Chapter 3:
Network Protocols and Communications

Introduction to Networks v5.1

Chapter Outline

3.0 Introduction

3.1 Rules of Communication

3.2 Network Protocols and Standards

3.3 Data Transfer in the Network

3.4 Summary

Section 3.1:
Rules of Communication

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

- Describe the types of rules that are necessary to successfully communicate.
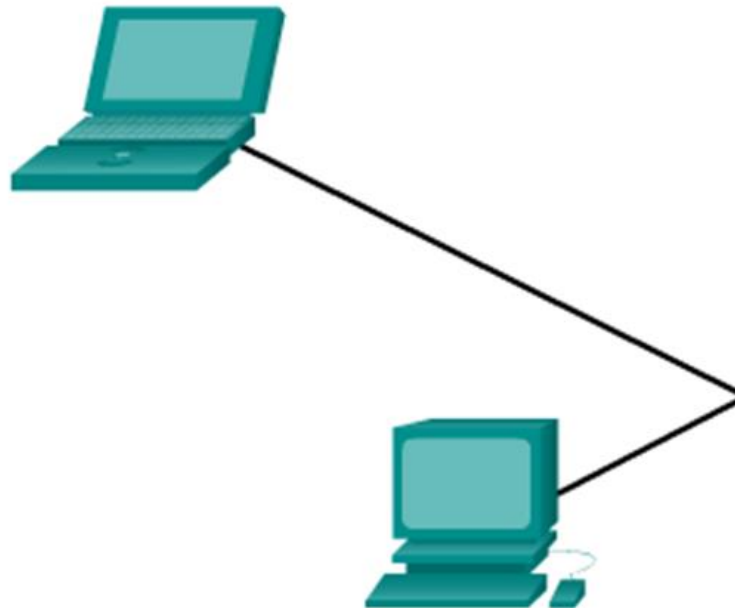
Topic 3.1.1:
The Rules

Communication Fundamentals

Human Communication

Communication Fundamentals (Cont.)

Computer Communication

Rule Establishment

humans communication between govern rules. It is verydifficult tounderstand messages that are not correctly formatted and donot follow the established rules and protocols. A estrutura da gramatica, da lingua, da pontuacao e do sentance faz a configuracao humana compreensivel por muitos individuos diferentes.

Translate

Rules govern communication between humans. It is very difficult to understand messages that are not correctly formatted and do not follow the established rules and protocols. The structure of the grammar, the language, the punctuation and the sentence make the configuration humanly understandable for many different individuals.
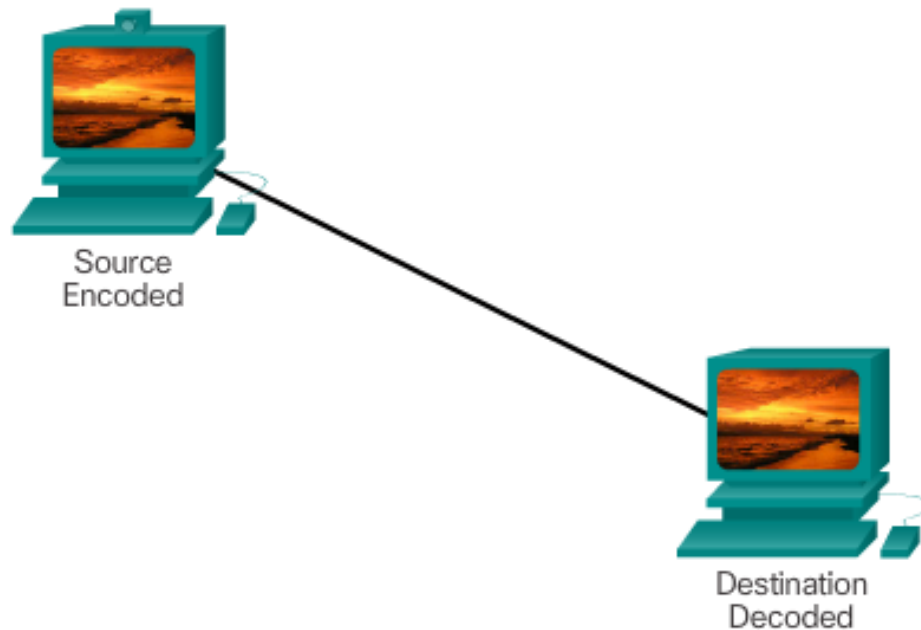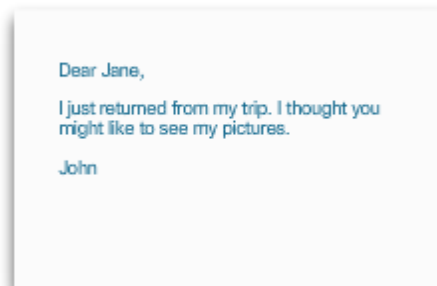
Untranslate

Rule Establishment (cont.)
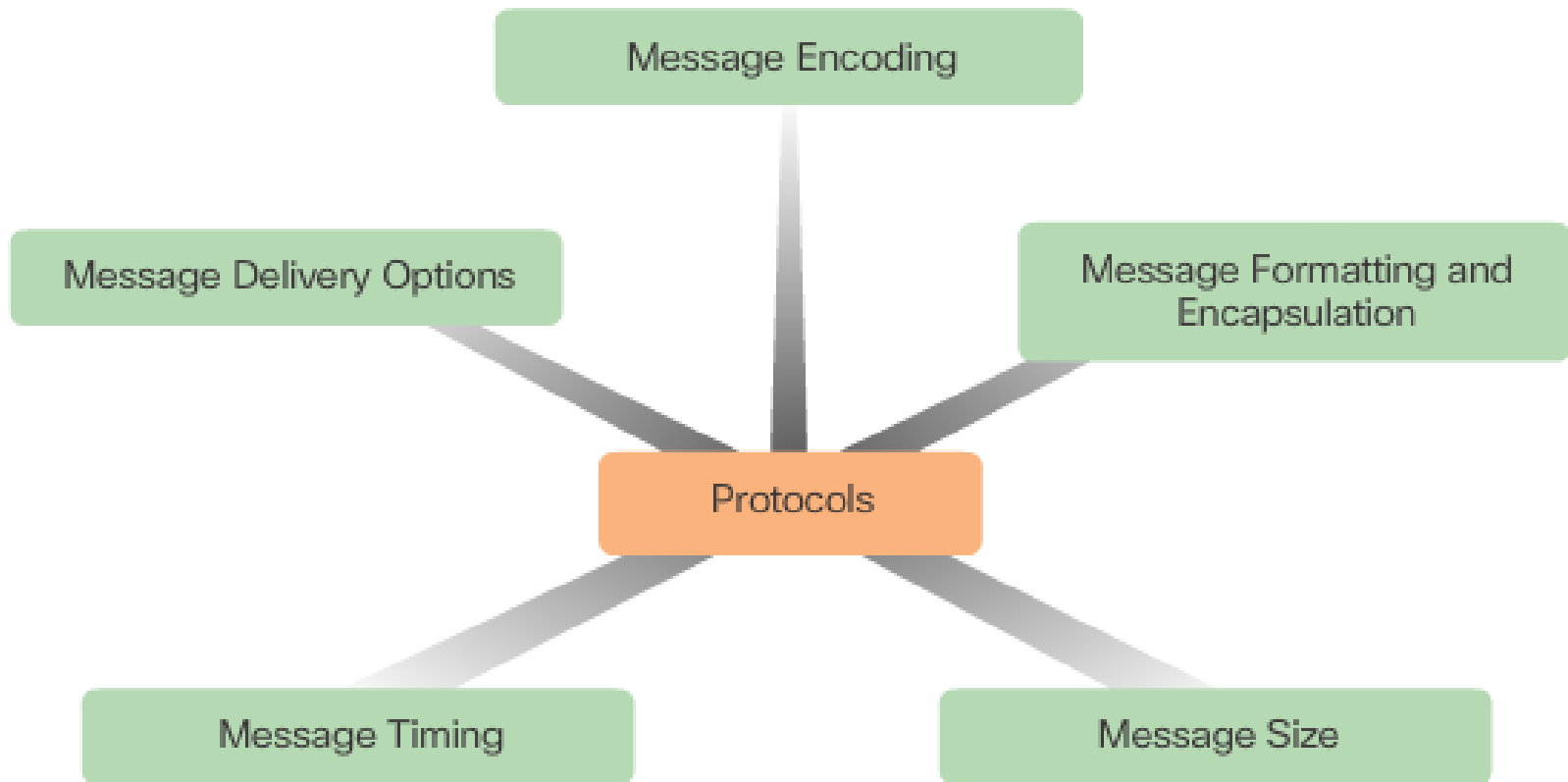
Message Encoding

Message Encoding (cont.)

Message Formatting and Encapsulation

Recipient (destination) Location address	Sender (source) Location address	Salutation (start of message indicator)	Recipient (destination) identifier	Content of Letter (encapsulated data)	Sender (source) identifier	End of Frame (End of message indicator)
Envelope Addressing		Encapsulated Letter				
1400 Main Street Canton, Ohio 44203	4085 SE Pine Street Ocala, Florida 34471	Dear	Jane	I just returned from my trip. I thought you might like to see my pictures.	John	

Message Formatting and Encapsulation

Example: Personal letter contains the following elements:

- An identifier of the recipient

- A salutation or greeting

- The message content

- A closing phrase

- An identifier of the sender

Message Formatting and Encapsulation (cont.)

Destination (physical / hardware address)	Source (physical / hardware address)	Start Flag (start of message indicator)	Recipient (destination identifier)	Sender (source identifier)	Encapsulated Data (bits)	End of Frame (end of message indicator)
Frame Addressing		Encapsulated Message				

Message Size

Human Communication

Message Size

Computer Communication

- The source host breaks a long message into individual pieces or frames that meet both the minimum and maximum size requirements.

- Each frame will also have its own addressing information.

- At the receiving host, the pieces are reconstructed to be processed and interpreted.

Message Timing

Rules of engagement:

