



Instructor Materials Chapter 3 Communicating on a Local Network



Networking Essentials

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Chapter 3: Communicating on a Local Network



Networking Essentials

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Chapter 3 - Sections & Objectives

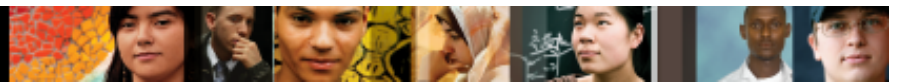
- 3.1 Principles of Communications
 - Explain the importance of standards and protocols in network communications.
- 3.2 Talking the Language of Networking
 - Explain how protocol model layers represent network functionality.
- 3.3 How do Ethernet Networks Work?
 - Explain how communication occurs on Ethernet networks.
- 3.4 How are Networks Built?
 - Explain why routers and switches are important in a network.
- 3.5 Routing Across Networks
 - Configure devices on a LAN.



3.1 Principles of Communications



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Principles of Communications

Establishing the Rules

- The Three Elements
 - The source, the destination, and the transmission medium.
- Communication Protocols
 - Before beginning to communicate with each other, we establish rules or agreements to govern the conversation.
- Why Protocols Matter
 - Networking protocols define the rules of communication over the local network.





Principles of Communications

So Who Makes the Rules

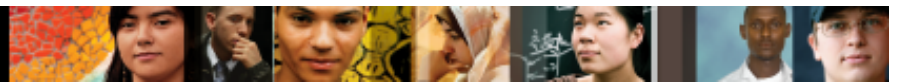
■ The Internet and Standards

- A standard is a set of rules that determines how something must be done.
- Networking protocols and Internet standards make it possible for different types of devices to communicate over the Internet.

■ Network Standards Organizations

- Standards are developed, published, and maintained by a variety of organizations.





Principles of Communications

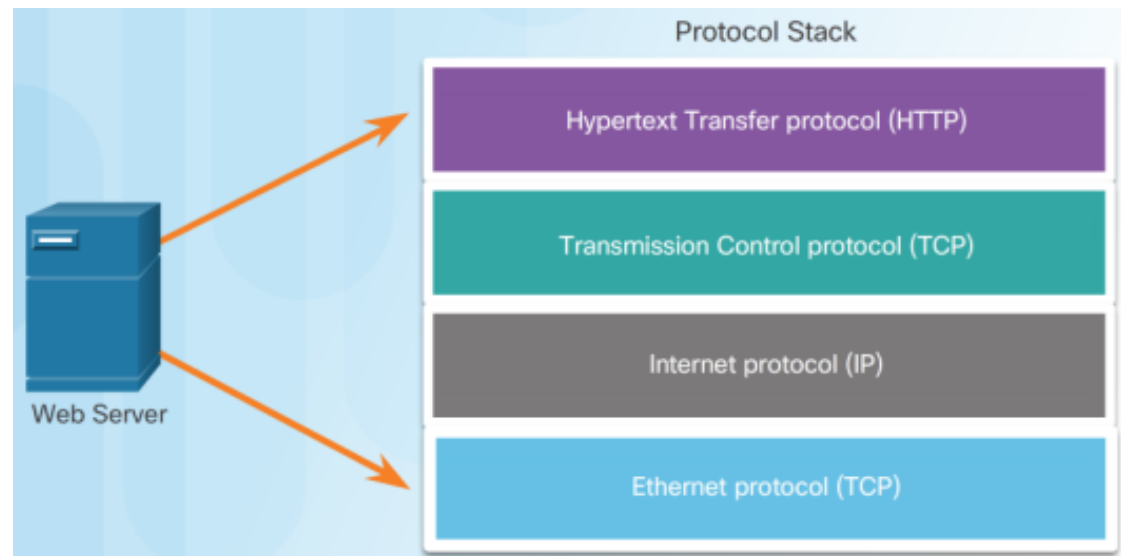
Visualizing How Protocols Work

■ Stacking Them Up

- Successful communication requires interaction between protocols.
- A protocol stack is used to help separate the function of each protocol.
- This enables each layer in the stack to operate independently of others.

