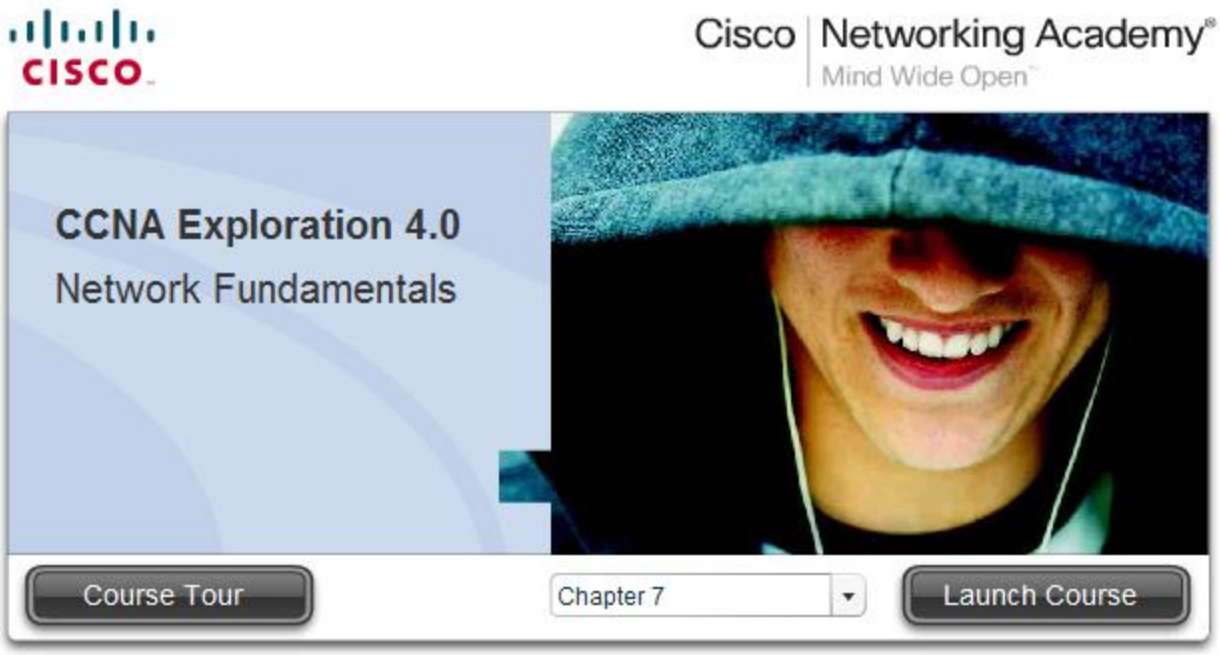
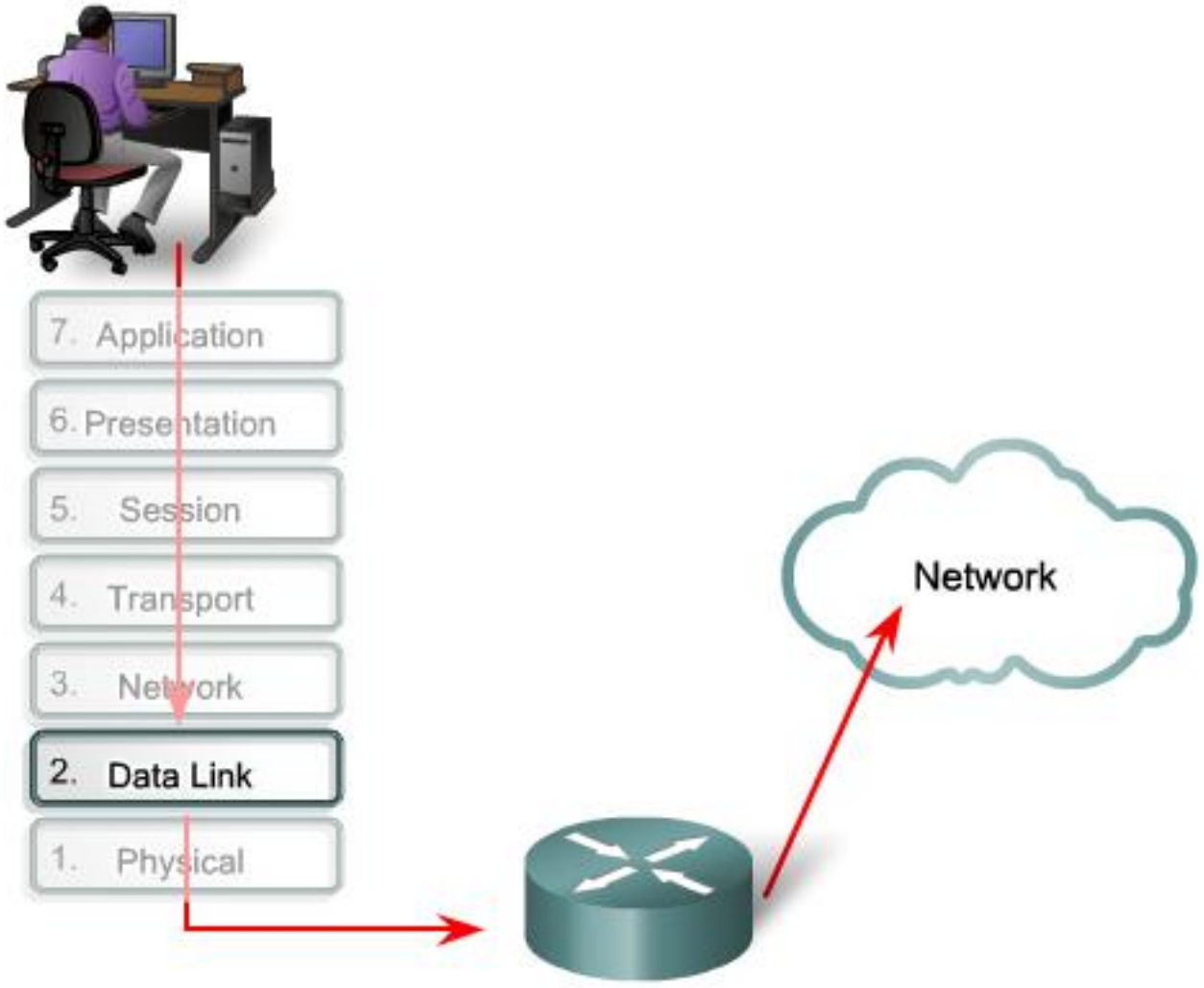
Chapter 7 The Datalink Layer

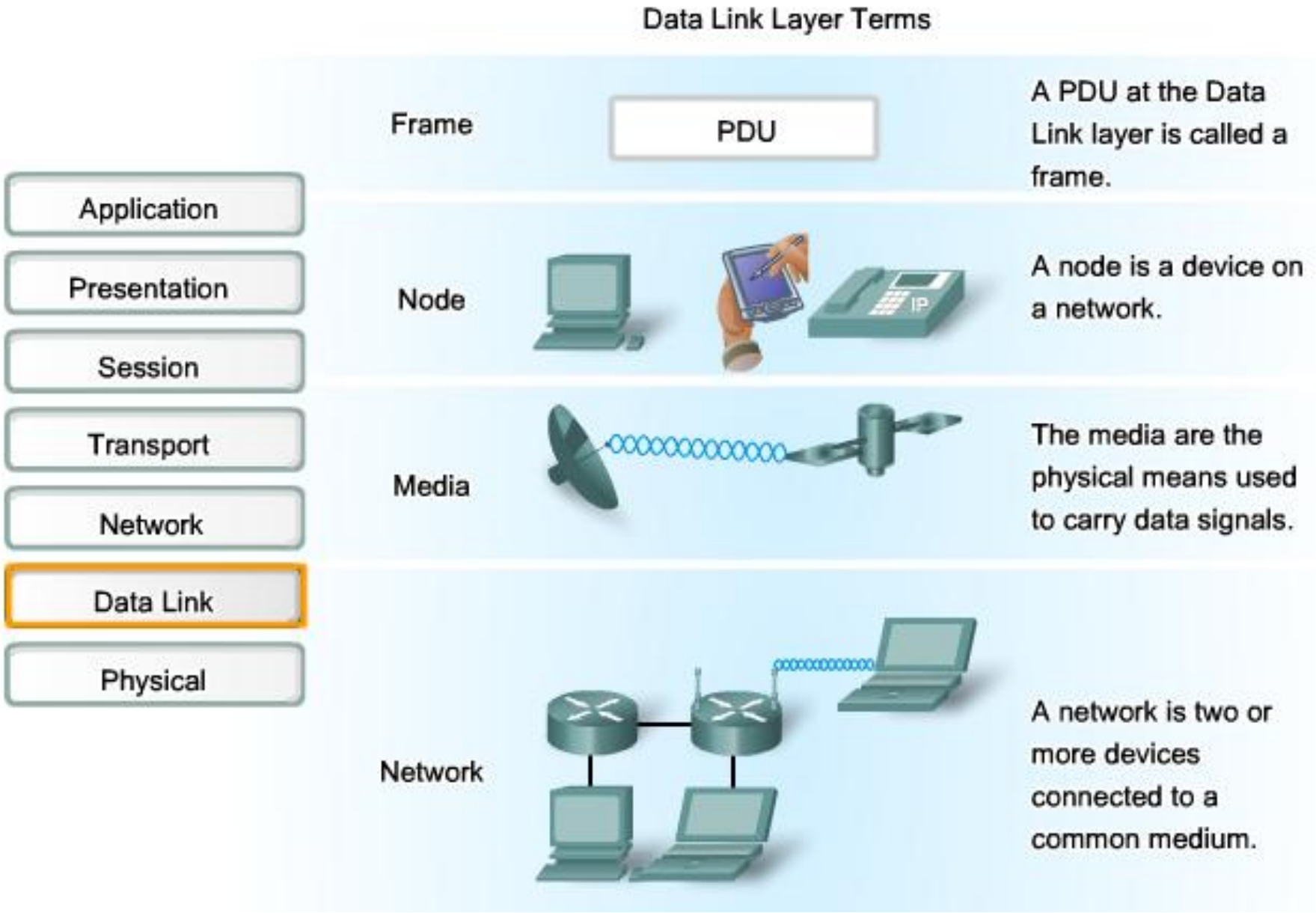


7.0.1 Introduction



The Data Link layer prepares network data for the physical network.