- Access Method
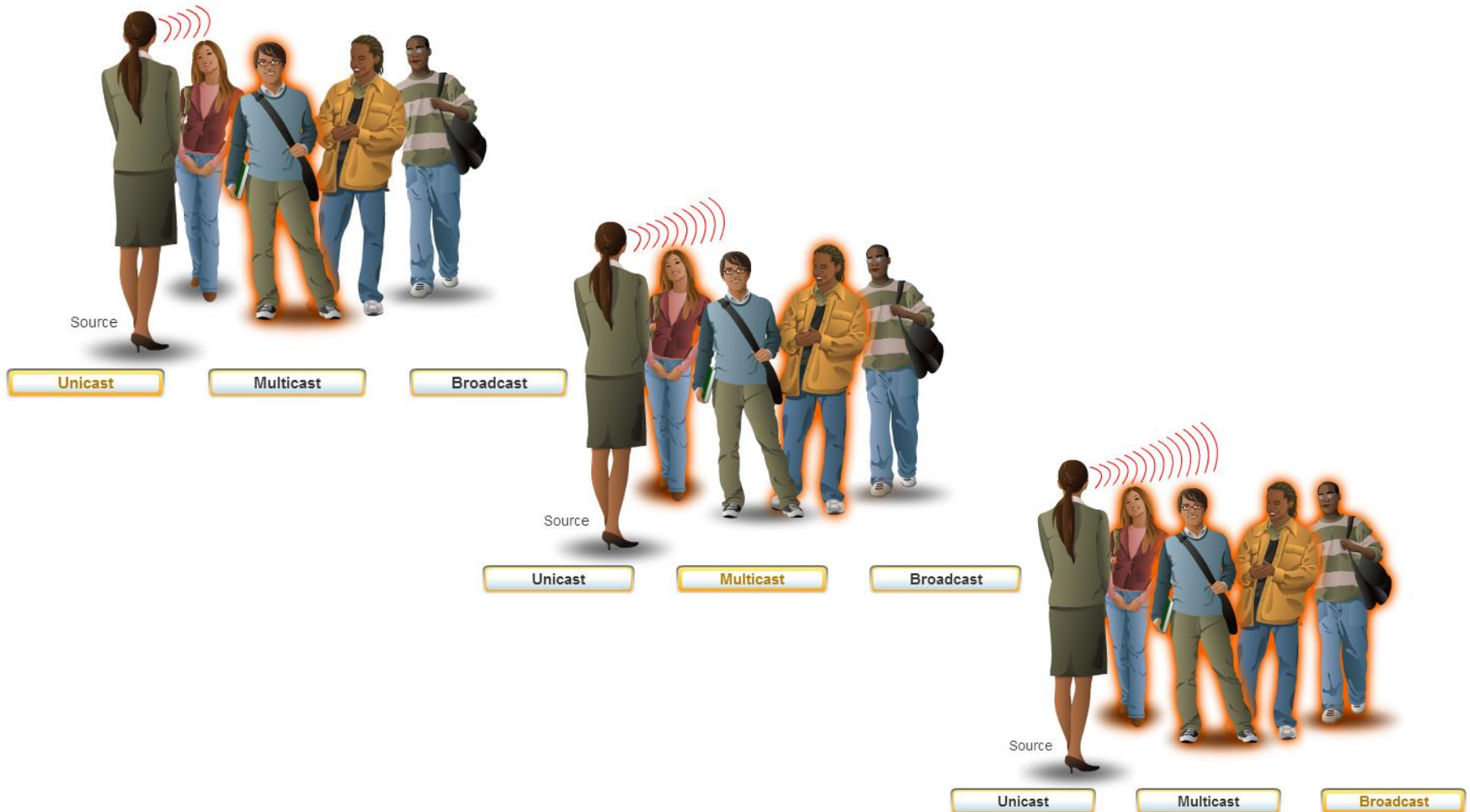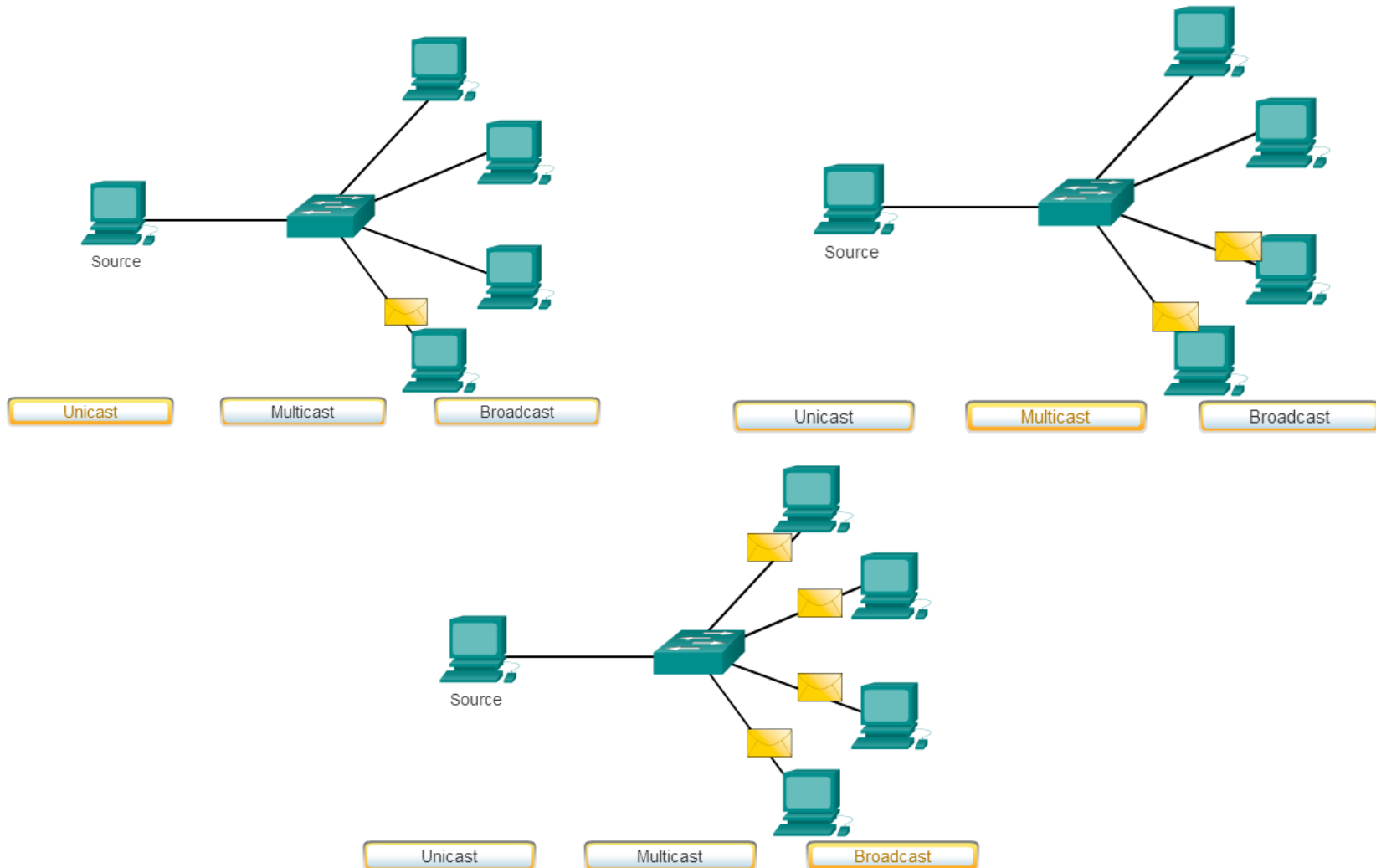
- Flow Control

- Response Timeout

Message Delivery Options

Message Delivery Options (cont.)

Unicast   Multicast   Broadcast

Unicast   Multicast   Broadcast

Unicast   Multicast   Broadcast

Section 3.2:
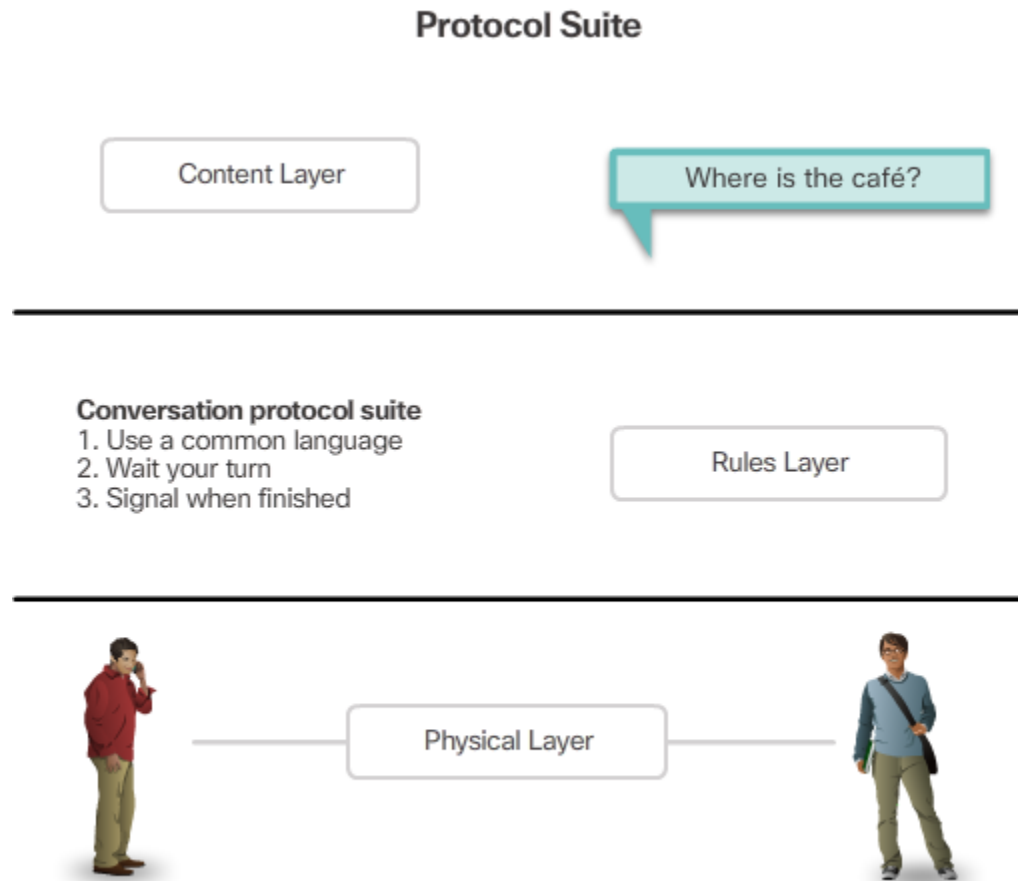# Network Protocols and Standards

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

- Explain why protocols are necessary in communication.

- Explain the purpose of adhering to a protocol suite.

- Explain the role of standards organizations in establishing protocols for network interoperability.

- Explain how the TCP/IP model and the OSI model are used to facilitate standardization in the communication process.

Topic 3.2.1:
Protocols

Rules that Govern Communications

Protocol Suite

Content Layer

Where is the café?

Conversation protocol suite
1. Use a common language
2. Wait your turn
3. Signal when finished

Rules Layer

Physical Layer

Protocol suites are sets of rules that work together to help solve a problem.

Network Protocols

- The role of protocols

- How the message is formatted or structured

- The process by which networking devices share information about pathways with other networks

- How and when error and system messages are passed between devices

- The setup and termination of data transfer sessions

Protocol Interaction

Interaction of protocols in communication between a web server and web client.
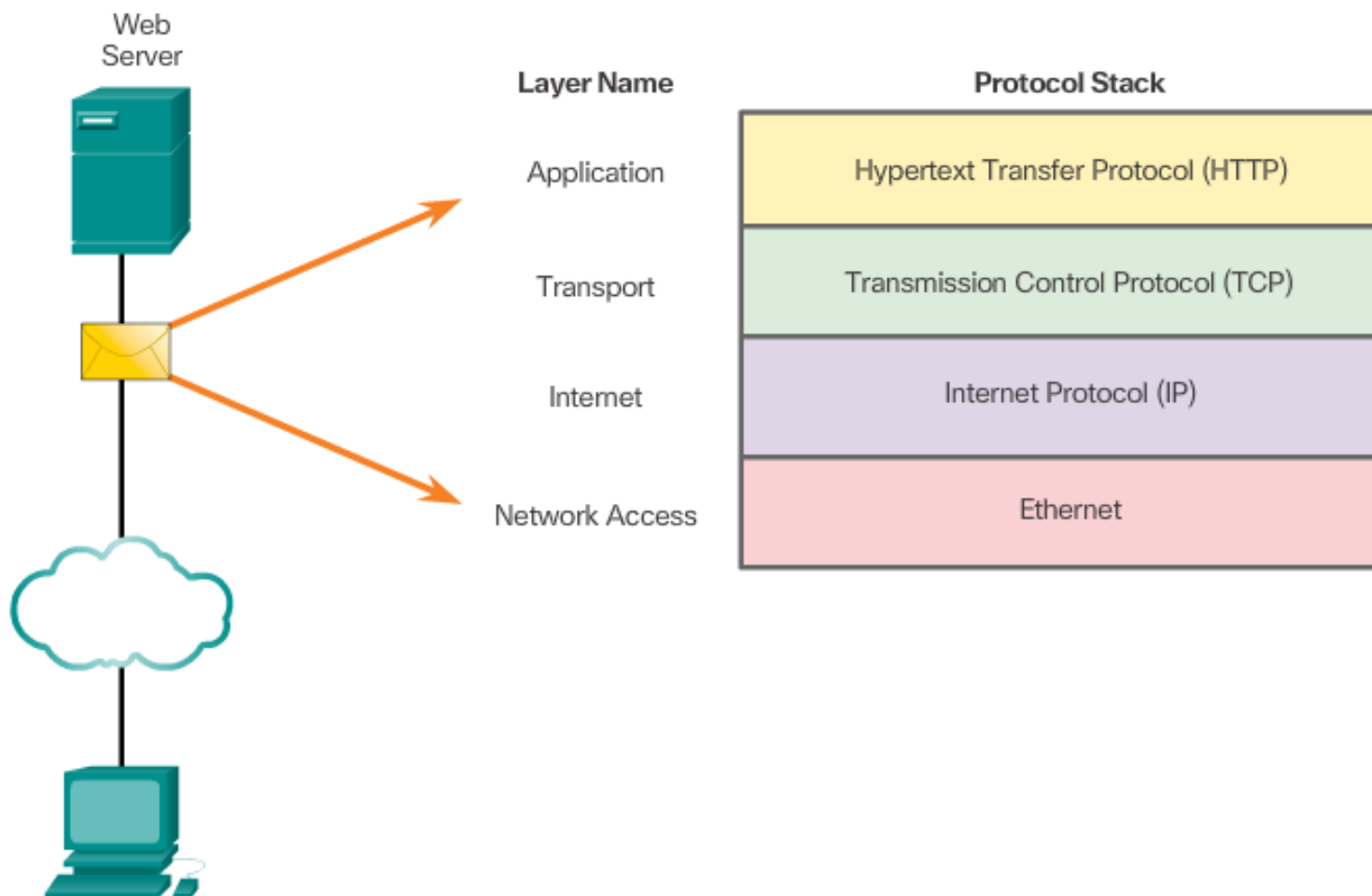
Topic 3.2.2:
Protocol Suites