■ Using a Layered Model

- Layered models help us visualize how the various protocols work together to enable network communications

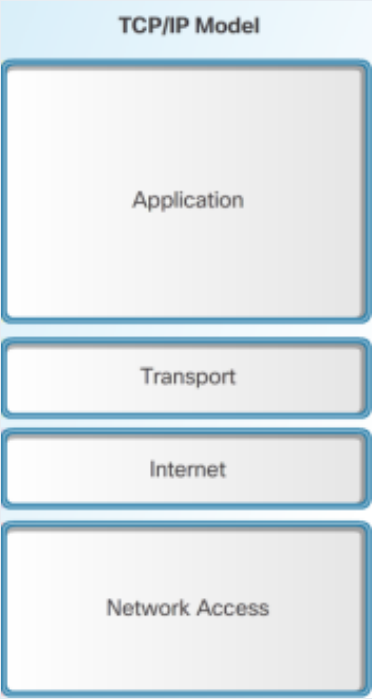





Principles of Communications

Visualizing How Protocols Work

- Different types of Network Models

| Protocol Model | Reference Model |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TCP/IP Model | Open Systems Interconnection (OSI) Model |
|  <p>The diagram shows the TCP/IP Model with four layers stacked vertically. From top to bottom, they are: Application, Transport, Internet, and Network Access. Each layer is represented by a light blue rounded rectangle with a dark blue border.</p> |  <p>The diagram shows the OSI Model with seven layers stacked vertically. From top to bottom, they are: 7. Application, 6. Presentation, 5. Session, 4. Transport, 3. Network, 2. Data Link, and 1. Physical. Each layer is represented by a light blue rounded rectangle with a dark blue border.</p> |



3.2 Talking the Language of Networking



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Talking the Language of Networking

Working with the OSI Model

- Dividing the Tasks
 - The OSI model divides communication into multiple processes.
 - Each process is a small part of the larger task.

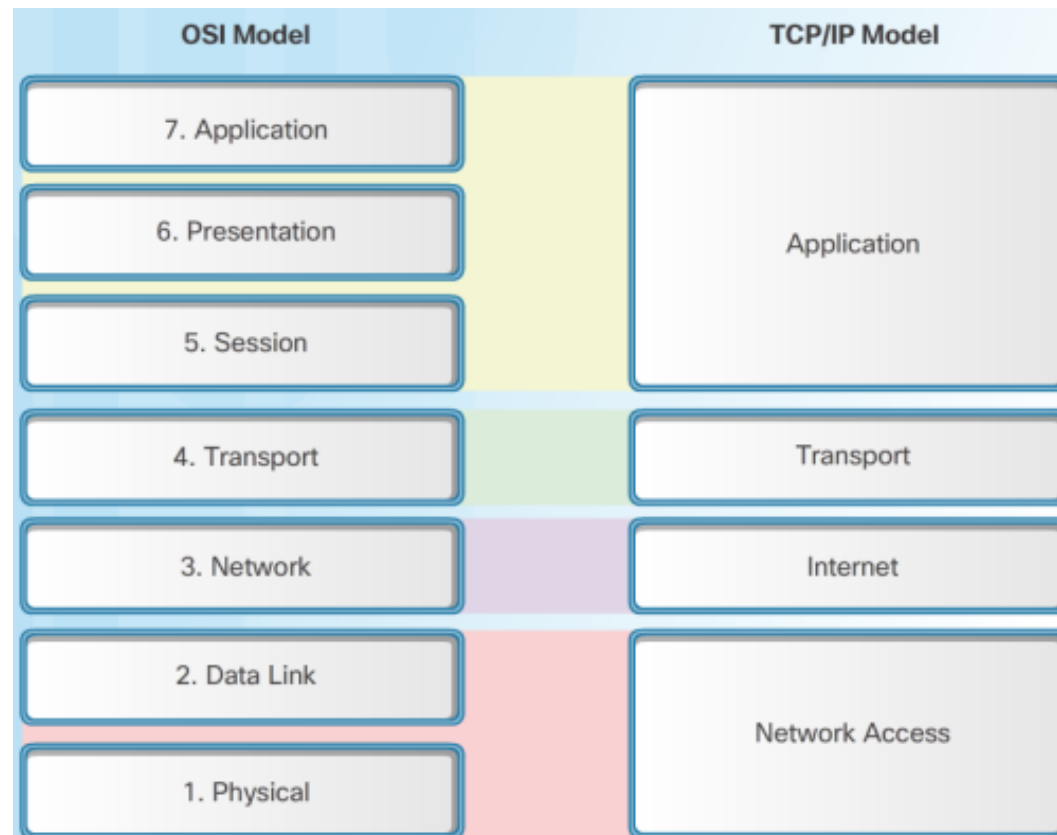
| Group | # | Layer Name | Common Network Components Associated with this Layer |
|--------------|---|--------------|-----------------------------------------------------------------------------------------------------|
| Upper Layers | 7 | Application | Network aware applications, Email, Web Browsers and Servers, File Transfer, Name Resolution |
| | 6 | Presentation | |
| | 5 | Session | |
| Lower Layers | 4 | Transport | Video and Voice streaming mechanisms firewall filtering lists |
| | 3 | Network | IP Addressing, Routing |
| | 2 | Data Link | Network Interface cards and Drivers, Network Switching, WAN connectivity |
| | 1 | Physical | Physical Medium (copper twisted pair, fiber optic cable, wireless transmitters), Hubs and Repeaters |