7.1.1 Supporting and Connecting to Upper Layers

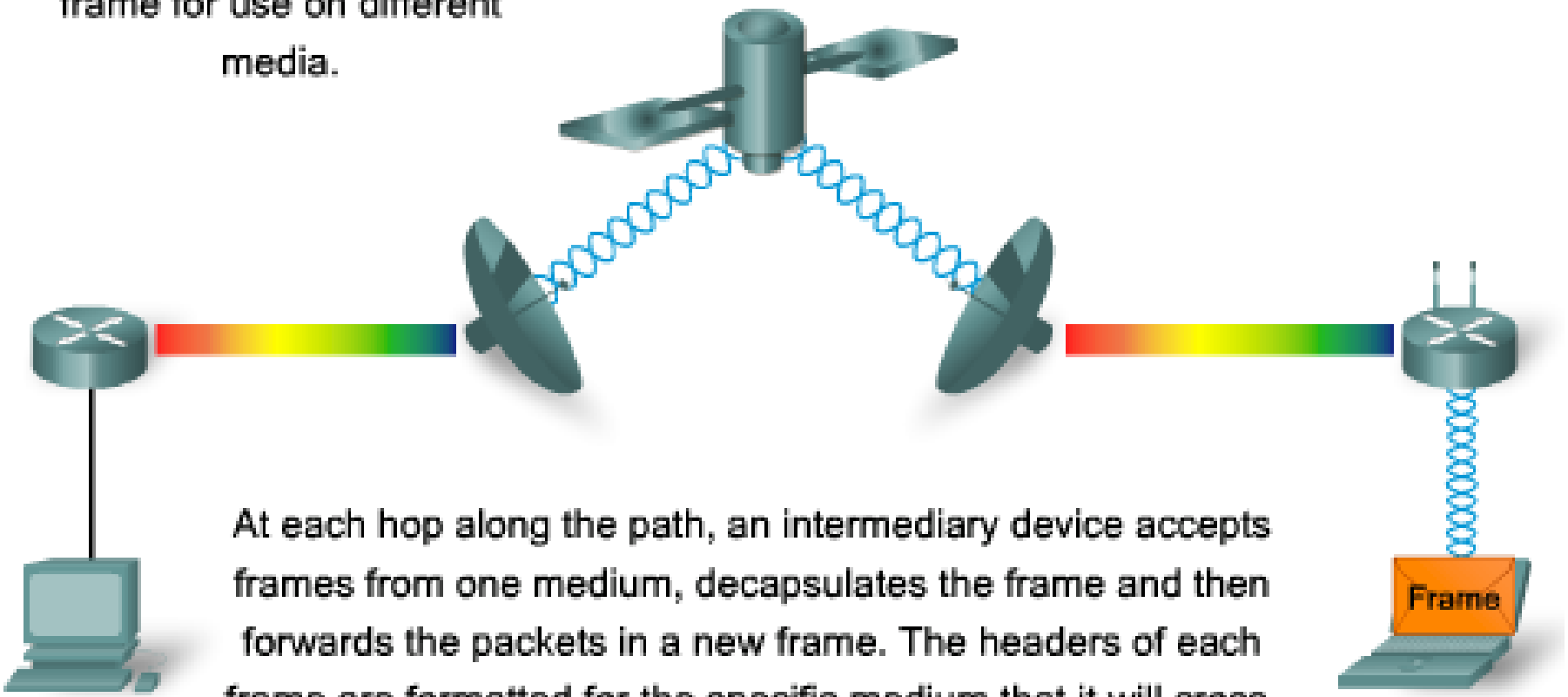


7.1.1 Supporting and Connecting to Upper Layers

The Data Link Layer

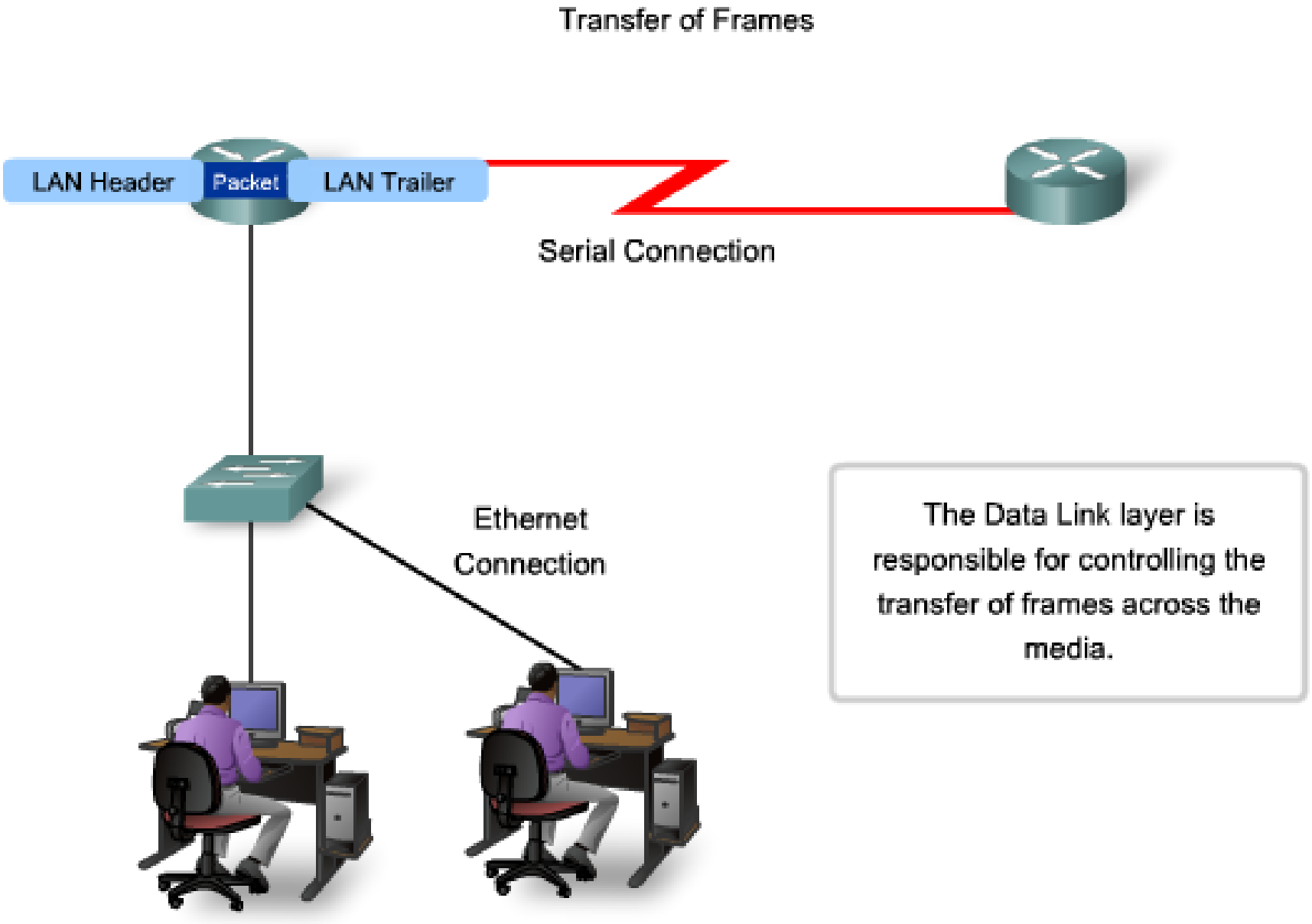
Data link layer protocols govern how to format a frame for use on different media.

Different protocols may be in use for different media.



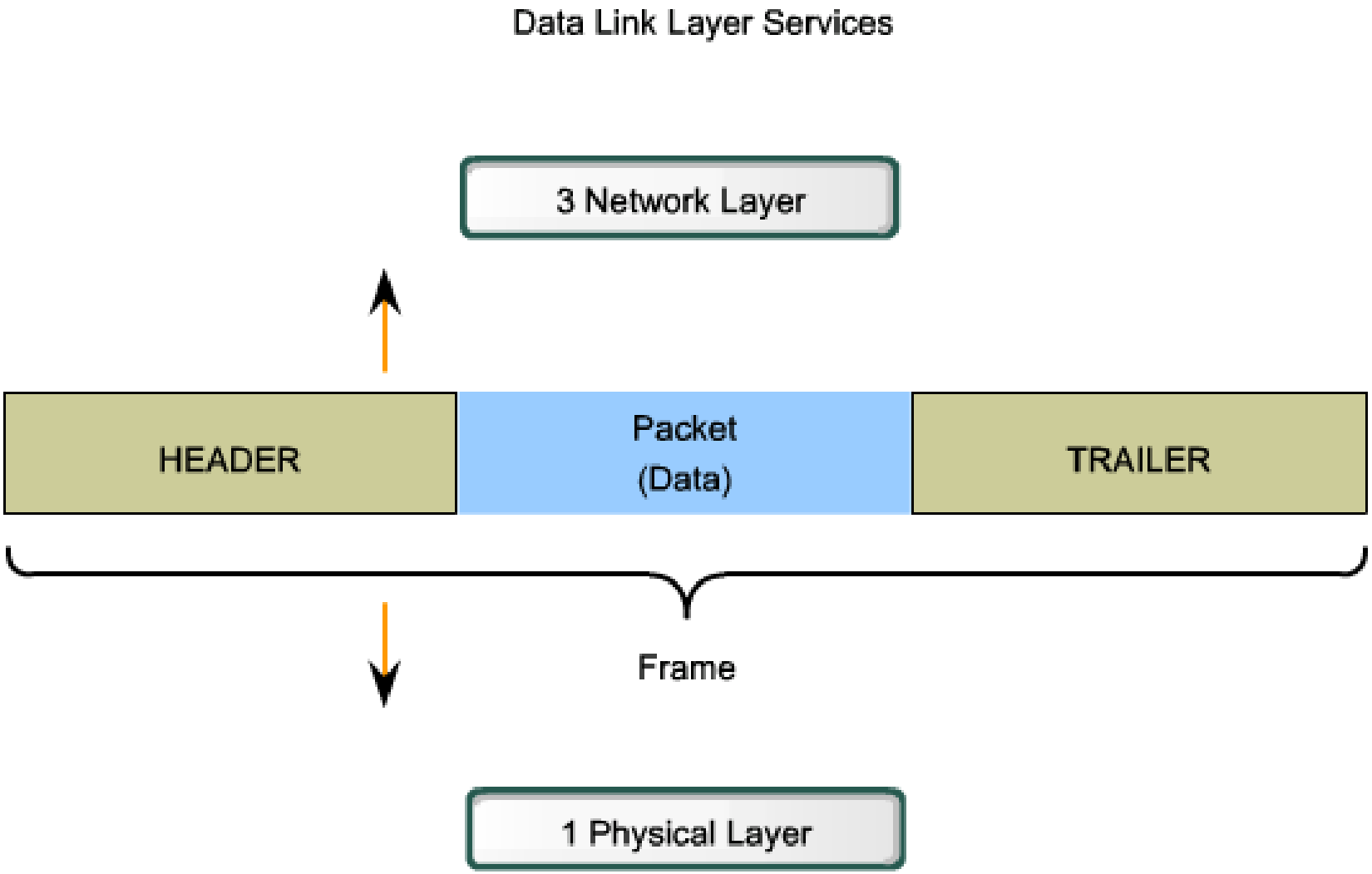
At each hop along the path, an intermediary device accepts frames from one medium, decapsulates the frame and then forwards the packets in a new frame. The headers of each frame are formatted for the specific medium that it will cross.

7.1.2 Controlling Data Across the Media

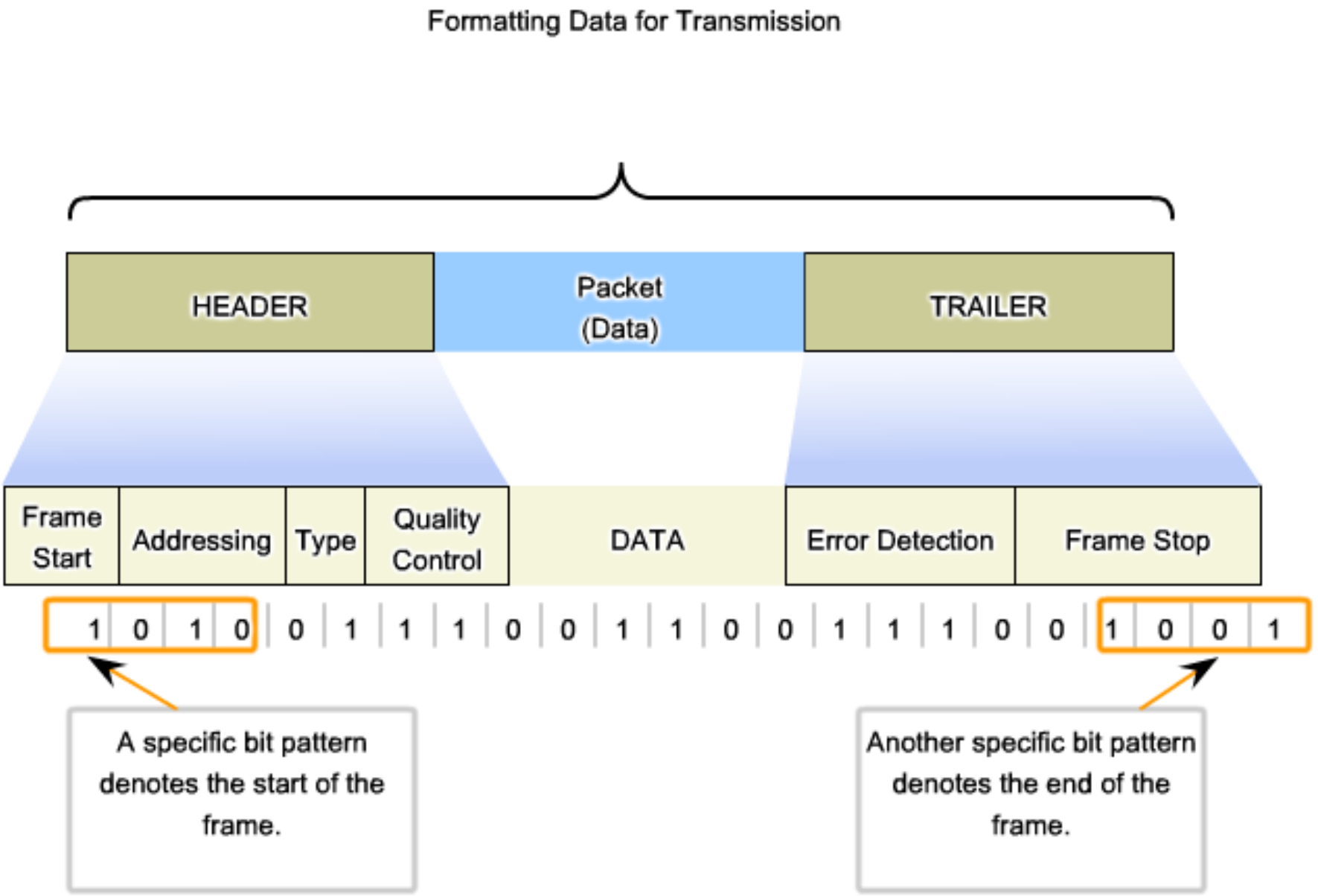


The Data Link layer is responsible for controlling the transfer of frames across the media.