Protocol Suites and Industry Standards

| Layer Name	TCP/IP	ISO	AppleTalk	Novell Netware
Application	HTTP DNS DHCP FTP	ACSE ROSE TRSE SESE	AFP	NDS
Transport	TCP UDP	TP0 TP1 TP2 TP3 TP4	ATP AEP NBP RTMP	SPX
Internet	IPv4 IPv6 ICMPv4 ICMPv6	CONP/CMNS CLNP/CLNS	AARP	IPX
Network Access	Ethernet PPP Frame Relay ATM WLAN			

Development of TCP/IP

2011

The first World IPv6 Day (June 8, 2011), many websites and Internet service providers around the world, including Google, Facebook, and Yahoo!, participated with more than 1,000 other companies for a worldwide trial of IPv6.
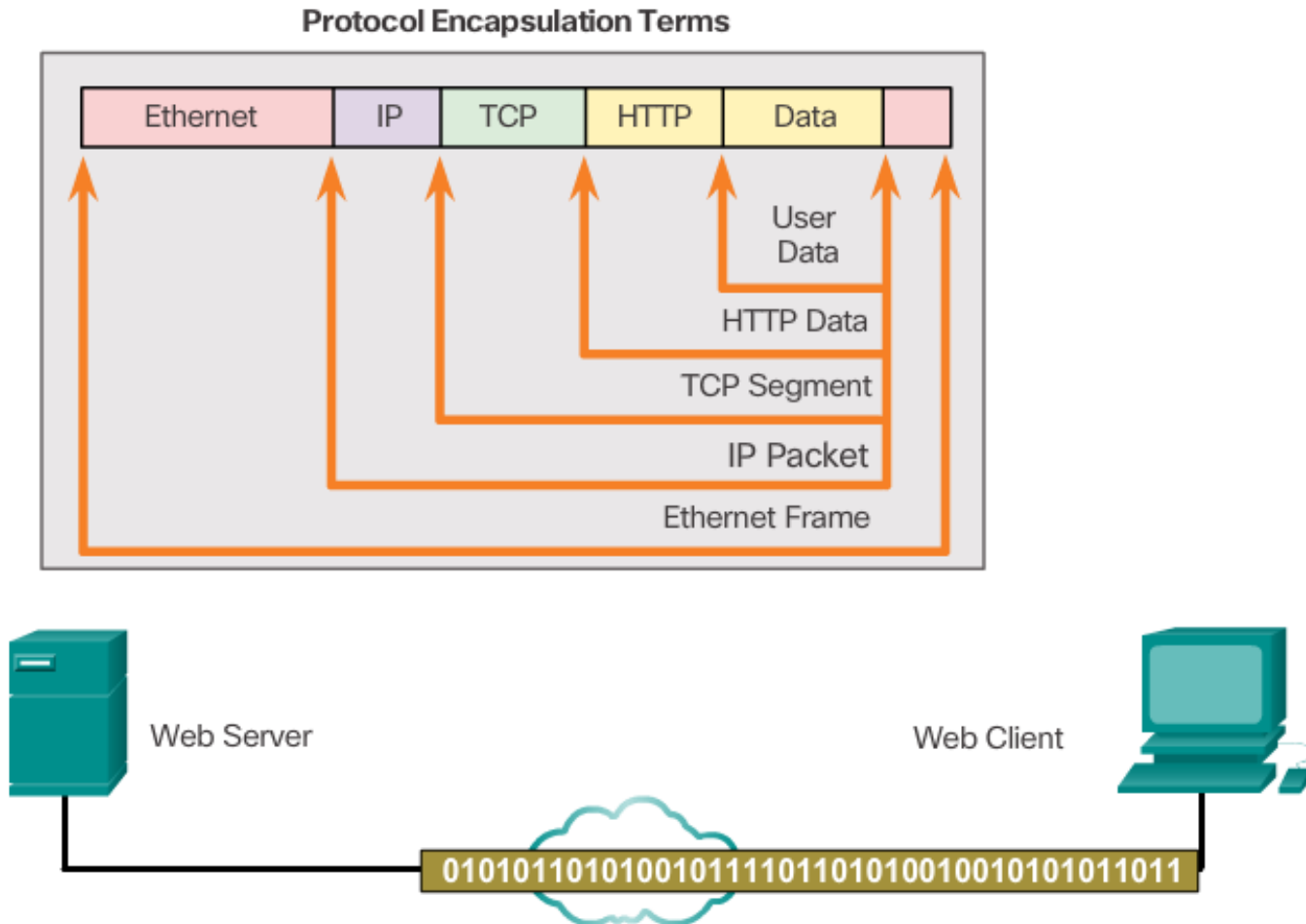
2015

2005

1995

1985

1975

1965

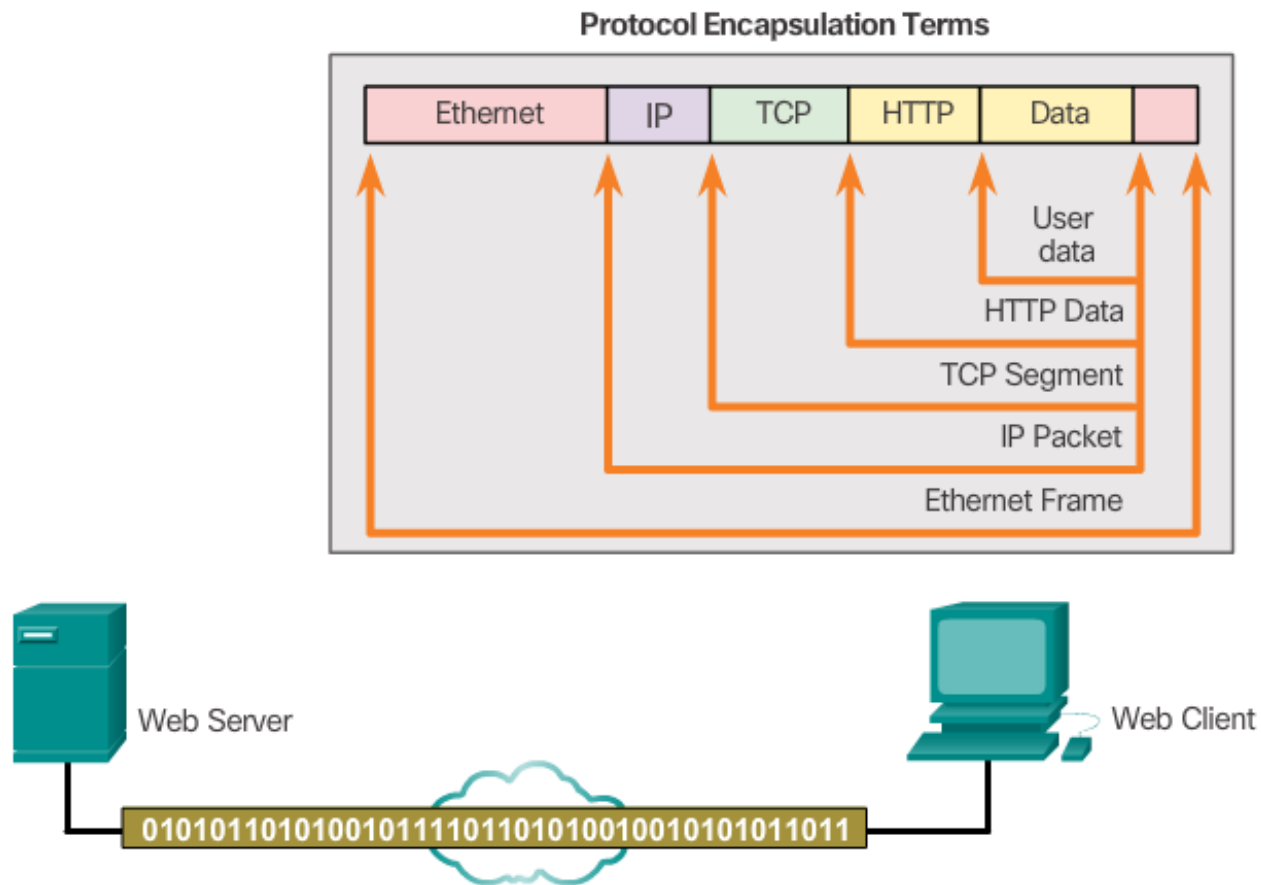# TCP/IP Protocol Suite
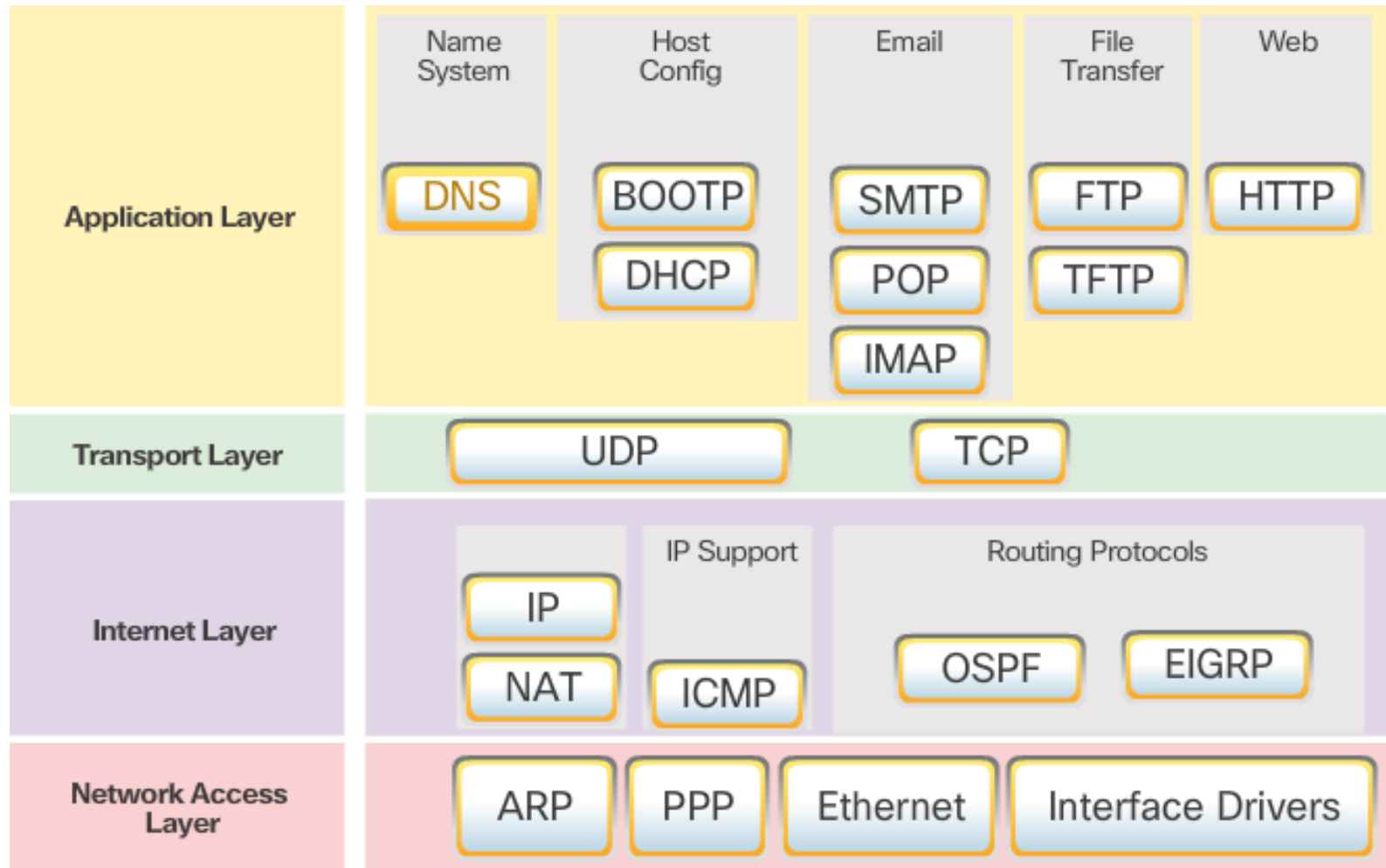
TCP/IP Communication Process