Talking the Language of Networking

Working with the OSI Model

- Comparing the OSI and TCP/IP Models



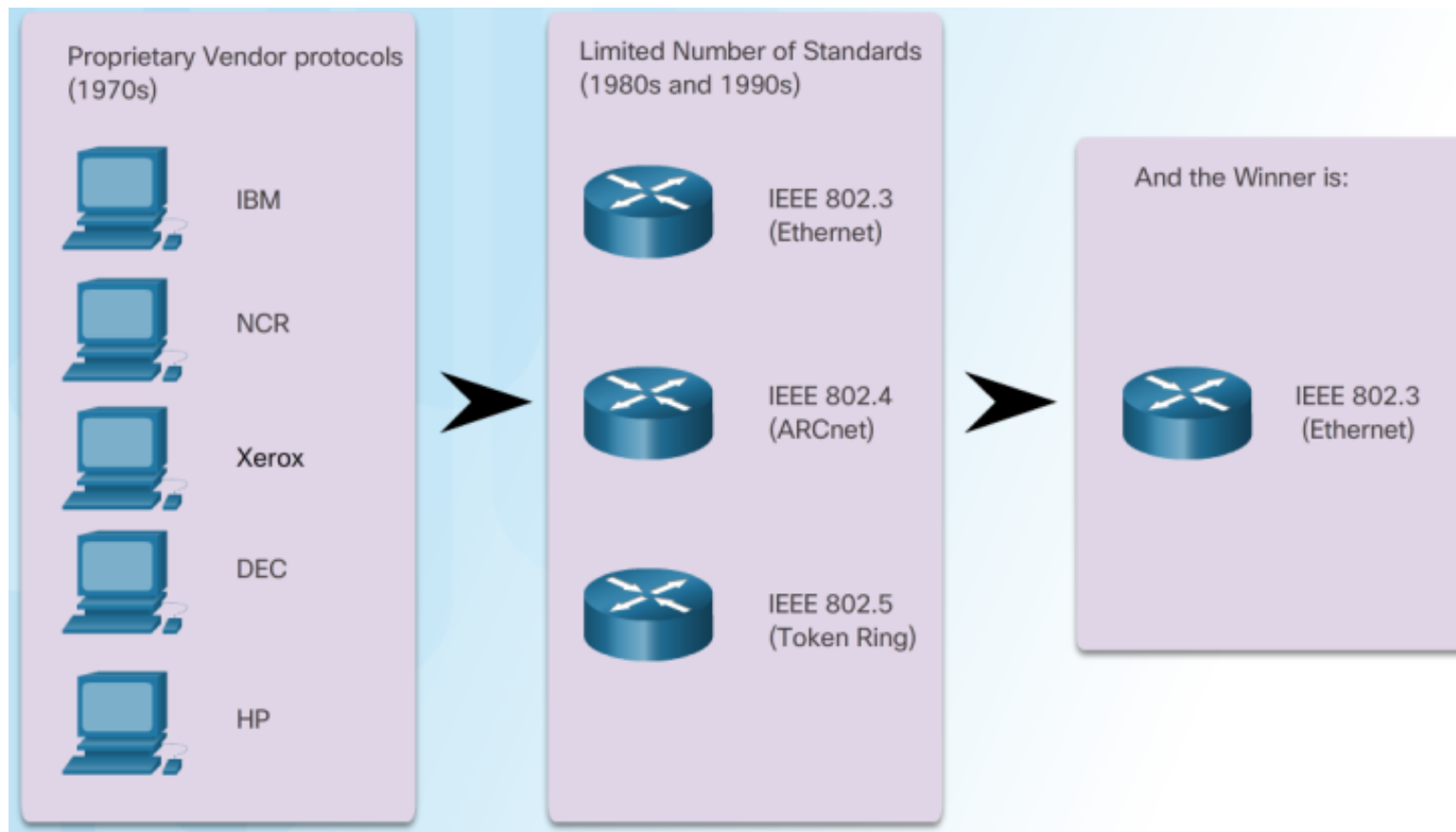
Both models are commonly used; therefore, it is wise to become very familiar with them.