7.1.3 Creating a Frame



7.1.3 Creating a Frame

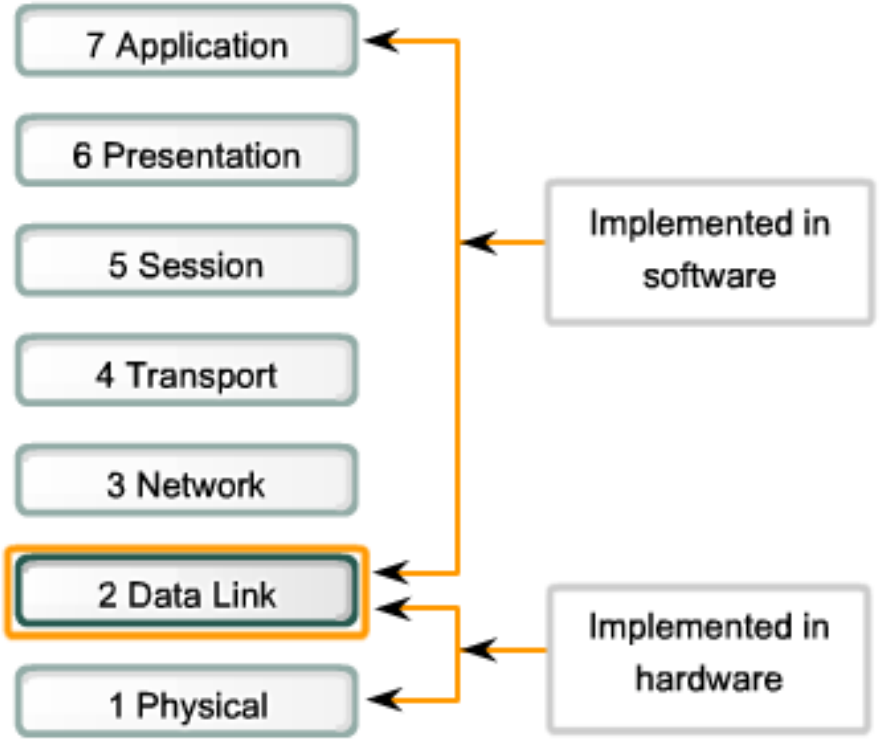


7.1.4 Connecting Upper Layer Services to the Media

Connecting Upper Layer Services to the Media

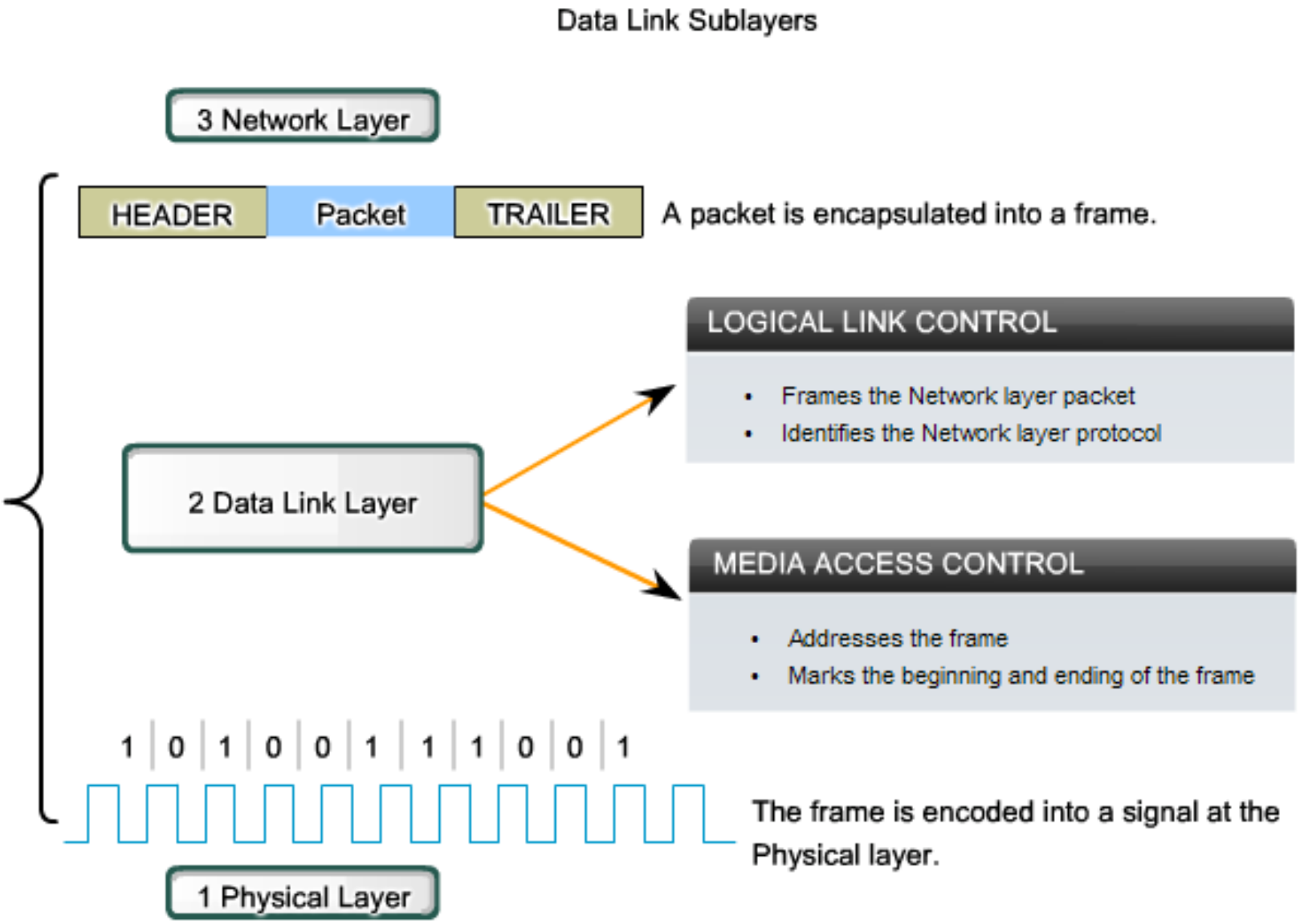
The Data Link layer links the software and hardware layers.

Physical devices devoted to the Data Link layer have both hardware and software components.



PC NIC

7.1.4 Connecting Upper Layer Services to the Media



7.1.5 Data Link Layer Services

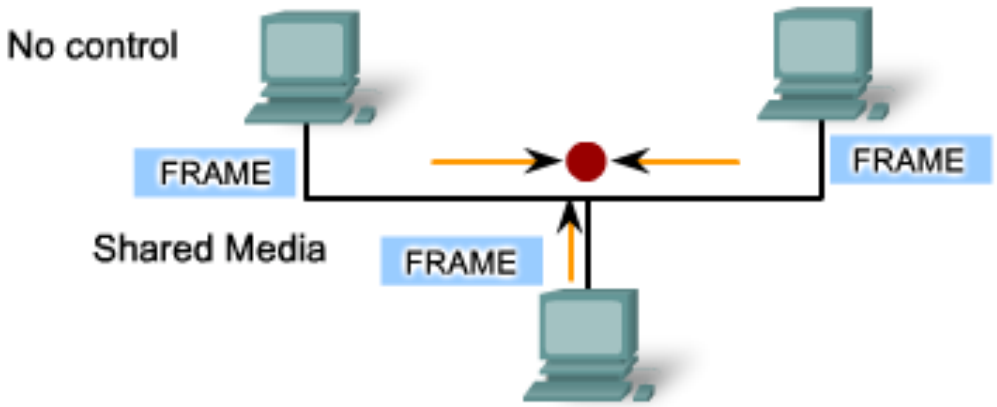
Standards for the Data Link Layer

ISO:	HDLC (High Level Data Link Control)
IEEE:	802.2 (LLC), 802.3 (Ethernet) 802.5 (Token Ring) 802.11(Wireless LAN)
ITU:	Q.922 (Frame Relay Standard) Q.921 (ISDN Data Link Standard) HDLC (High Level Data Link Control)
ANSI:	3T9.5 ADCCP (Advanced Data Communications Control Protocol)

7.2.1 Placing Data on the Media

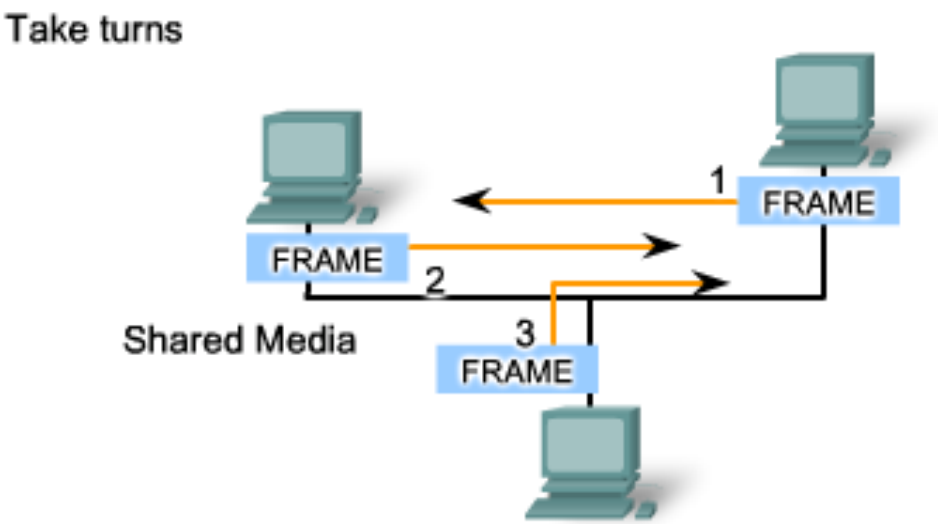
Media Access Control Methods

No control at all would result in many collisions.
Collisions cause corrupted frames that must be resent.