Protocol Operation - Sending a Message

TCP/IP Communication Process

Protocol Operation – Receiving a Message
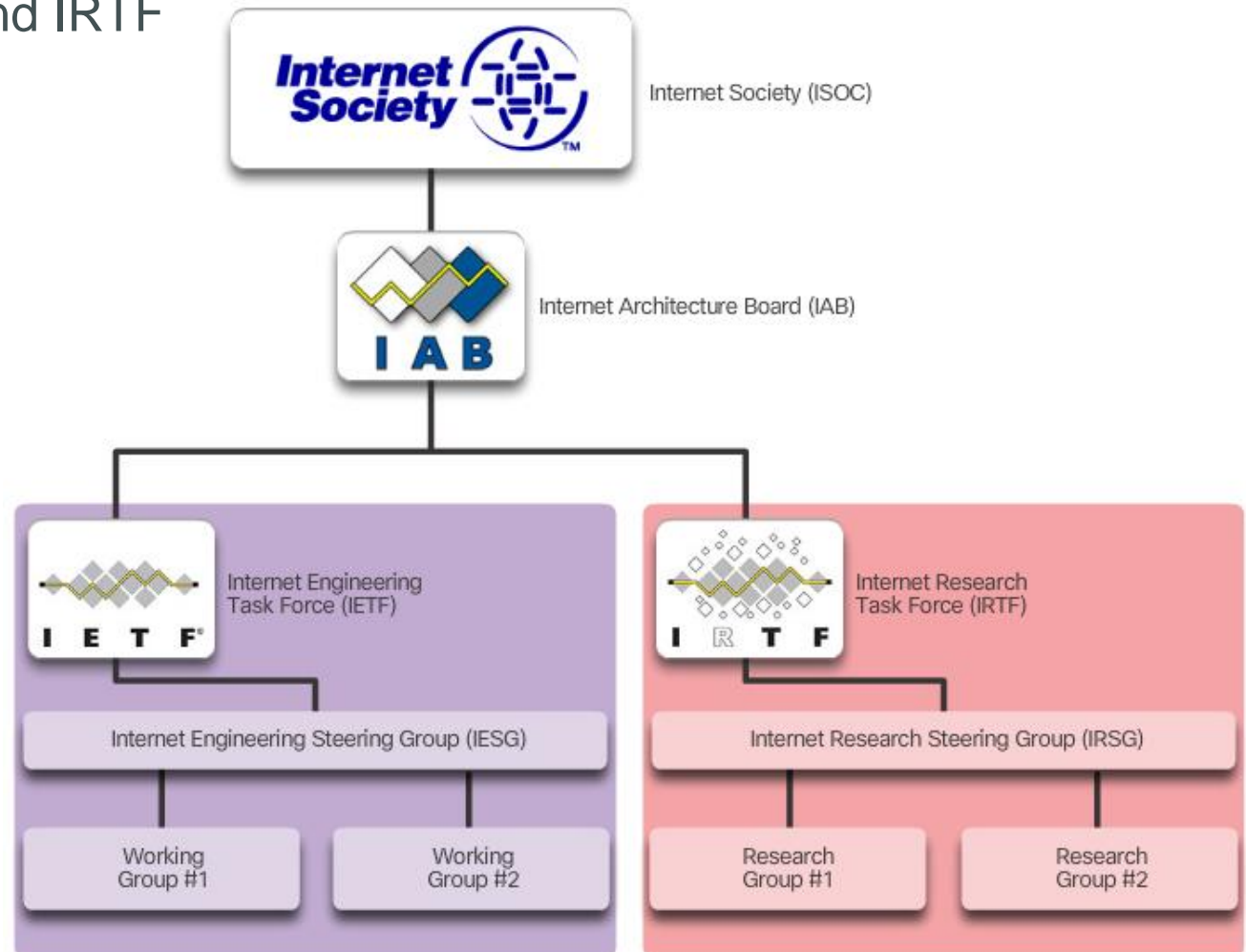
Topic 3.2.3:
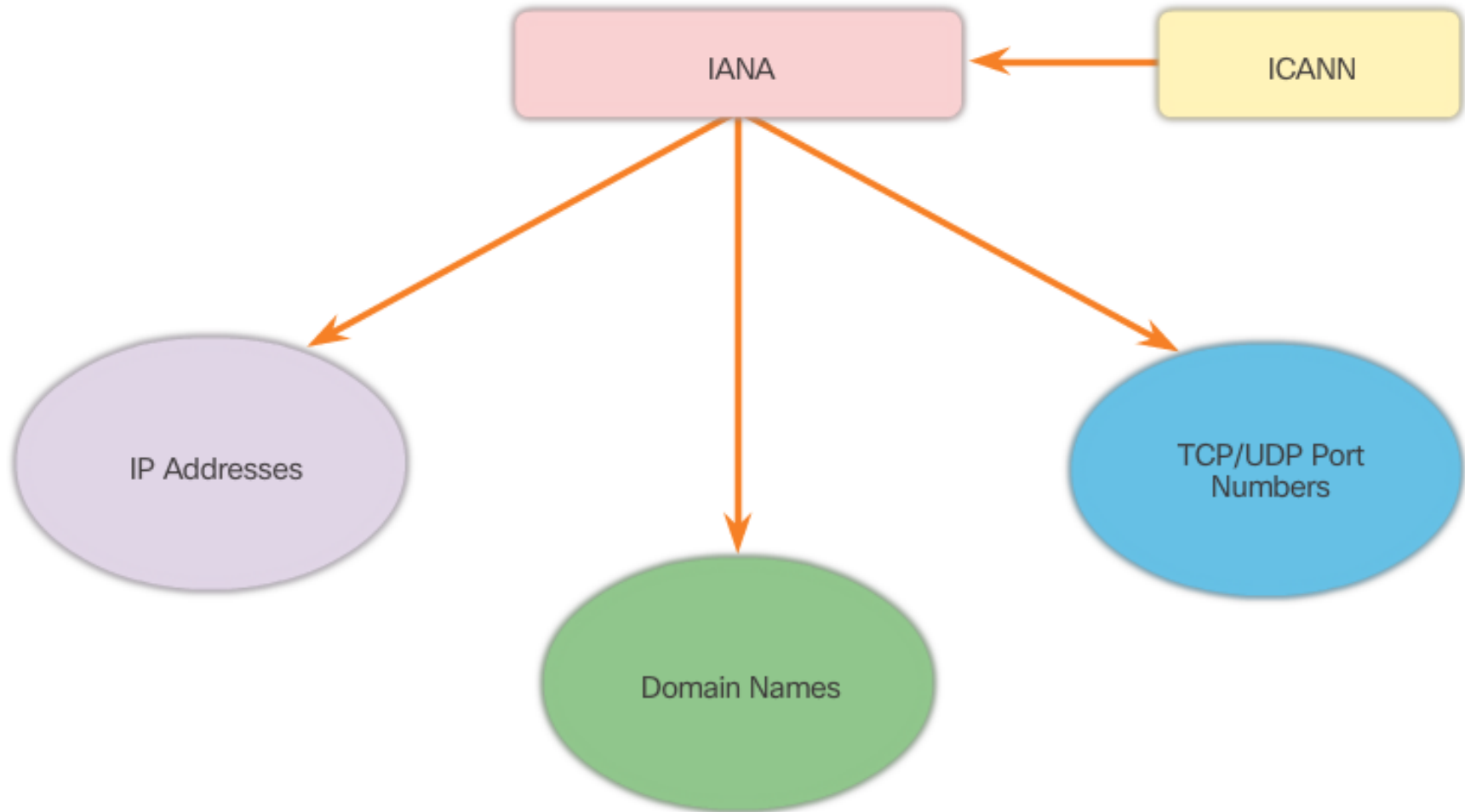# Standard Organizations

Open Standards

Internet Standards

ISOC, IAM, IETF, and IRTF

Internet Standards (cont.)

IANA and ICANN

Electronics and Communications Standard Organizations

Institute of Electrical and Electronics Engineers (IEEE)

IEEE 802 Working Groups and Study Groups

- 802.1 Higher Layer LAN Protocols Working Group
- 802.3 Ethernet Working Group
- 802.11 Wireless LAN Working Group
- 802.15 Wireless Personal Area Network (WPAN) Working Group
- 802.16 Broadband Wireless Access Working Group
- 802.18 Radio Regulatory TAG
- 802.19 Wireless Coexistence Working Group
- 802.21 Media Independent Handover Services Working Group
- 802.22 Wireless Regional Area Networks
- 802.24 Smart Grid TAG

Electronics and Communications Standard Organizations (cont.)

EIA/TIA Standards
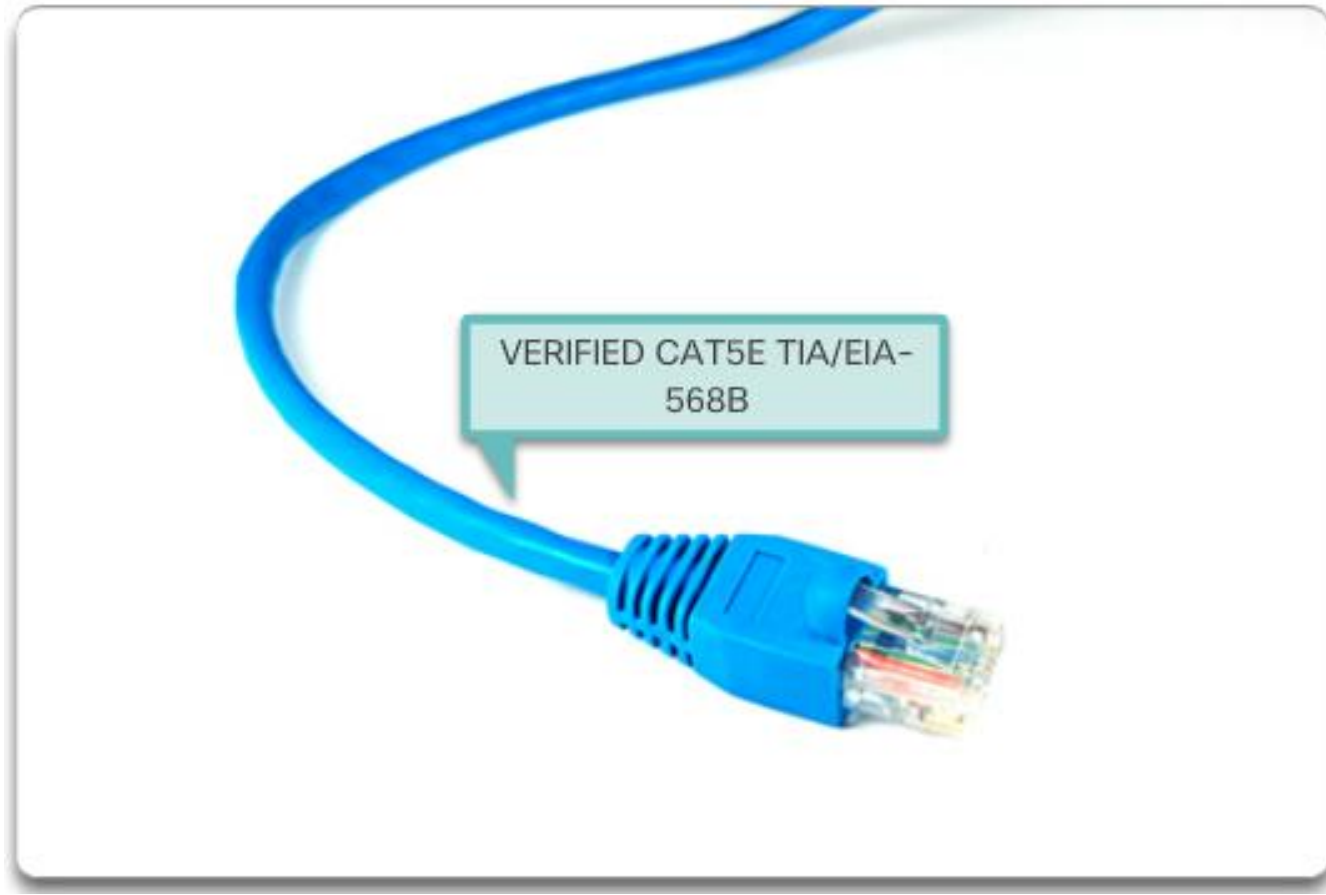
Topic 3.2.4:
Reference Models

The Benefits of Using a Layered Model

A networking model is only a representation of a network operation. The model is not the actual network.