Talking the Language of Networking

Protocols for Wired Networks

- Why Ethernet?
 - Ethernet has become the de facto standard
 - This means it is used by almost all wired local area networks





Talking the Language of Networking

Protocols for Wired Networks

- Ethernet is Constantly Evolving
 - The Institute of Electrical and Electronic Engineers (IEEE) maintains Ethernet and wireless standards.
 - They are responsible for maintaining the standards and for approving new enhancements.

- Ethernet Addressing
 - Each host connected to an Ethernet network is assigned a unique physical address which identifies it on the network.
 - The physical address is known as the Media Access Control (MAC) address and is assigned to a NIC it when it is manufactured.



3.3 How do Ethernet Networks Work?



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How do Ethernet Networks Work?

Preparing Data for Transmission

■ Encapsulation

- The process of placing one message inside another message format is called encapsulation.
 - De-encapsulation occurs when the process is reversed.
- Before a network message is sent over the network, it is encapsulated in a frame that identifies the destination and source MAC addresses.

■ Framing the Message

IEEE 802.3 Ethernet Frame

| | | | | | | |
|----------|--------------------------|-------------------------|--------------------|---------------|-----------------------|----------------------|
| 7 bytes | 1 | 6 | 6 | 2 | 46 to 1500 | 4 |
| Preamble | Start of Frame Delimiter | Destination MAC Address | Source MAC Address | Type / Length | 802.2 Header and Data | Frame Check Sequence |

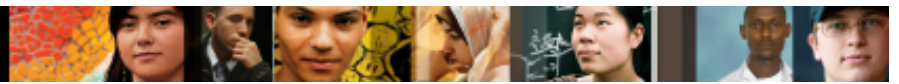


How do Ethernet Networks Work?

The Building Blocks of Ethernet Networks

- Why Networks Need Hierarchical Design
 - A MAC address identifies a specific host on a local network, but it cannot be used to reach remote hosts networks.
 - A hierarchical design is required.

- The Benefits of Hierarchical Design
 - Enterprise networks are most often designed in hierarchical manner using an access layer, distribution layer, and core layer.
 - Hierarchical networks require a logical addressing scheme such as Internet Protocol version 4 (IPv4) or Internet Protocol version 6 (IPv6) to reach remote hosts.



How do Ethernet Networks Work?

Logical Addressing

- Physical and Logical Addresses
 - A MAC address is physically assigned to a NIC and never changes.
 - The physical MAC address remains the same regardless of network.
 - An IP address (network address) is logically assigned to a host NIC.
 - The logical IP addresses contain two parts:
 - **Network portion:** The left-hand portion of an IP address identifies the network portion of the address. It is the same for all hosts connected to the local network.
 - **Host address:** The right-hand portion of an IP address that uniquely identifies the individual host on the network.

- Both the physical MAC and logical IP addresses are required for a computer to communicate on a hierarchical network.