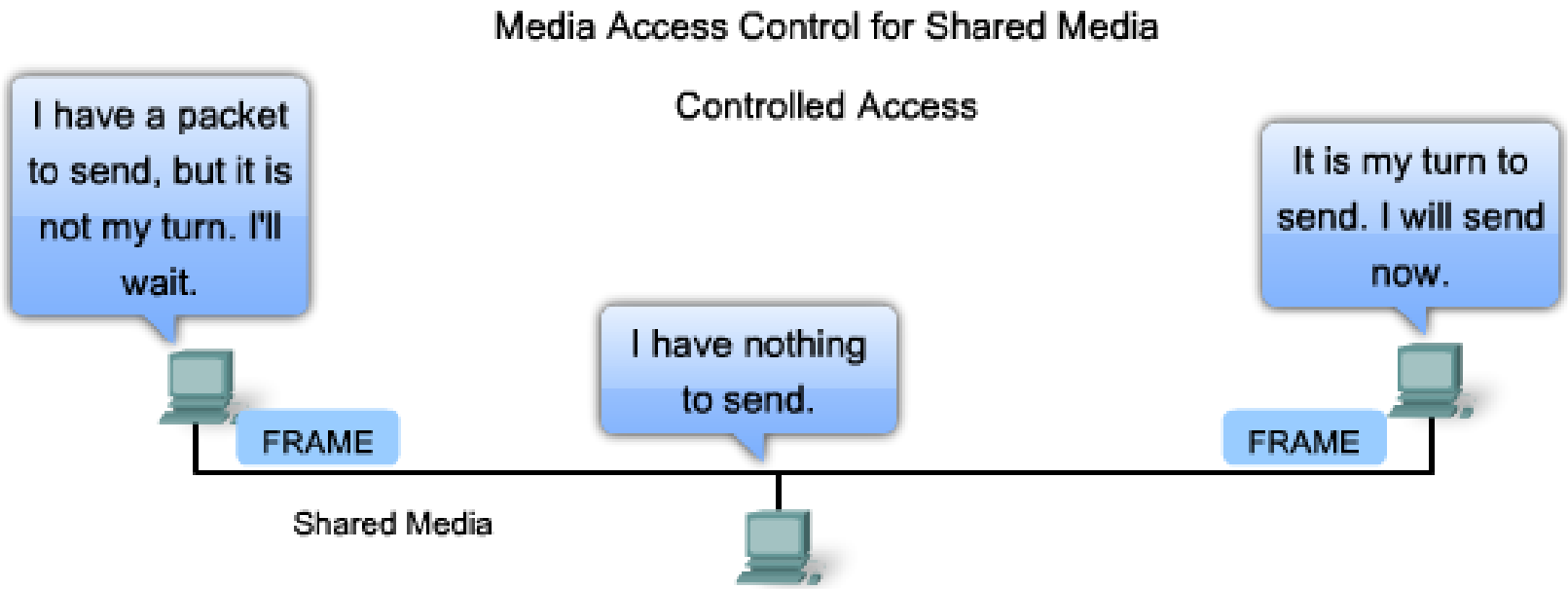


Methods that enforce a high degree of control prevent collisions, but the process has high overhead.

Methods that enforce a low degree of control have low overhead, but there are more frequent collisions.

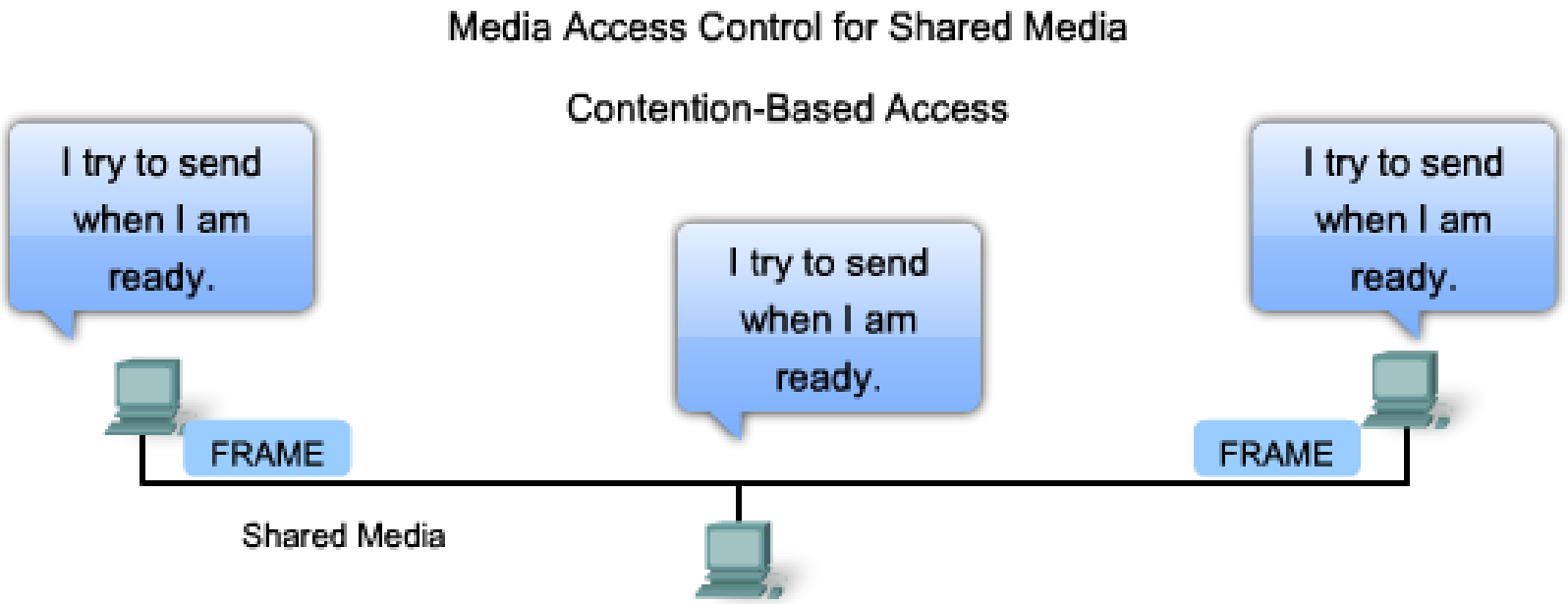


7.2.2 Media Access for Controlled Media



Method	Characteristics	Example
Controlled Access	• Only one station transmits at a time • Devices wishing to transmit must wait their turn • No collisions • Some deterministic networks use token passing	• Token Ring • FDDI

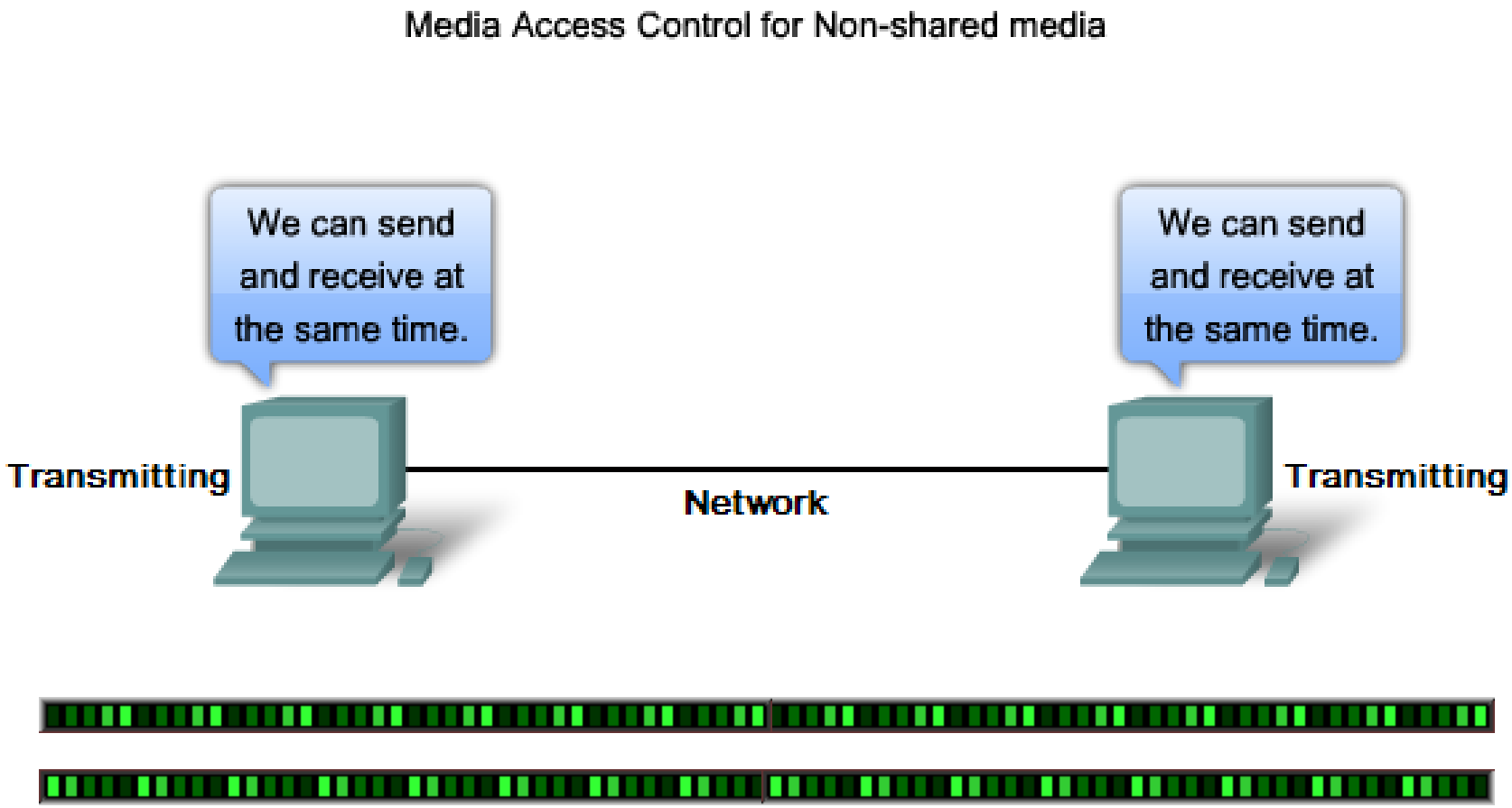
7.2.2 Media Access for Controlled Media



Method	Characteristics	Example

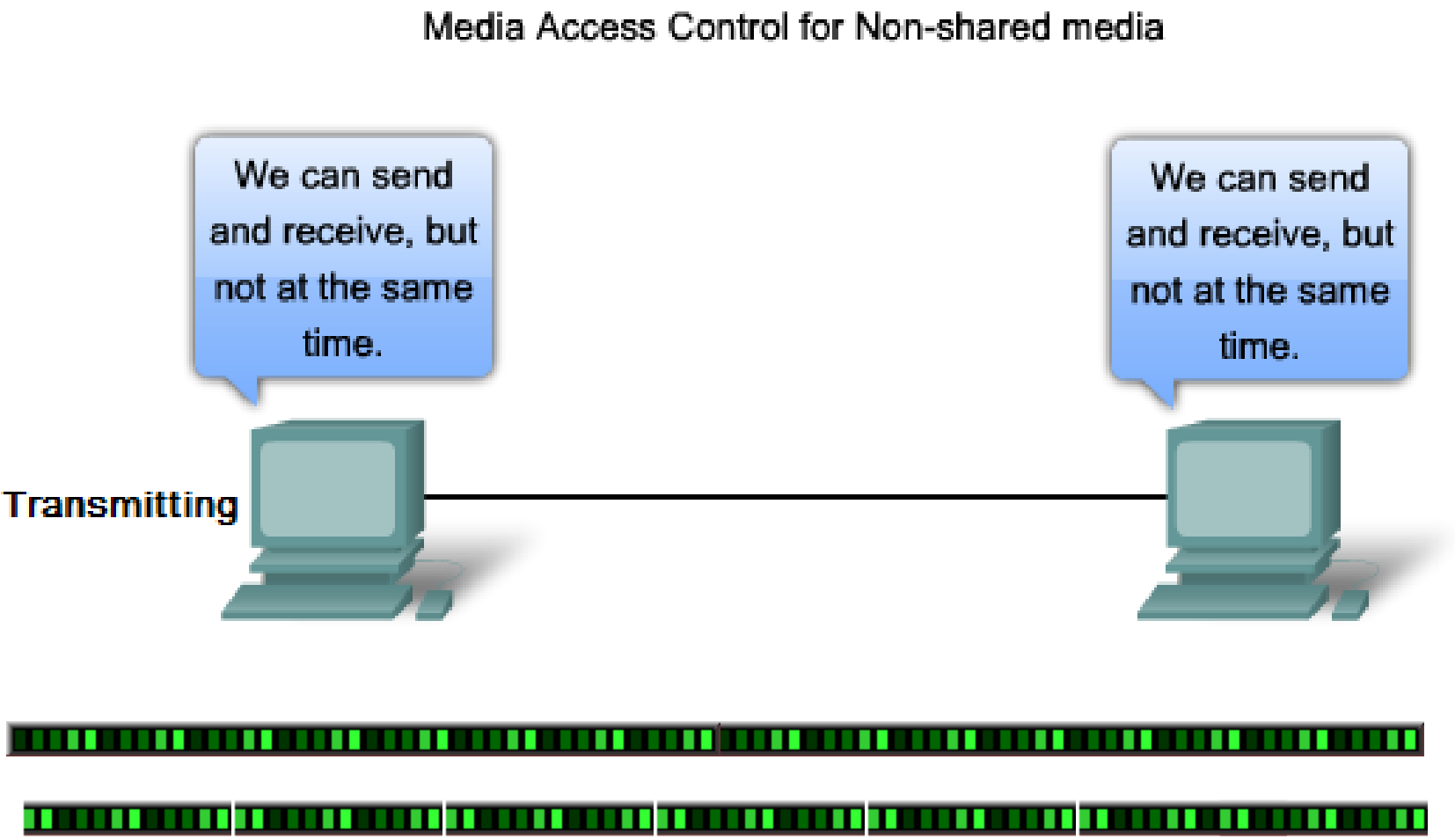
Contention Based Access	• Stations can transmit at any time
	• Collisions exist
	• Mechanisms exist to resolve contention:
	  • CSMA/CD for Ethernet networks
	  • CSMA/CA for 802.11 wireless networks
		• Ethernet
		• Wireless