OSI Model	TCP/IP Protocol Suite	TCP/IP Model
Application	HTTP, DNS, DHCP, FTP	Application
Presentation		
Session		
Transport	TCP, UDP	Transport
Network	IPv4, IPv6, ICMPv4, ICMPv6	Internet
Data Link	PPP, Frame Relay, Ethernet	Network Access
Physical		

The OSI Reference Model

OSI Model

7. Application

6. Presentation

5. Session

4. Transport

3. Network

2. Data Link

1. Physical

The TCP/IP Protocol Model

TCP/IP Model

Layer	Description
Application	Represents data to the user, plus encoding and dialog control.
Transport	Supports communication between diverse devices across diverse networks.
Internet	Determines the best path through the network.
Network Access	Controls the hardware devices and media that make up the network.
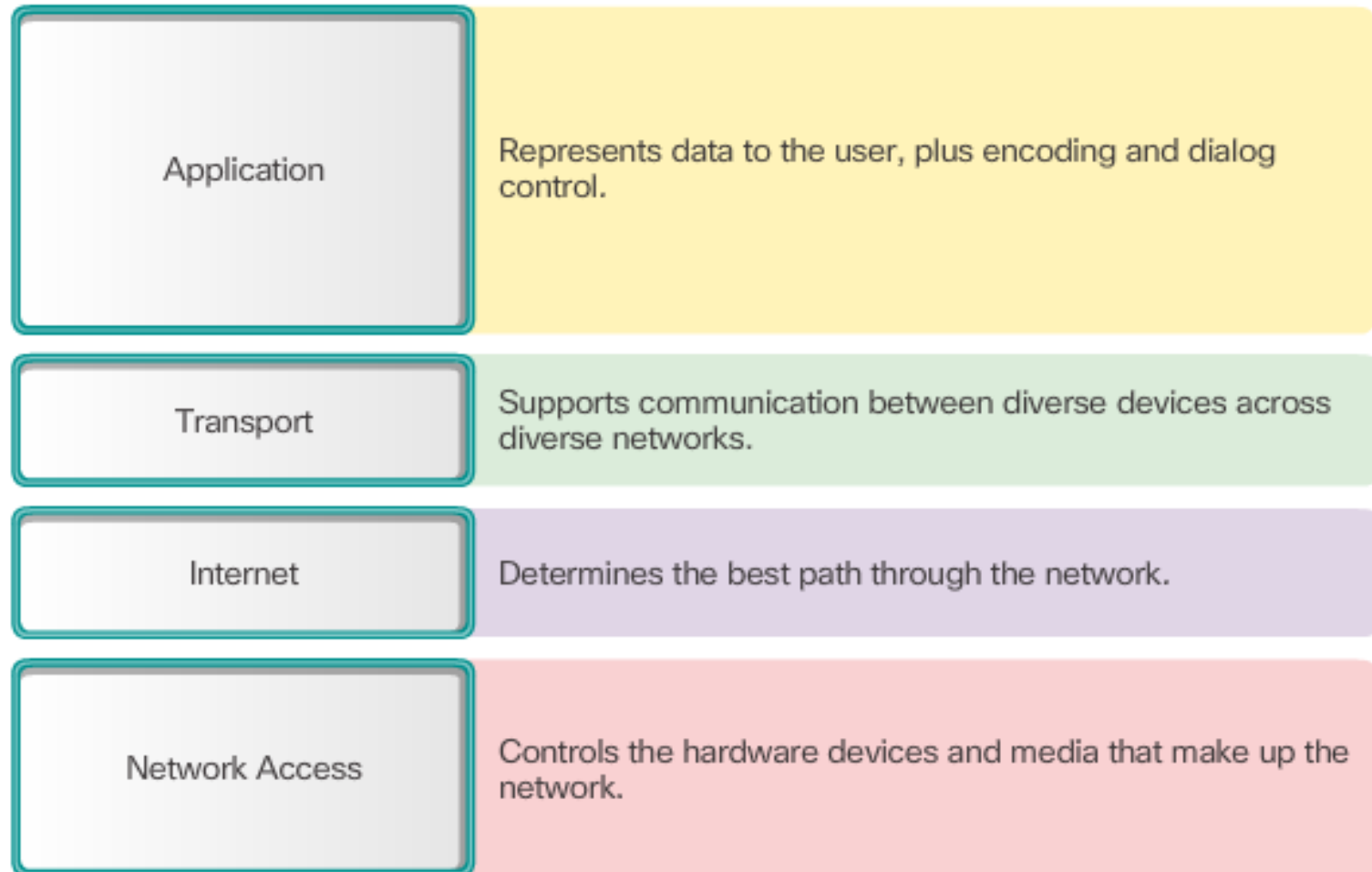
OSI Model and TCP/IP Model Comparison

OSI Model

	TCP/IP Model
7. Application	
6. Presentation	Application
5. Session	
4. Transport	Transport
3. Network	Internet
2. Data Link	Network Access
1. Physical	
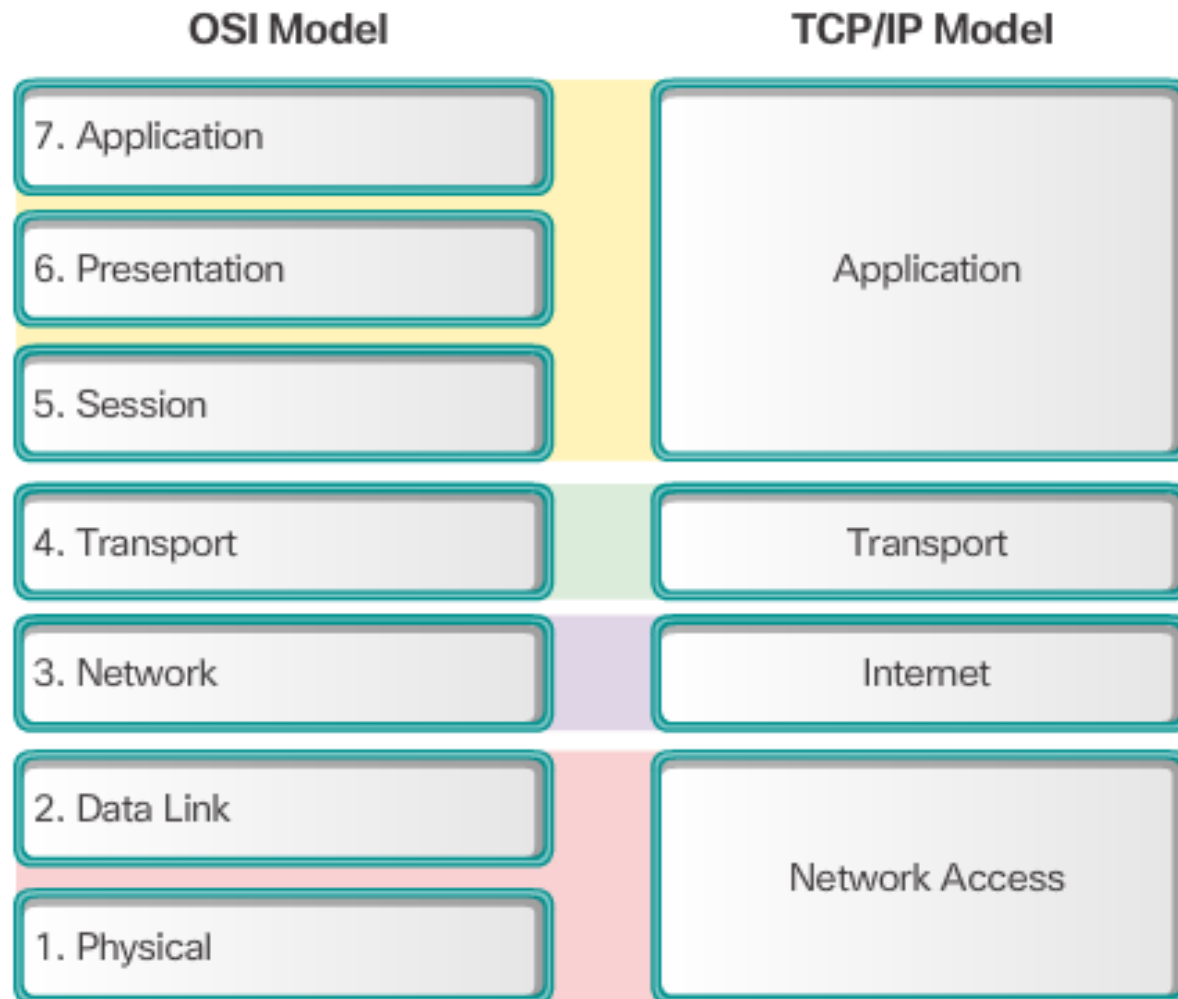
Section 3.3:
Data Transfer in the Network

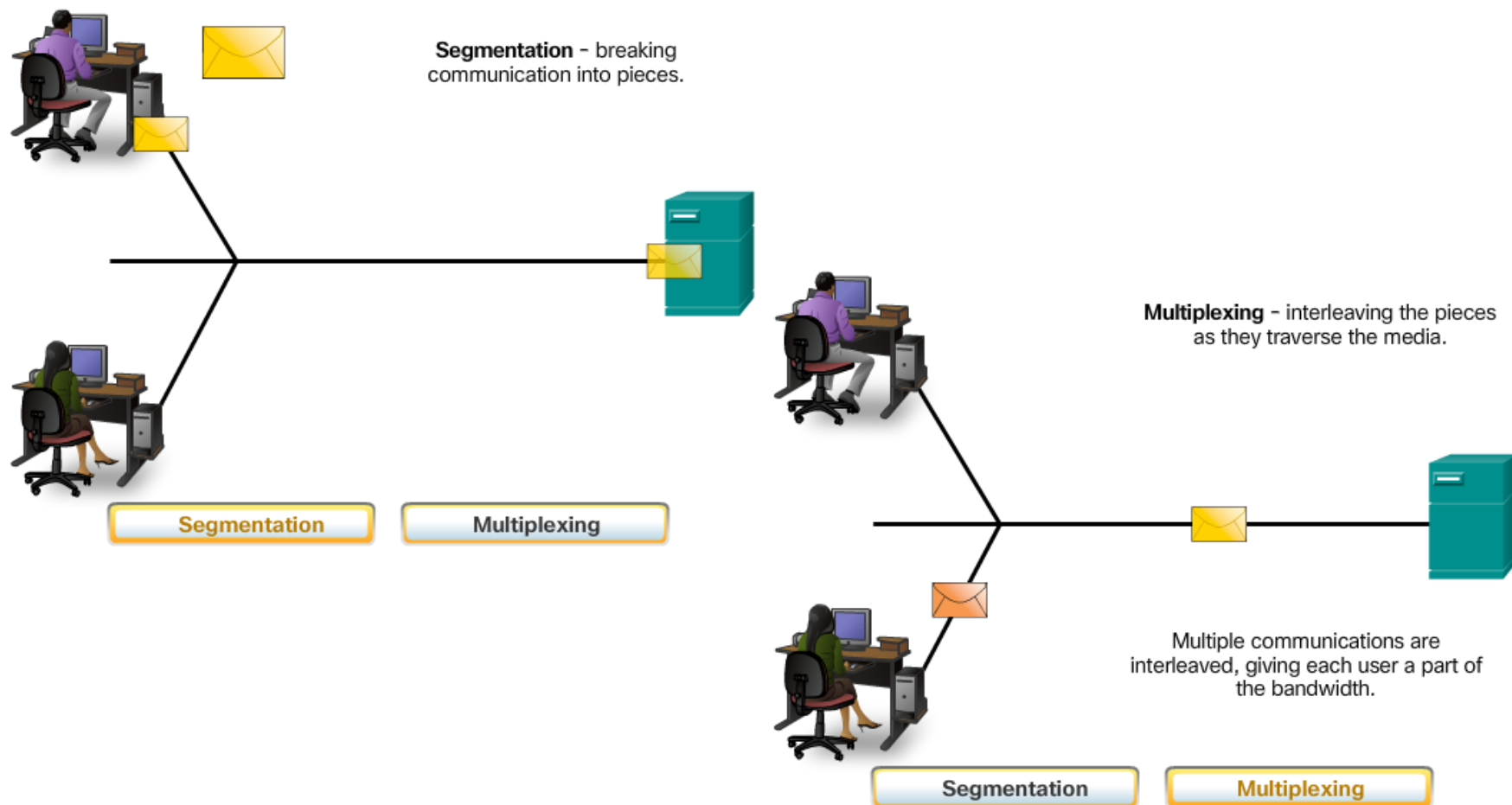Upon completion of this section, you should be able to:

- Explain how data encapsulation allows data to be transported across the network.

