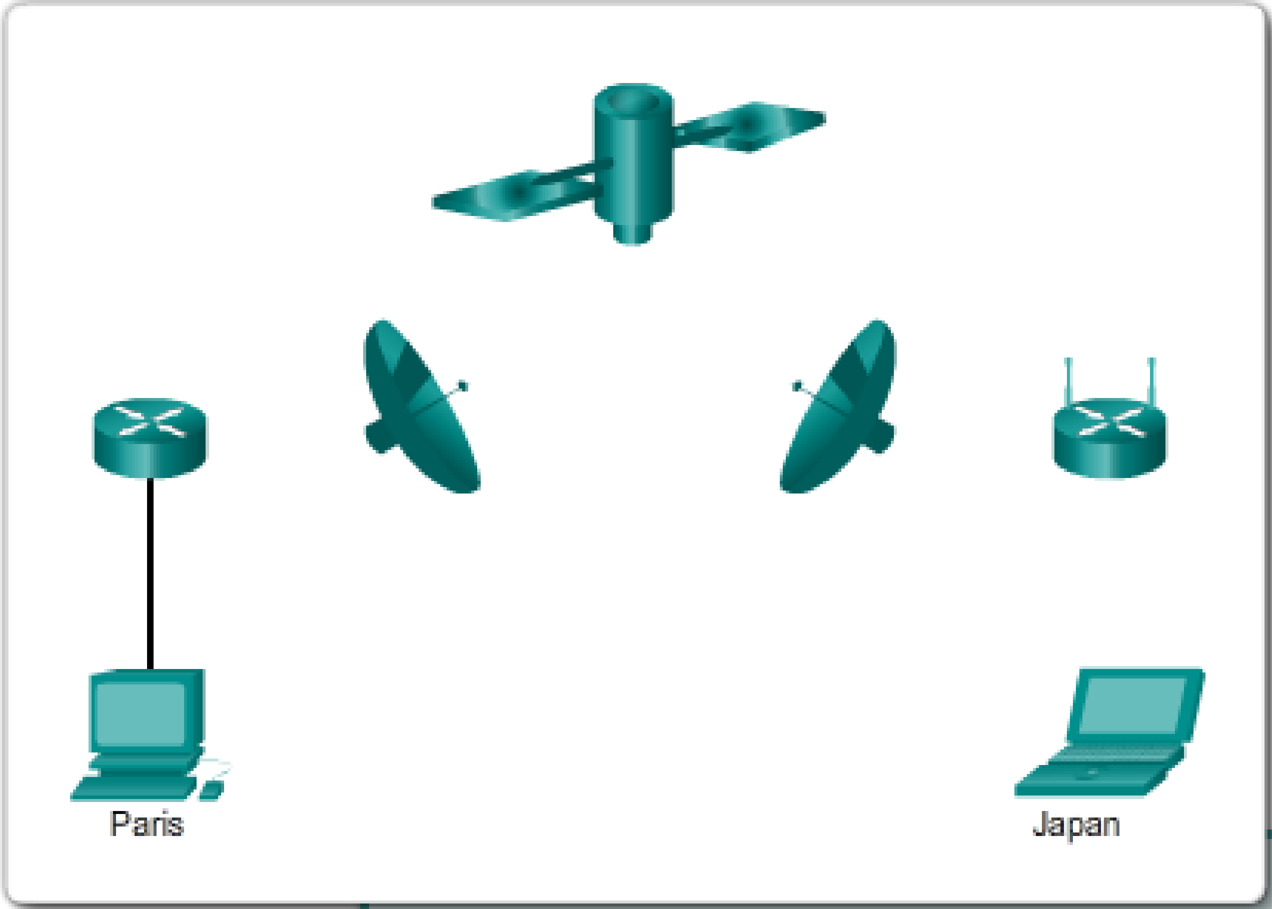
PPP Frame

Flag	Address	Control	Protocol	Data	FCS
1 byte	1 byte	1 bytes	2 bytes	Variable	2 or 4 bytes

802.11 Wireless Frame

Frame Control	Duration/ ID	DA	SA	RA	Sequence Control	TA	Frame Body	FCS
2 octets	2 octets	6 octets	6 octets	6 octets	2 octets	6 octets	0-2312 octets	4 octets