7.2.3 Media Access Control for Non-Shared Media



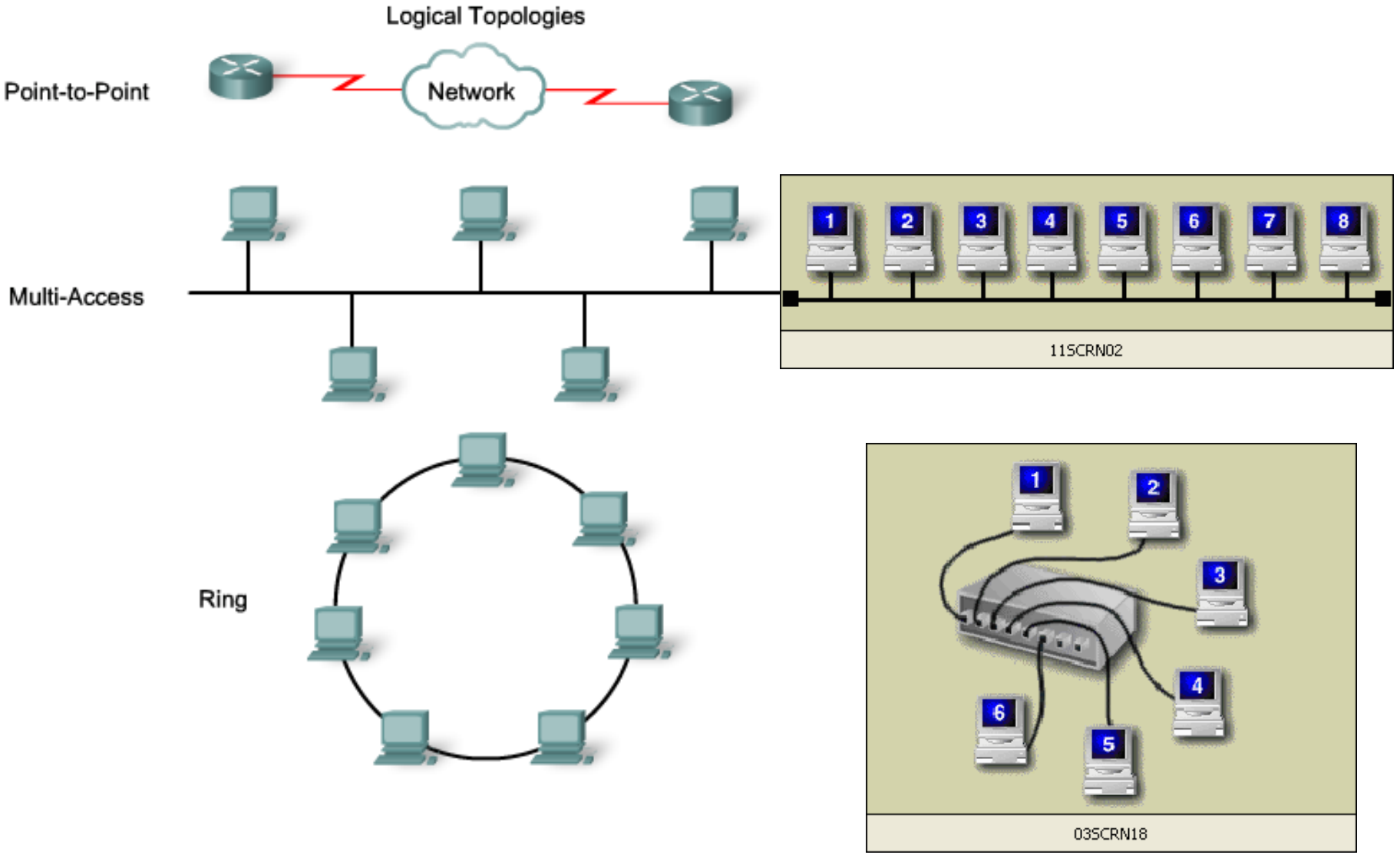
Full Duplex

7.2.3 Media Access Control for Non-Shared Media

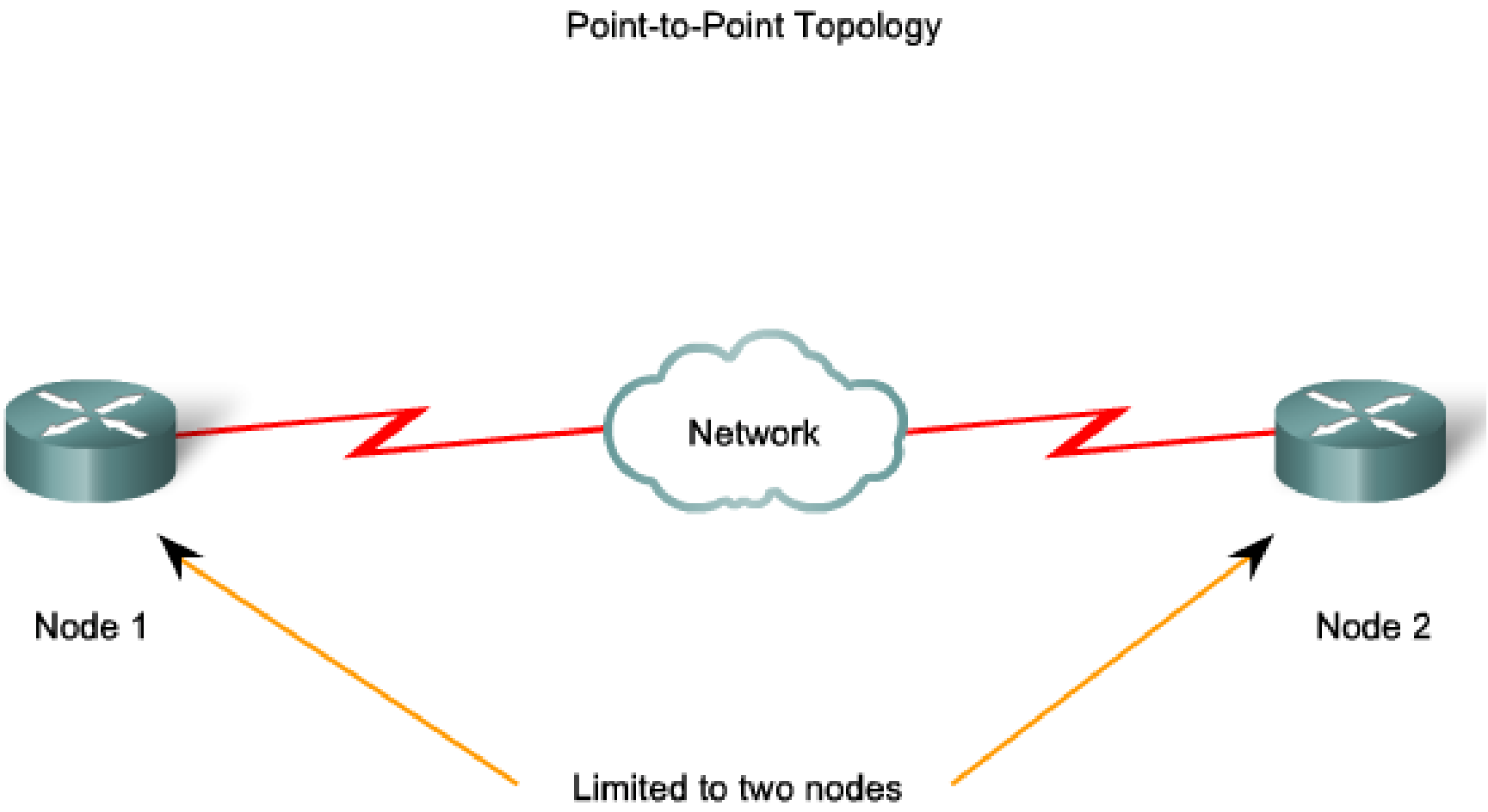


Half Duplex

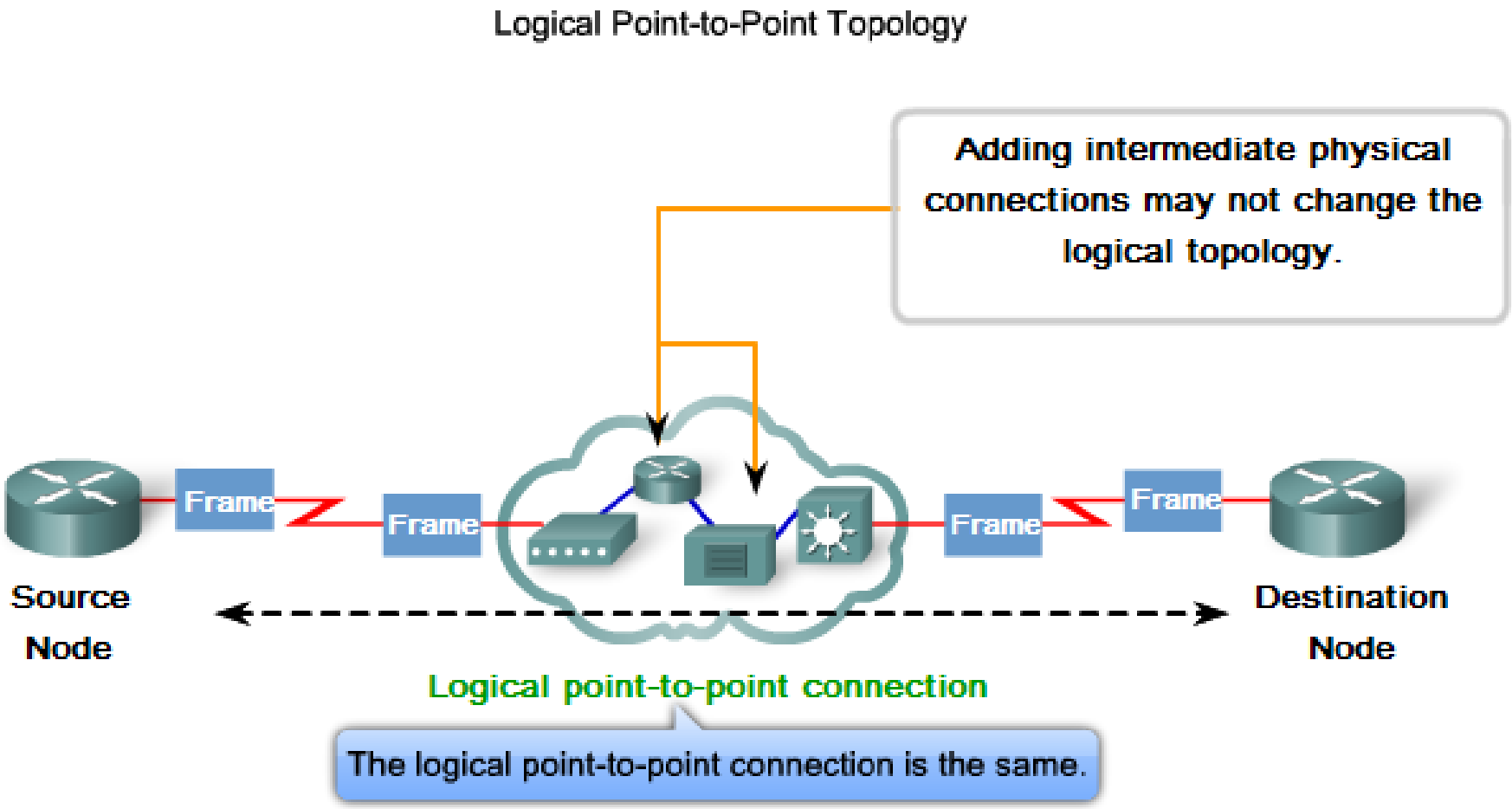
7.2.4 Logical Topology vs Physical Topology