- Explain how local hosts access local resources on a network.
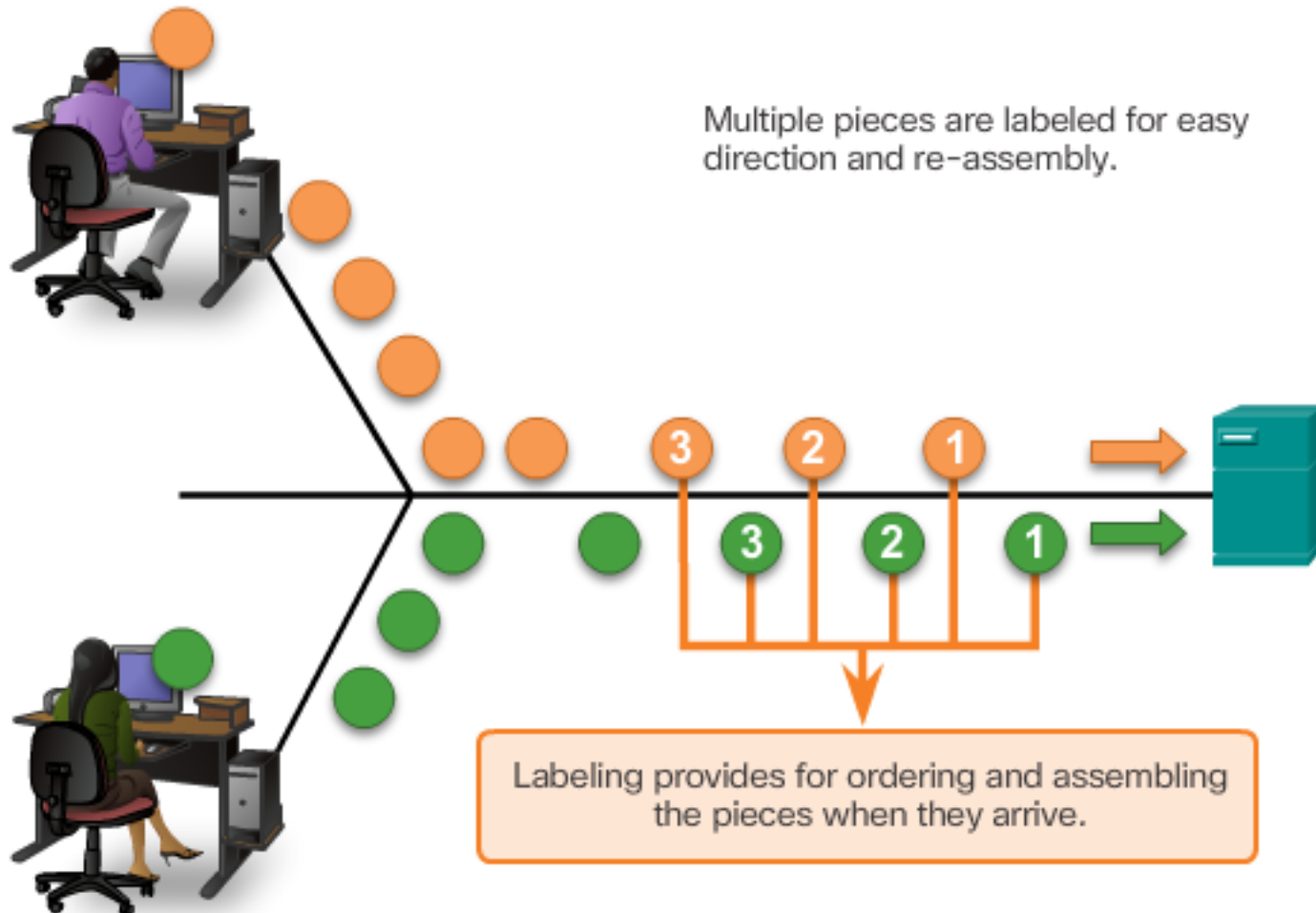
Topic 3.3.1:
Data Encapsulation

Message Segmentation

Communicating the Message

Segmentation - breaking communication into pieces.

Multiplexing - interleaving the pieces as they traverse the media.

Multiple communications are interleaved, giving each user a part of the bandwidth.

Segmentation

Multiplexing

Segmentation

Multiplexing

Message Segmentation (cont.)

Communicating the Message

Multiple pieces are labeled for easy direction and re-assembly.

Labeling provides for ordering and assembling the pieces when they arrive.

Communicating the Message
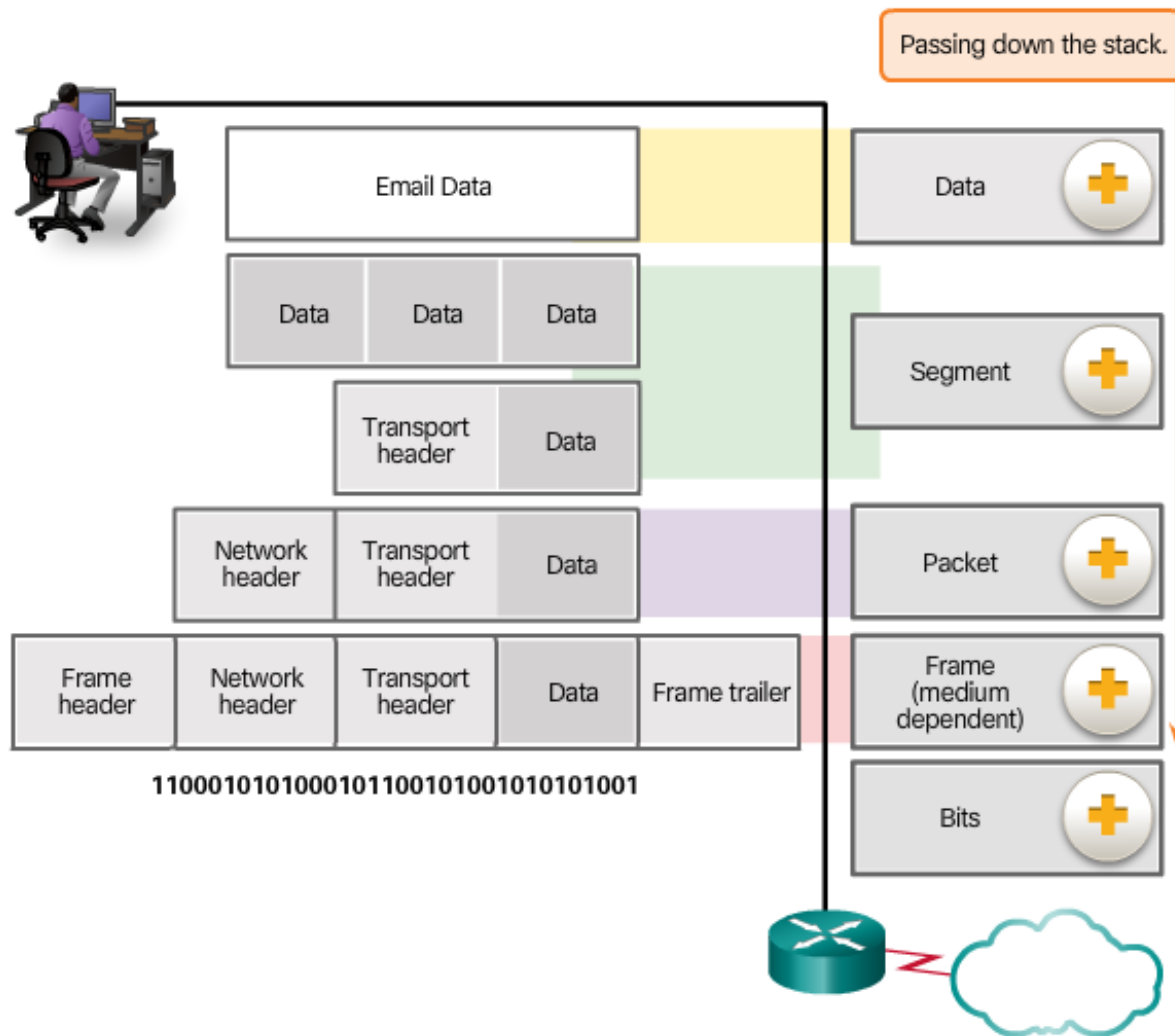
Segmenting Messages:

- Allows many different conversations to be interleaved

- Increases the efficiency of network communications
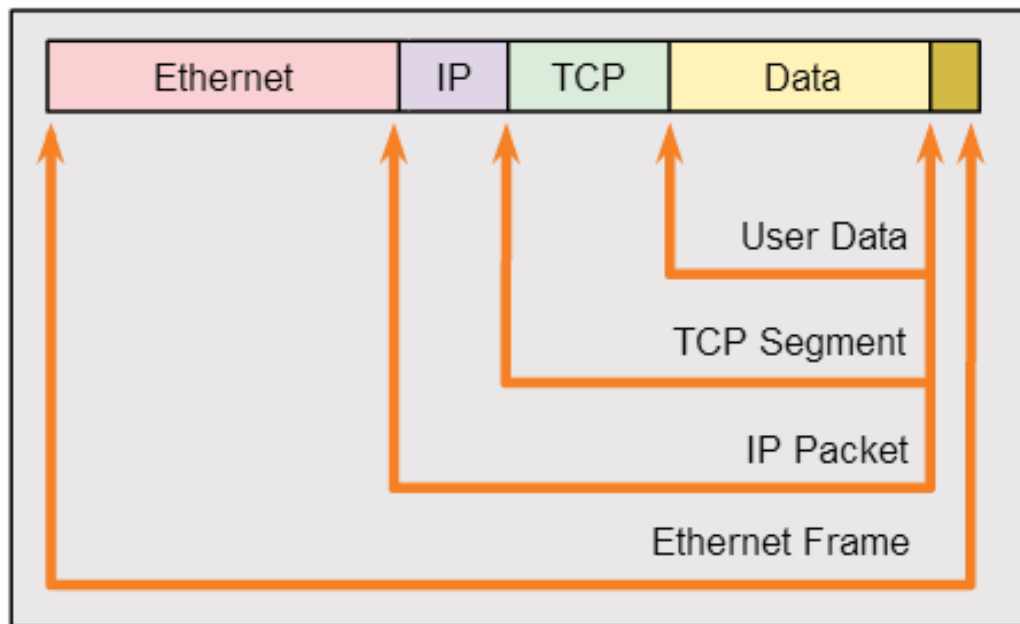
- Adds complexity