4.5.1.1 Class Activity - Linked In!

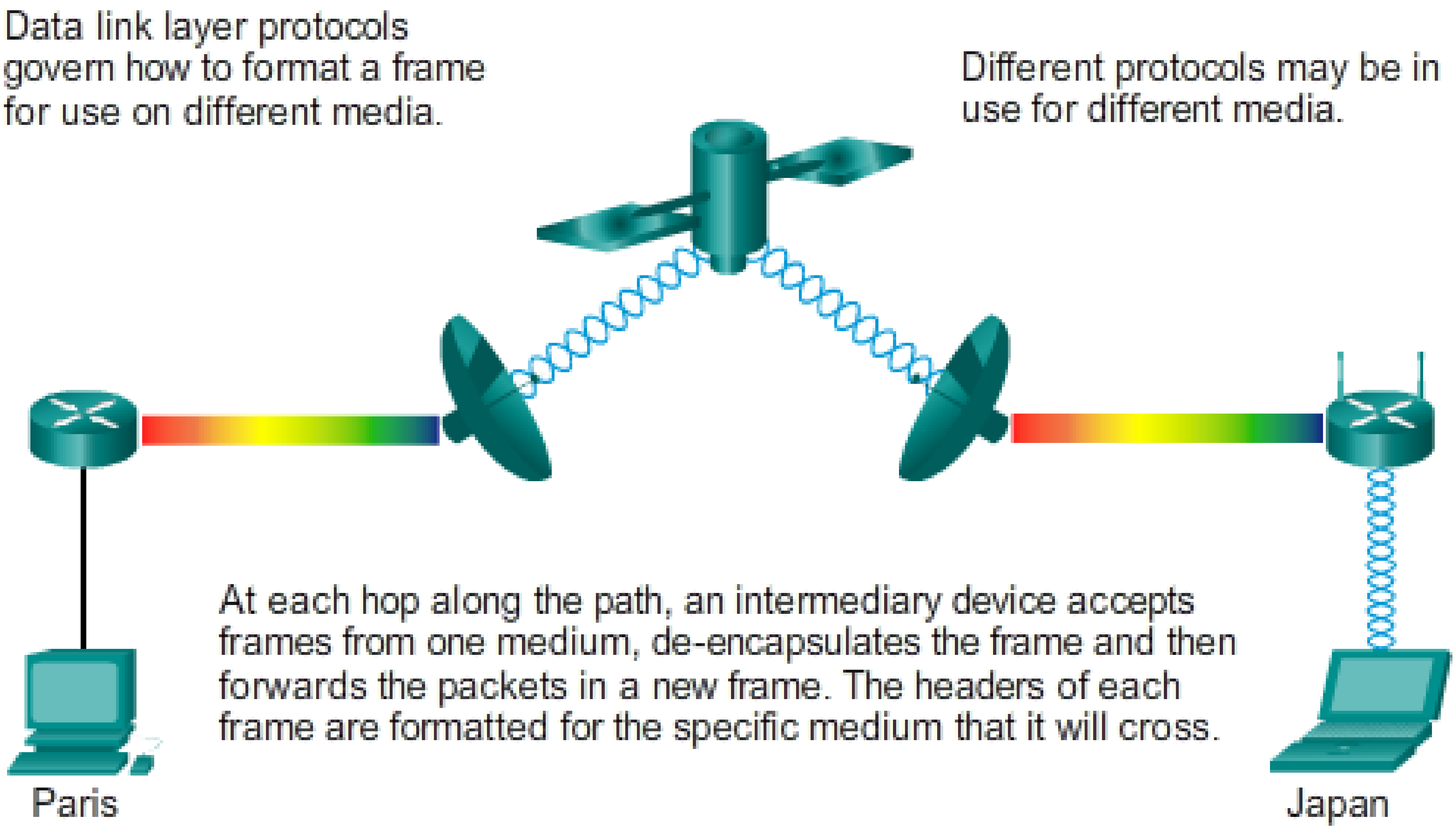


The Network Access Layer combines the type of data link and signaling method to deliver data packets securely and seamlessly.

This activity is best completed in groups of 2-3 students.

Your small business is moving to a new location! Your building is brand new, and you have been tasked to come up with a physical model so that network port installation can begin.

4.5.1.2 Summary



Thanks for your attention!