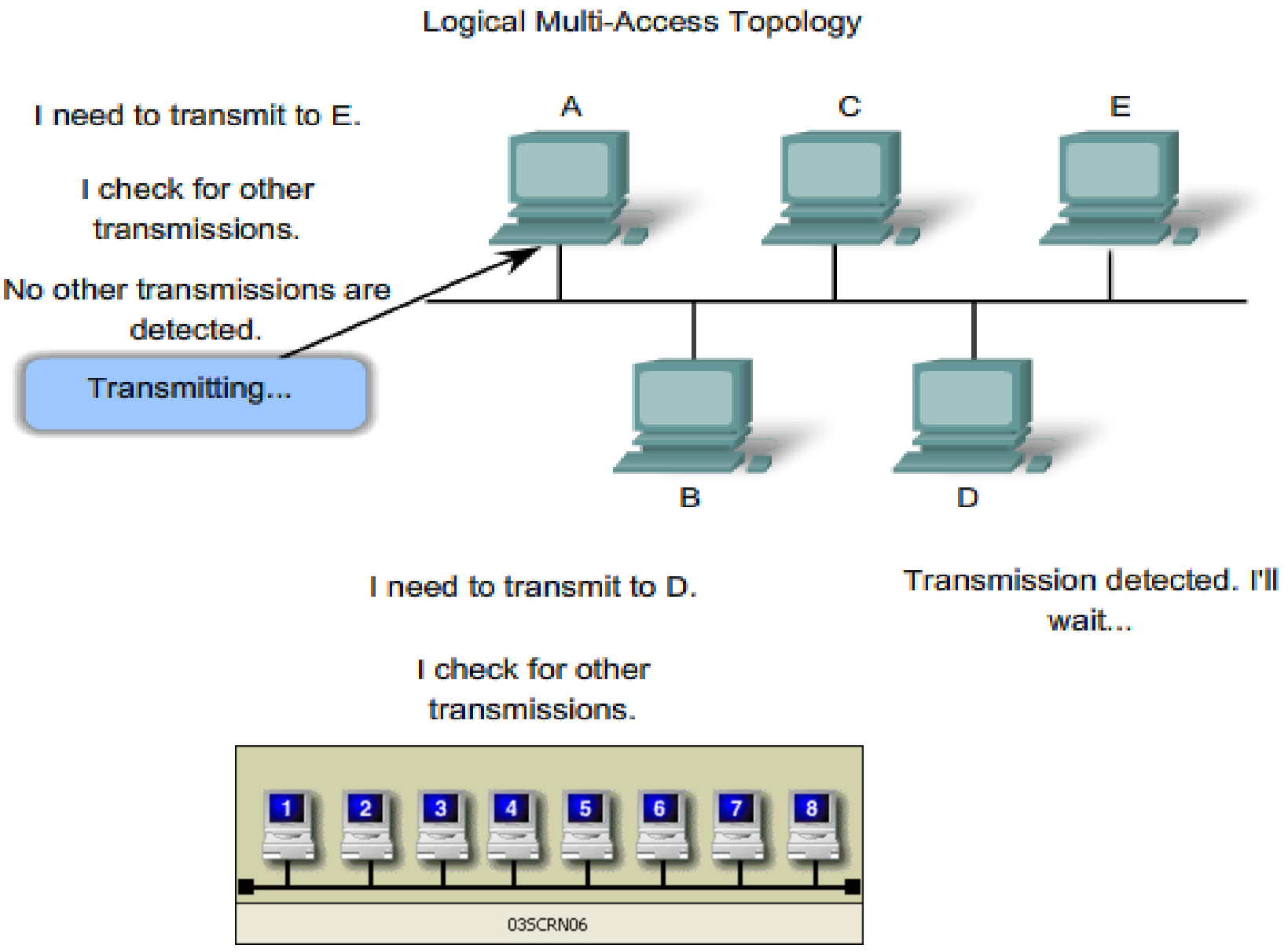
7.2.5 Point to Point Topology



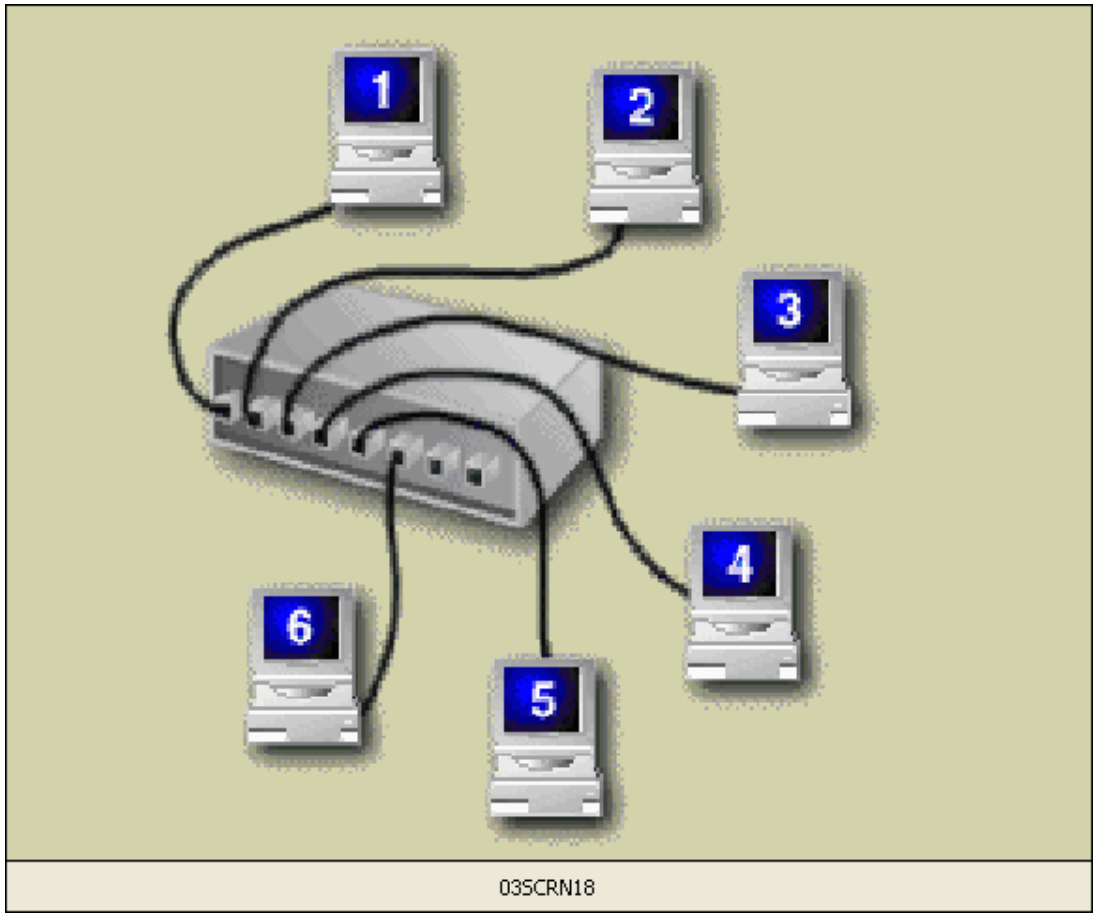
7.2.5 Point to Point Topology



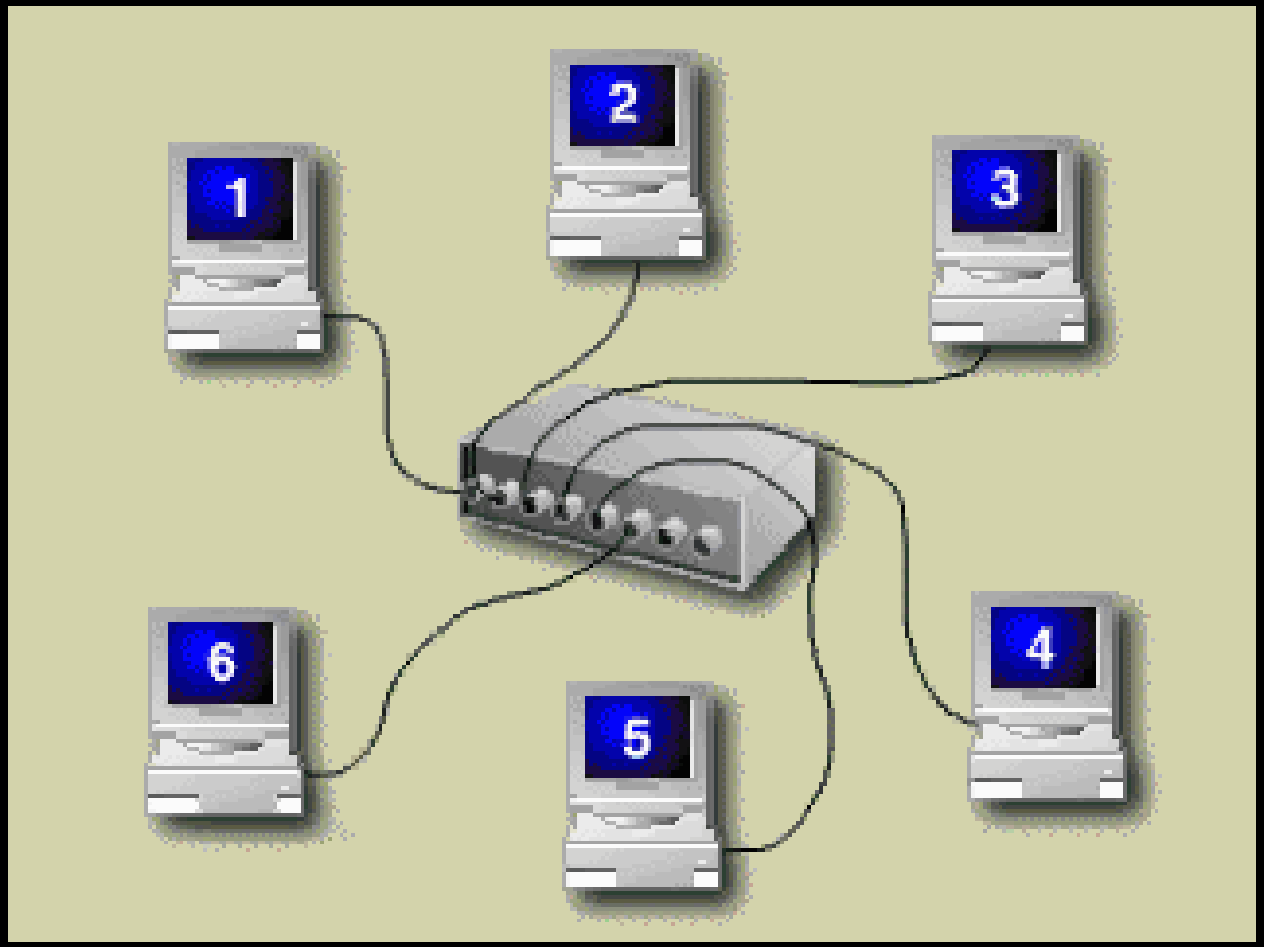
7.2.6 Logical Multi Access Topology



7.2.7 Logical Ring Topology / Physical Star Topology



7.2.7 Logical Bus / Physical Star

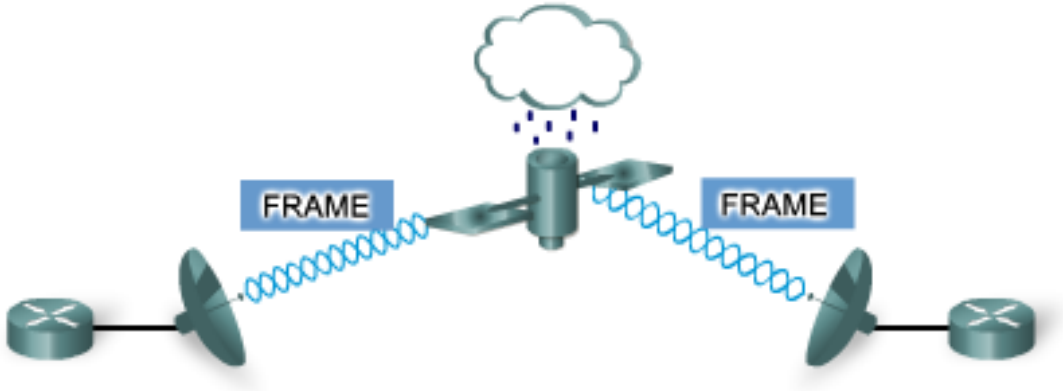


7.3.1 Datalink Frame

Data Link Layer Protocols - The Frame

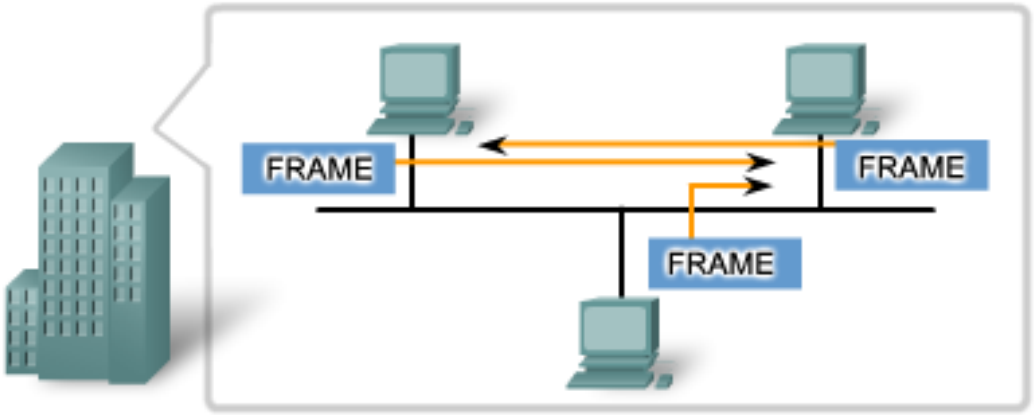
In a fragile environment, more controls are needed to ensure delivery. The header and trailer fields are larger as more control information is needed.

Greater effort needed to ensure delivery = higher overhead = slower transmission rates