Protocol Data Units
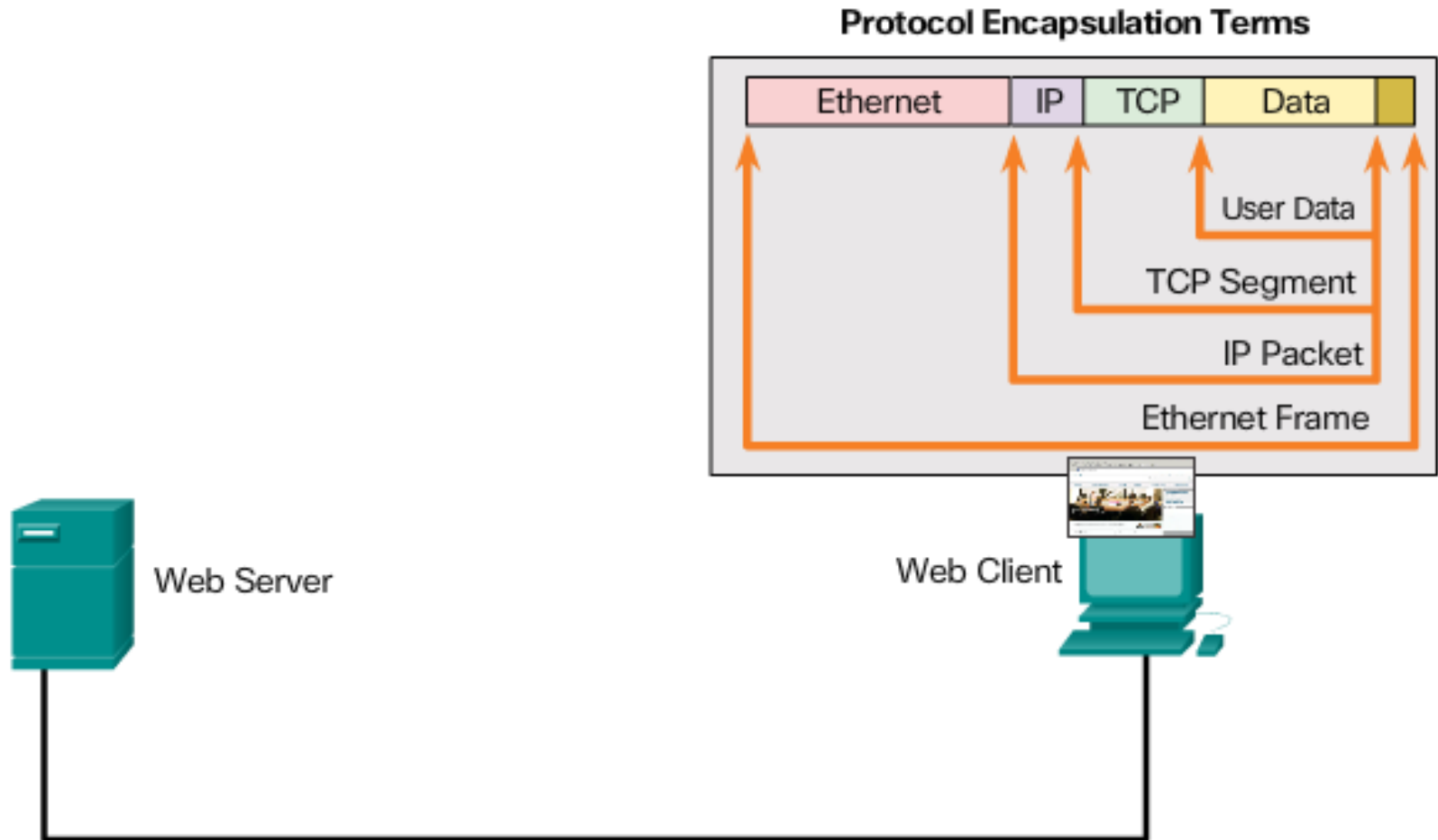
Encapsulation

- Data
- Segment
- Packet
- Frame
- Bits

Passing down the stack.

Email Data

Data | Data | Data

Transport header | Data

Network header | Transport header | Data

Frame header | Network header | Transport header | Data | Frame trailer

1100010101000101100101001010101001

Data

Segment

Packet

Frame (medium dependent)

Bits

Encapsulation Example

Protocol Encapsulation Terms

Ethernet	IP	TCP	Data	

User Data

TCP Segment

IP Packet

Ethernet Frame

Web Server

Web Client

0101011010100101111011010100100101011011

De-Encapsulation

Protocol Encapsulation Terms

Ethernet	IP	TCP	Data	

User Data

TCP Segment

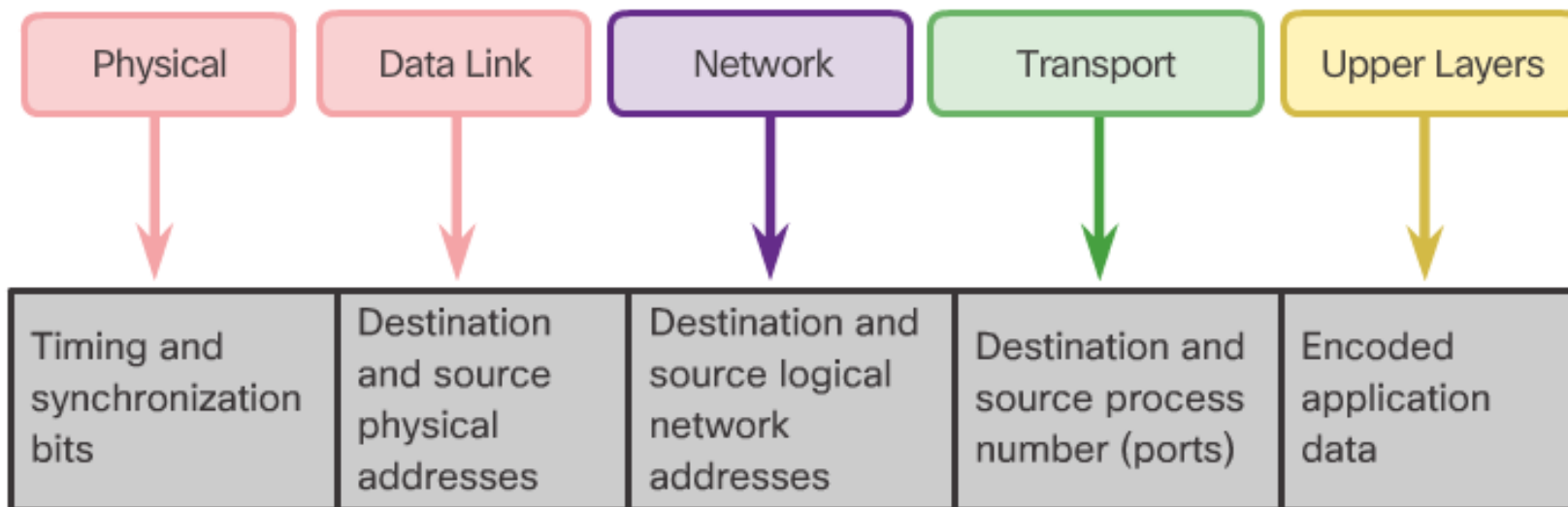IP Packet

Ethernet Frame

Web Server
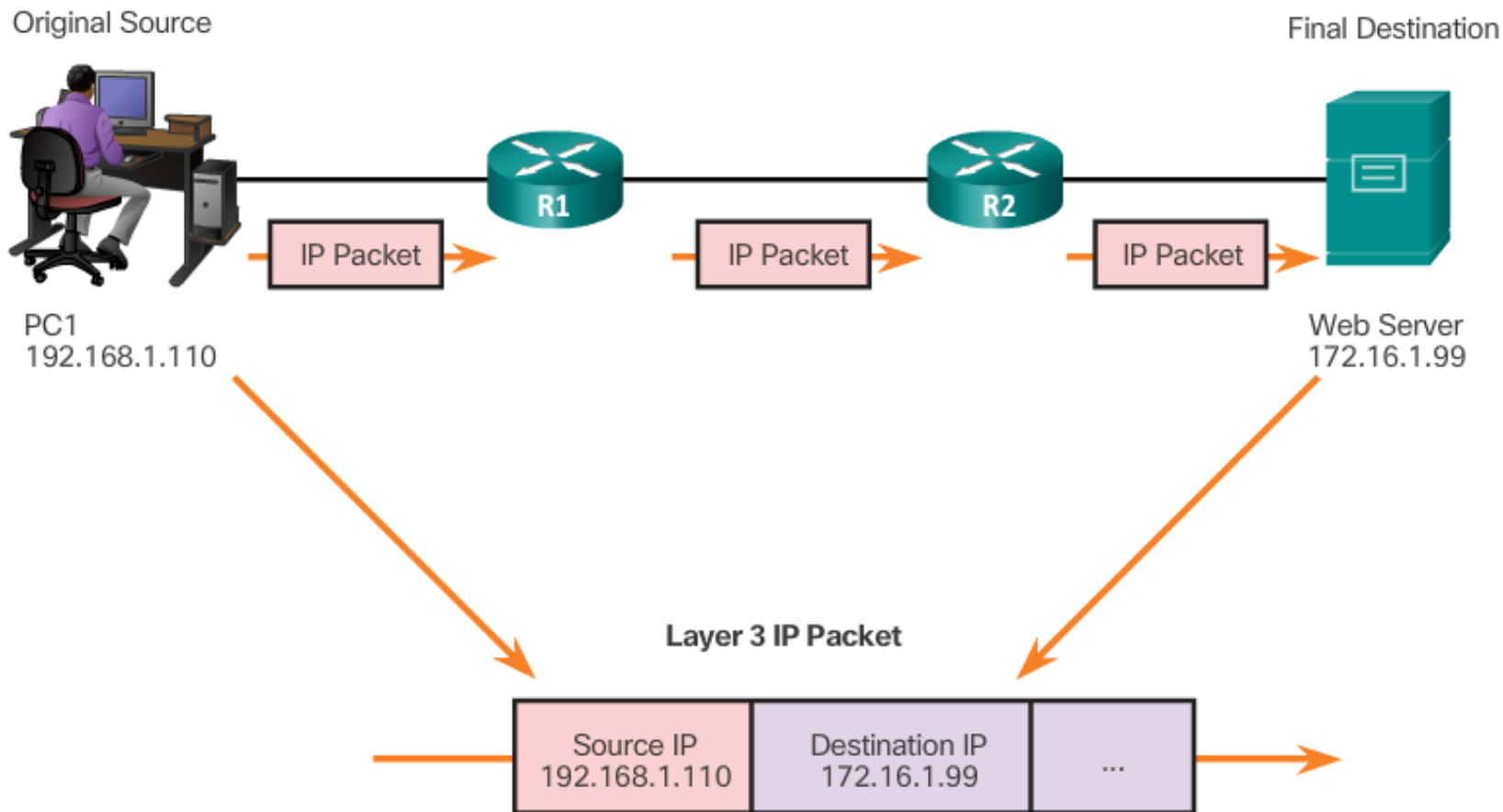
Web Client

Topic 3.3.2:
Data Access

Network Addresses

Network Addresses and Data Link Addresses

Network Addresses (cont.)

Layer 3 Network Addresses
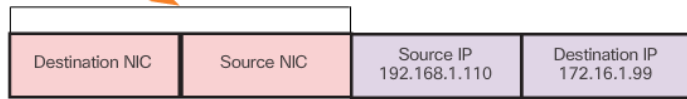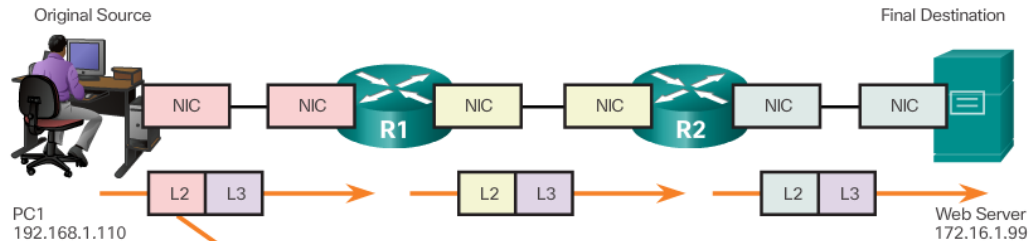
Data Link Addresses

Network Address

- Source IP address

- Destination IP address

- Responsible for delivering the IP packet from the original source to the final destination, either on the same network or to a remote network.

Data Link Address

- Source data link address

- Destination data link address

- Responsible for delivering the data link frame from one network interface card (NIC) to another NIC on the same network
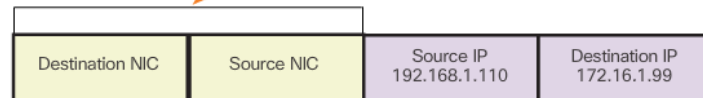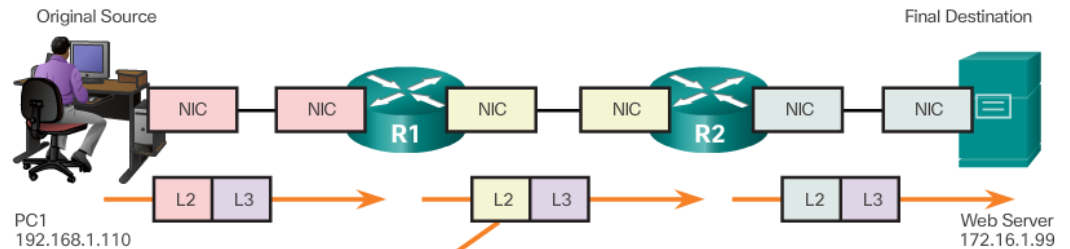
Data Link Address (cont.)