3.4 How are Networks Built?



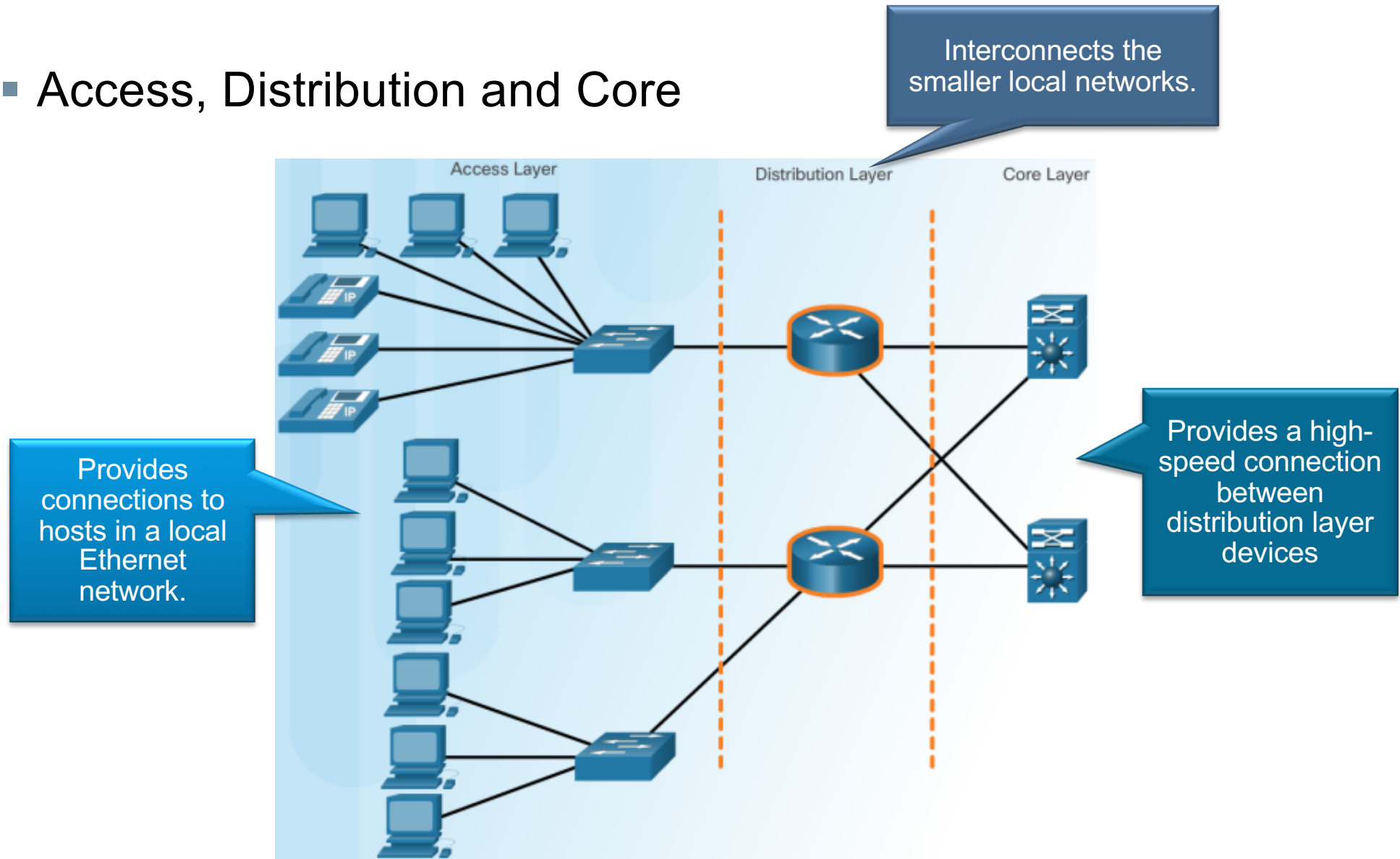
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How are Networks Built?

Starting with a Good Design

- Access, Distribution and Core





How are Networks Built?

Starting with a Good Design

- Access Layer Devices
 - Provides the first line of networking devices that connect hosts to the wired Ethernet network.
 - Typically connected using Layer 2 switches.

- Ethernet Hubs
 - Legacy access layer device that broadcast frames to all ports.
 - Created excessive collision domains.
 - Hubs have been superseded by Layer 2 switches.



How are Networks Built?