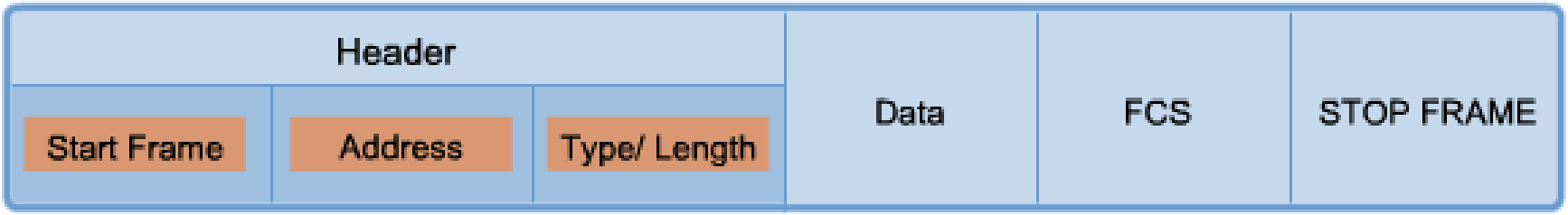
In a protected environment, we can count on the frame arriving at its destination. Fewer controls are needed, resulting in smaller fields and smaller frames.

Less effort needed to ensure delivery = lower overhead = faster transmission rates



7.3.2 Role of the Header

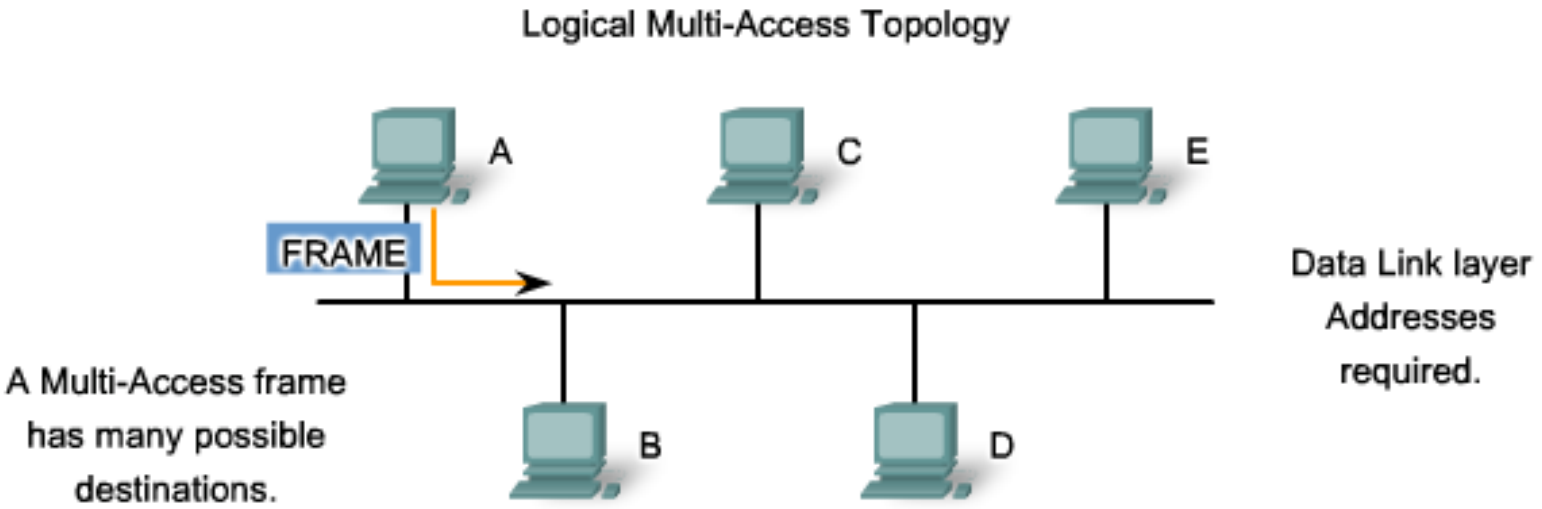
The Role of the Header

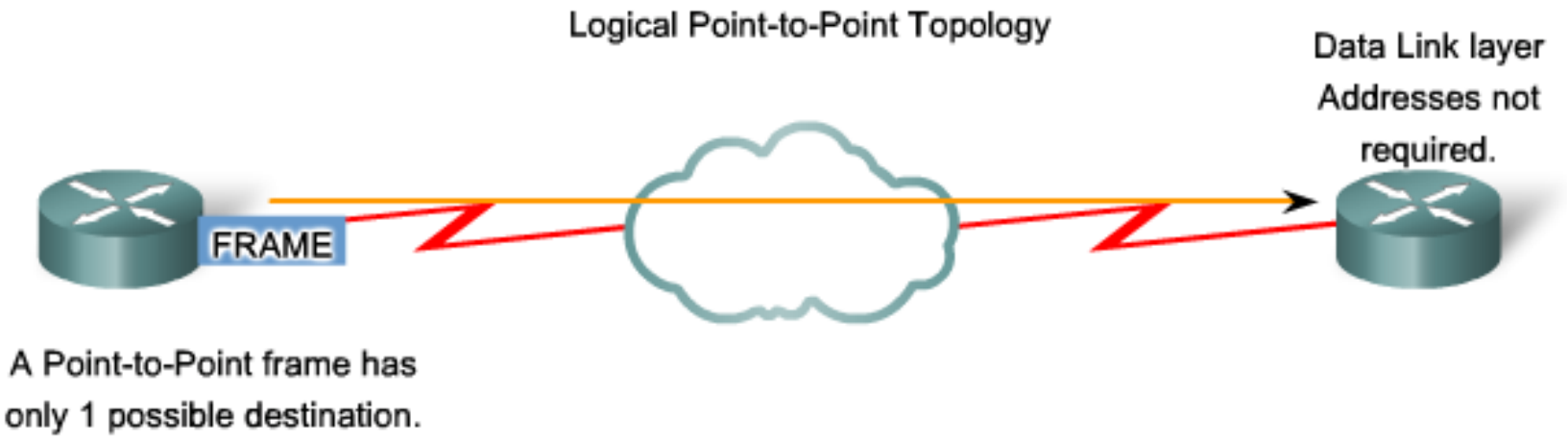


- **The Start Frame field warns other devices on the NW that a frame is coming**
- **The Address Field stores the Source and Destination Addresses**
- **The Type/Length field is an optional field used by some protocols to announce the type of data that is coming or maybe the length of the frame**