Layer 2 Data Link Addresses

Original Source
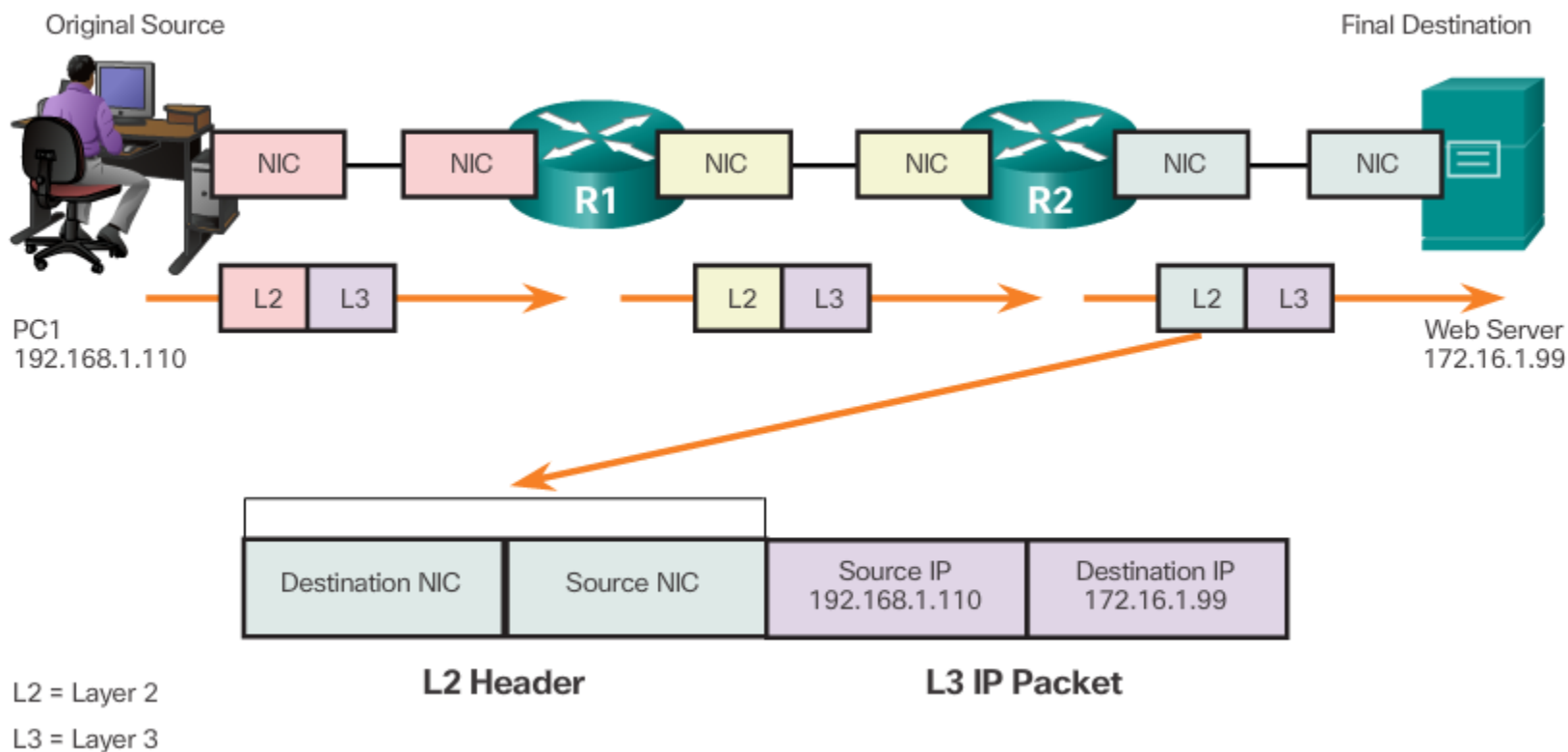
Final Destination

NIC NIC R1 NIC NIC R2 NIC NIC

PC1
192.168.1.110

L2 L3   L2 L3   L2 L3

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

Original Source

Final Destination

NIC NIC R1 NIC NIC R2 NIC NIC

PC1
192.168.1.110

L2 L3   L2 L3   L2 L3

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

Data Link Address (cont.)

Layer 2 Data Link Addresses

Devices on the Same Network

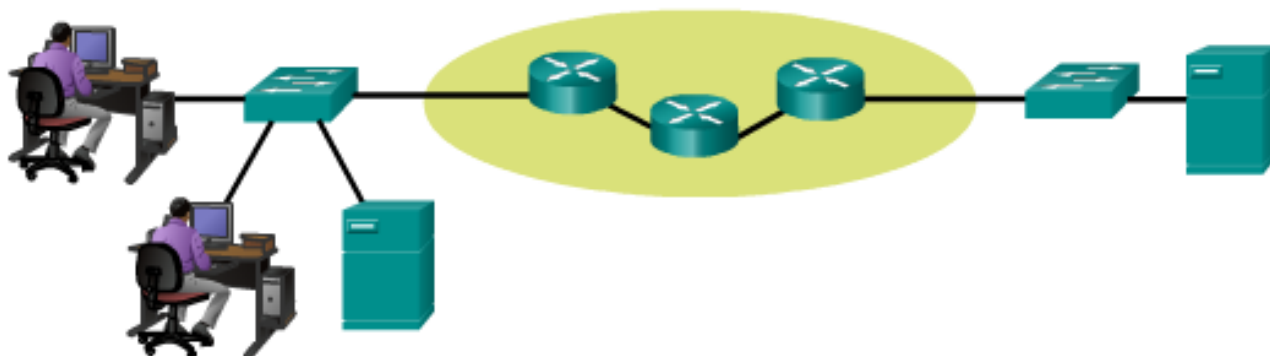| Data Link Ethernet Frame Header		Network Layer IP Packet Header		
Destination	**Source**	**Source**	**Destination**	**Data**
CC-CC-CC-CC-CC-CC	AA-AA-AA-AA-AA-AA	Network 192.168.1. ⋮ Host 110	Network 192.168.1. ⋮ Host 9	
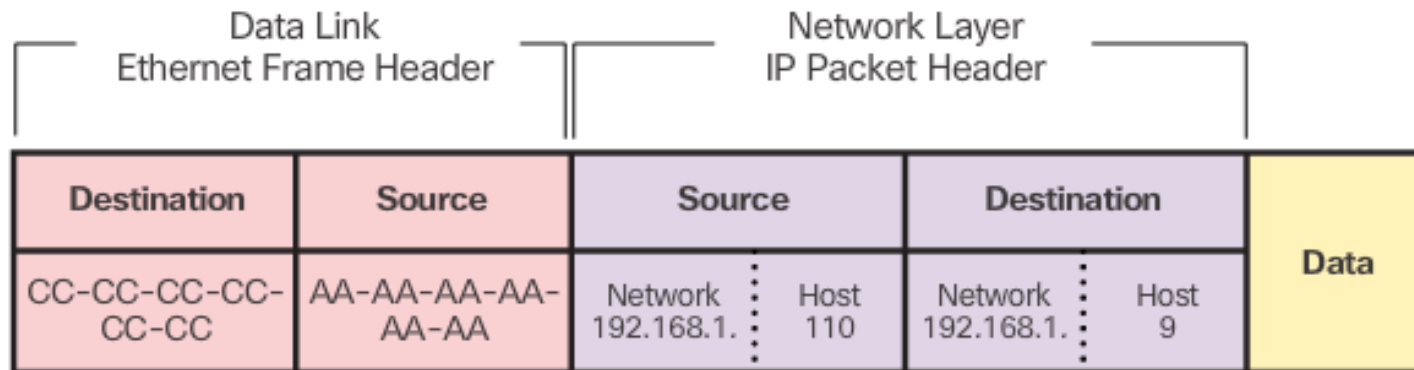
PC1
192.168.1.110
AA-AA-AA-AA-AA-AA

FTP Server
192.168.1.9
CC-CC-CC-CC-CC-CC

Devices on the Same Network (cont.)

- Role of the Network Layer Addresses

    Network portion of the IP Address – The left-most part of the address that indicates which network the IP address is a member.

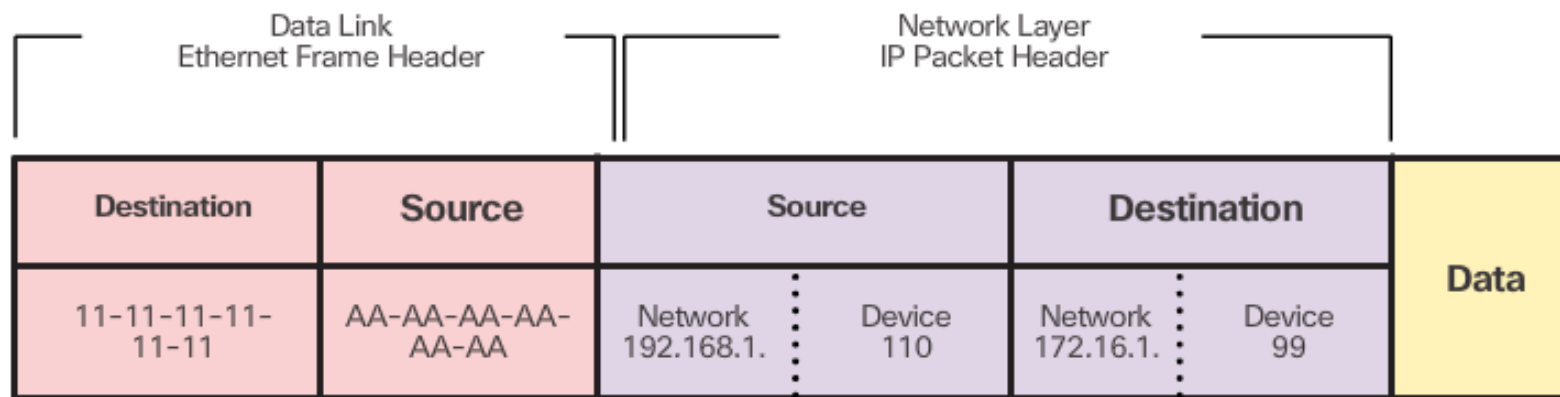   Host portion – The remaining part of the address that identifies a specific device on the network.

- Source IP address – The IP address of the sending device

- Destination IP address – The IP address of the receiving device

- Role of the Data Link Layer Addresses

    Source MAC address – This is the data link address, or the Ethernet MAC address, of the sending device.

    Destination MAC address – When the receiving device is on the same network as the sending device, this is the data link address of the receiving device.
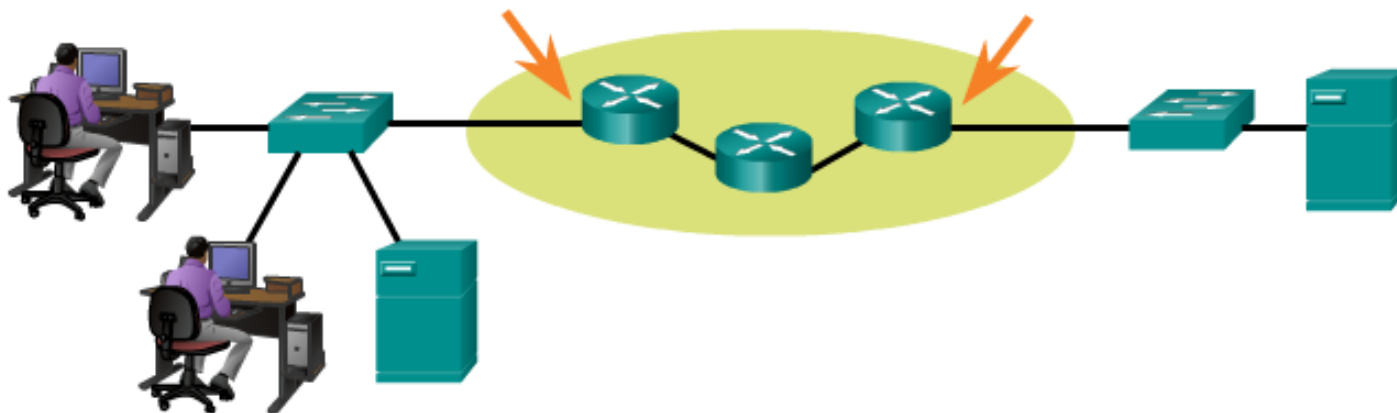
Devices on a Remote Network

Devices on a Remote Network (cont.)

Role of the Network Layer Addresses

- The source and destination IP addresses will represent hosts on different networks indicated by the different network portions of the source and destination addresses.

Role of the Data Link Layer Addresses

- Destination MAC address - When the receiving device is on a different network from the sending device, the sending device uses the Ethernet MAC address of the default gateway or router.

Section 3.4: Summary

Chapter Objectives:

- Explain how rules are used to facilitate communication.

- Explain the role of protocols and standards organizations in facilitating interoperability in network communications.

- Explain how devices on a LAN access resources in a small to medium-sized business network.

Thank you.

Cisco Networking Academy
Mind Wide Open