Building a Better Access Layer

■ Ethernet Switches

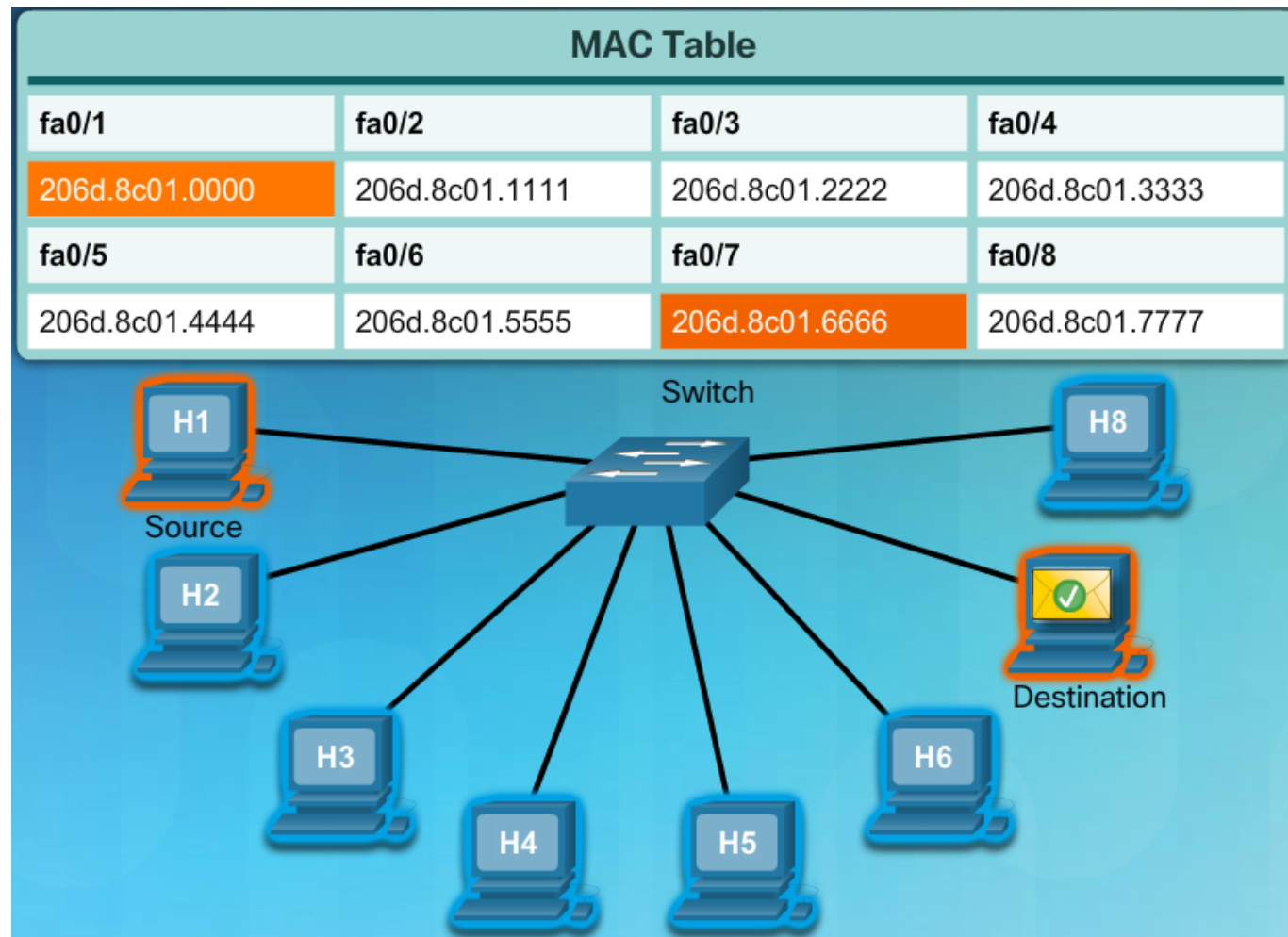
- A switch accepts and decodes the frames to read the physical (MAC) address portion of the message.
- The switch checks a table on the switch, called a MAC address table, that contains a list of all of the active ports and the host MAC addresses that are attached to them.
- The switch creates a circuit that connects those two ports, enabling the switch to support multiple conversations between different pairs of ports.



How are Networks Built?

Building a Better Access Layer

- MAC Address Tables





How are Networks Built?

Containing Broadcasts

- What are Broadcasts Anyway?
 - A broadcast message is simultaneously sent by a host to all other hosts.
 - A broadcast MAC address in hexadecimal notation is **FFFF.FFFF.FFFF**

- Broadcast Domains
 - A local area network, a network with one or more Ethernet switches, is also referred to as a broadcast domain.
 - When a broadcast message is sent, all switches forward the message to every connected host within the same local network.



How are Networks Built?