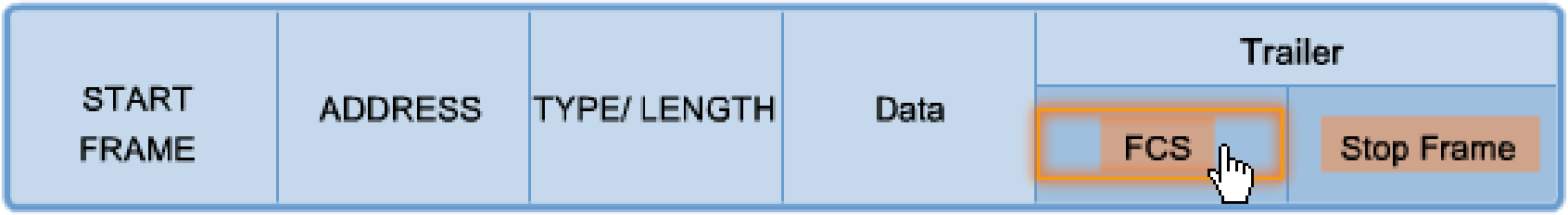
7.3.3 Addressing

Frames use the Physical MAC Address for addressing

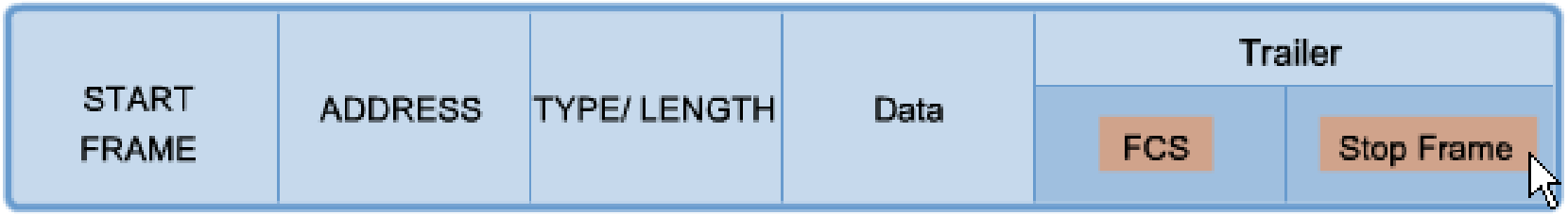




7.3.4 Framing Trailer

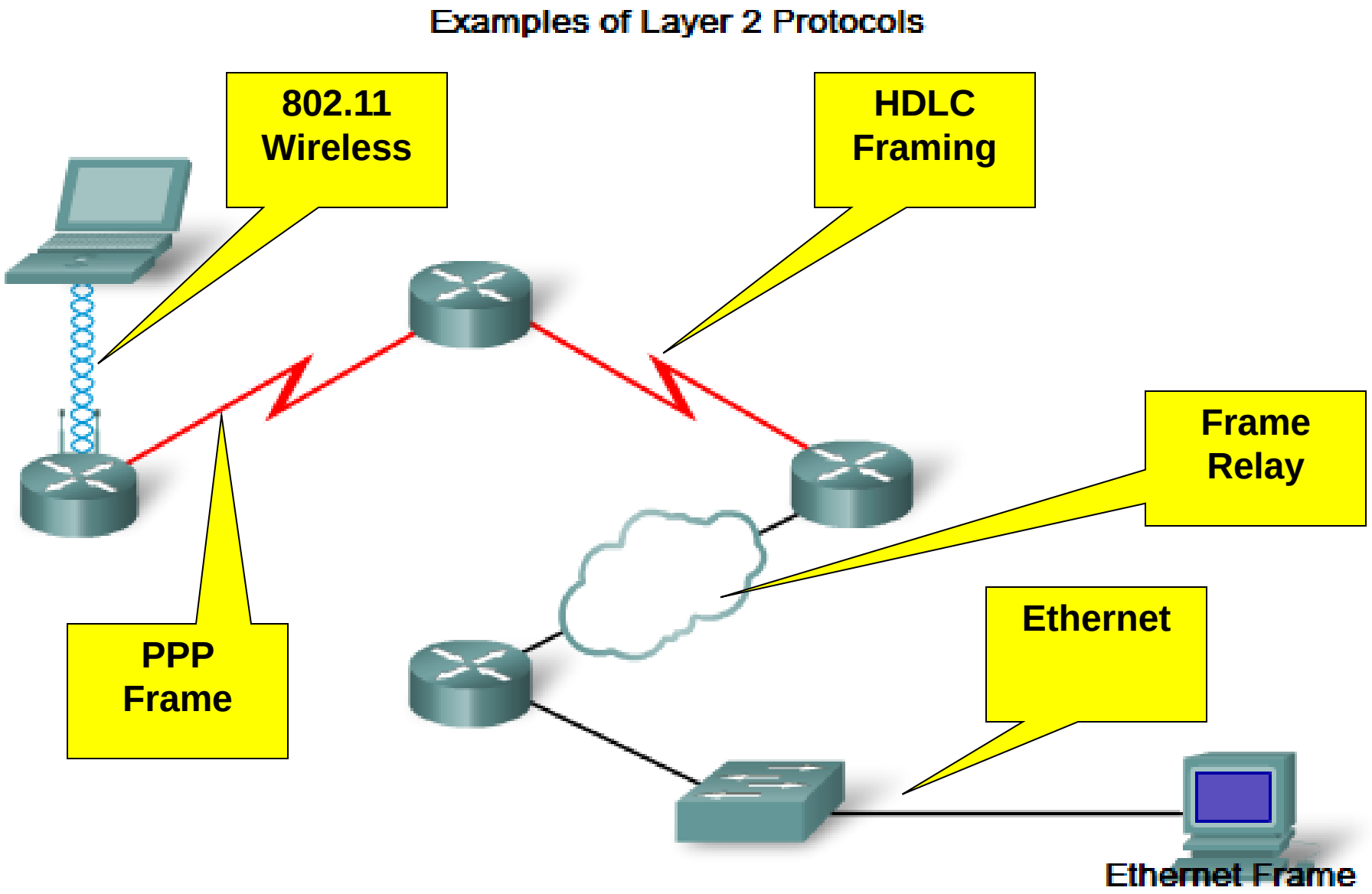


The Frame Check Sequence field is used for error checking. The source calculates a number based on the frame's data and places that number in the FCS field. The destination then recalculates the data to see if the FCS matches. If they don't match, the destination deletes the frame.



The **Stop Frame** field, also called the Frame Trailer, is an optional field that is used when the length of the frame is not specified in the Type/Length field. It indicates the end of the frame when transmitted.

7.3.5 Datalink Layer Protocols



7.3.5 Datalink Layer Protocols

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.

7.3.5 Datalink Layer Protocols

Point-to-Point Protocol

A Common Data Link Protocol for WANs

Frame

Field name	Flag	Address	Control	Protocol	Data	FCS
Size (bytes)	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.

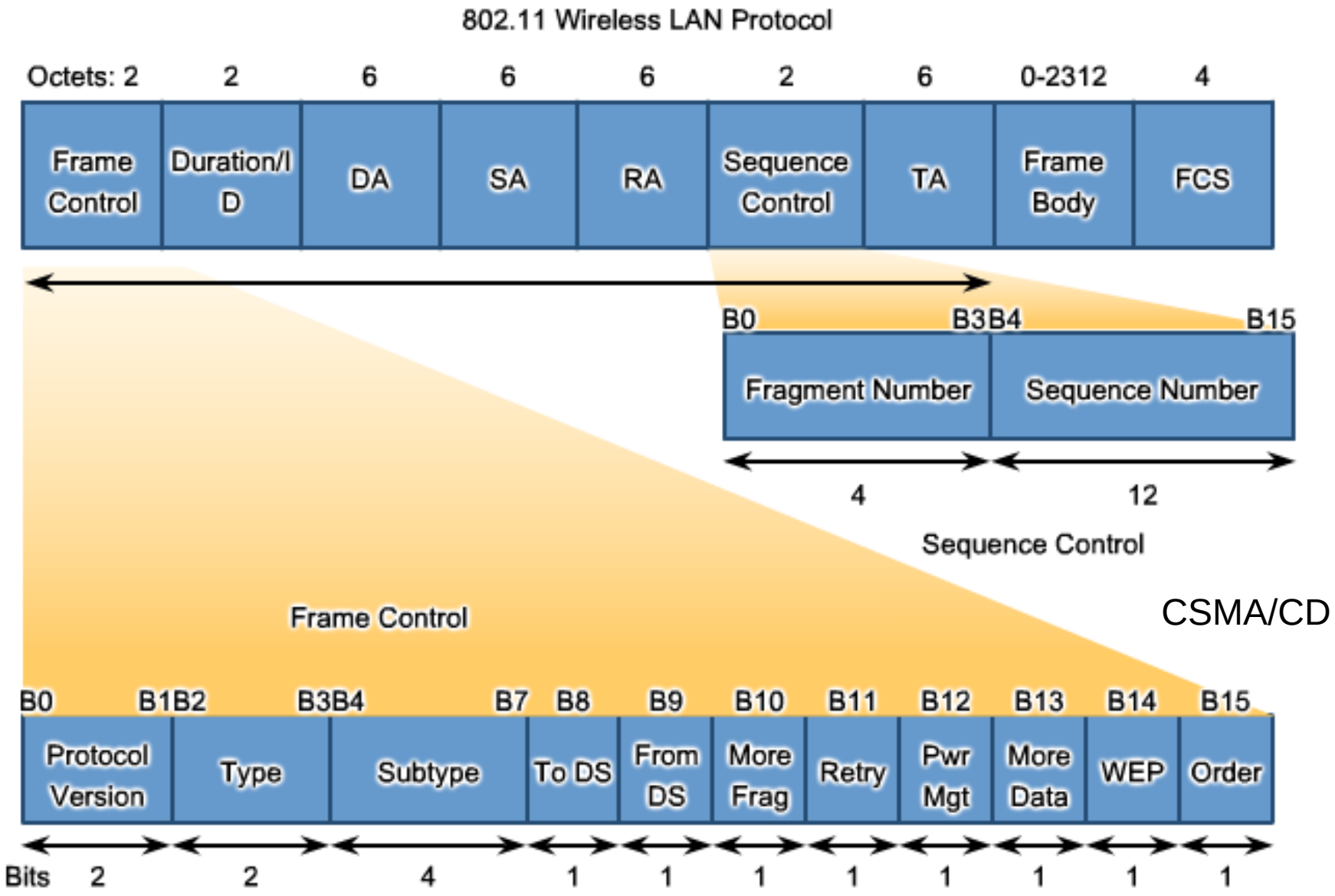
Control - A single byte that contains the binary sequence 00000011, which calls for transmission of user data in an unsequenced frame.

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.

7.3.5 Datalink Layer Protocols

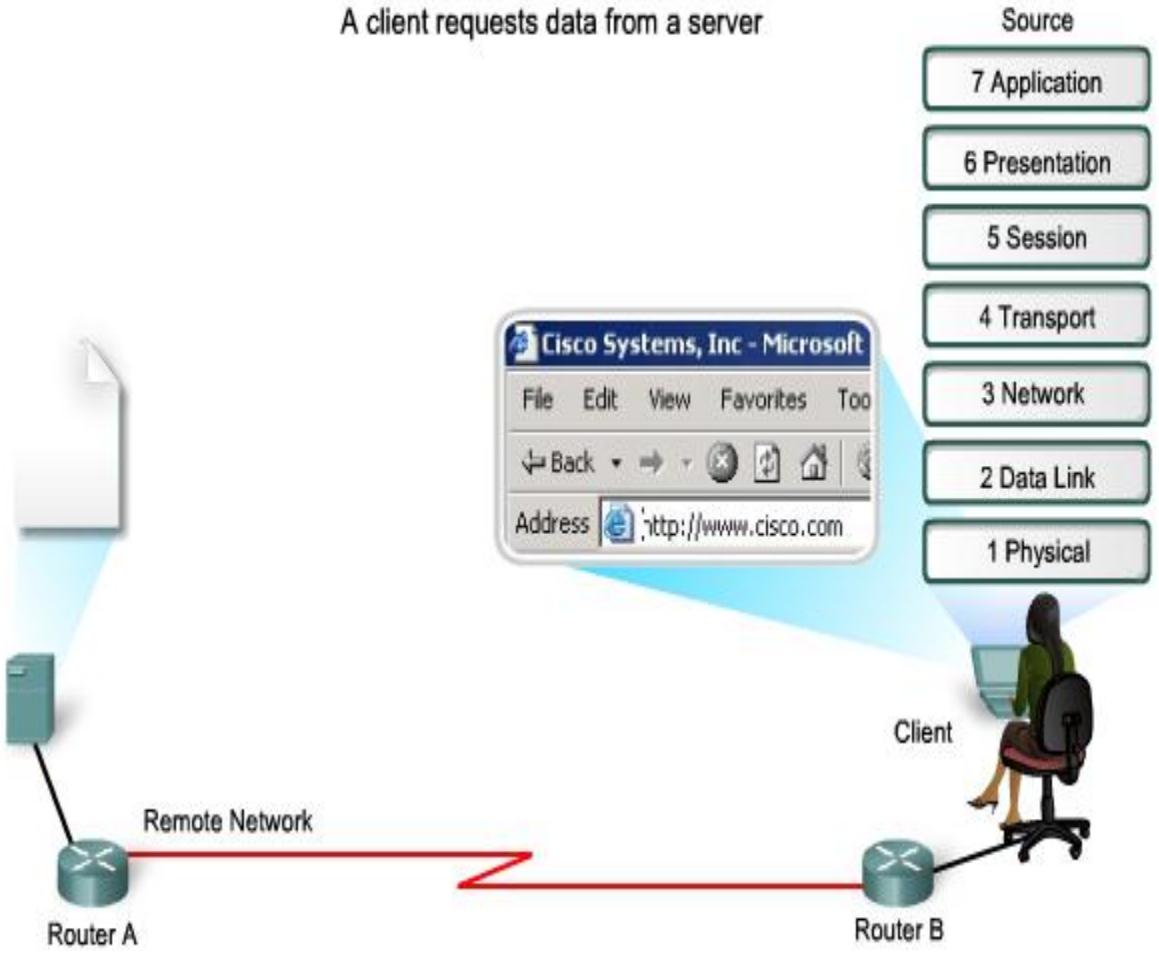


CSMA/CD

7.4.1 Following Data Through the Internetwork

A user on a LAN network wants to access a web page stored on a server that is located on a remote network. The user starts by activating a link on a web page.

A client requests data from a server



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

Click to see the steps.

7 Summary

In this chapter, you learned to:

- Explain the role of Data Link layer protocols in data transmission.
- Describe how the Data Link layer prepares data for transmission on network media.
- Describe the different types of media access control methods.
- Identify several common logical network topologies and describe how the logical topology determines the media access control method for that network.
- Explain the purpose of encapsulating packets into frames to facilitate media access.
- Describe the Layer 2 frame structure and identify generic fields.
- Explain the role of key frame header and trailer fields, including addressing, QoS, type of protocol, and Frame Check Sequence.