Containing Broadcasts

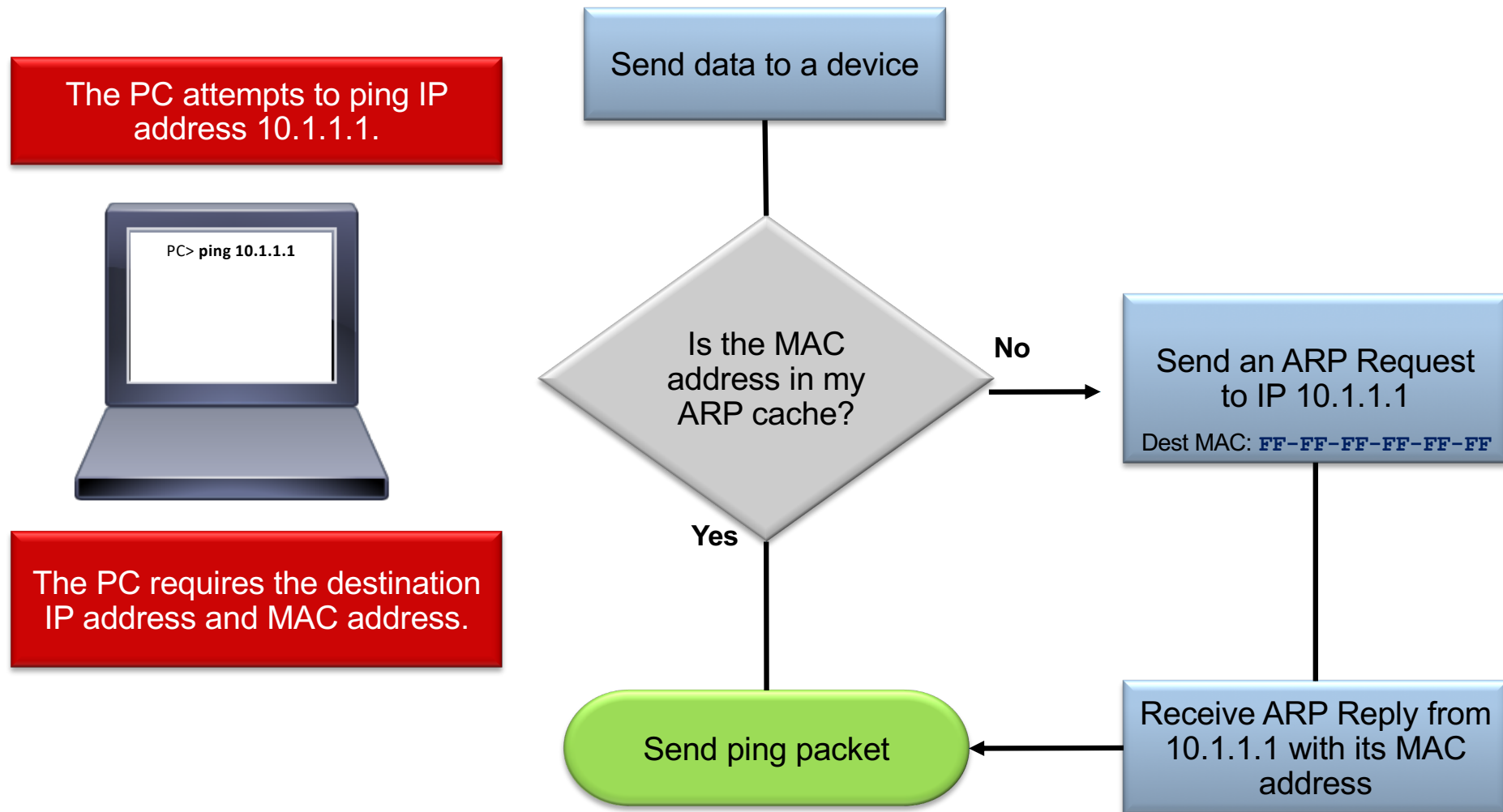
- Communicating at the Access Layer
 - To send a message, a host needs the IP address and MAC address of the destination host.
 - The destination IP address is typically known; therefore, how does the sending host determine the destination MAC address?
 - The sending host can use an IPv4 protocol called **address resolution protocol (ARP)** to discover the MAC address of any host on the same local network.
 - IPv6 uses a similar method known as Neighbor Discovery.



How are Networks Built?

Containing Broadcasts

■ How ARP Works



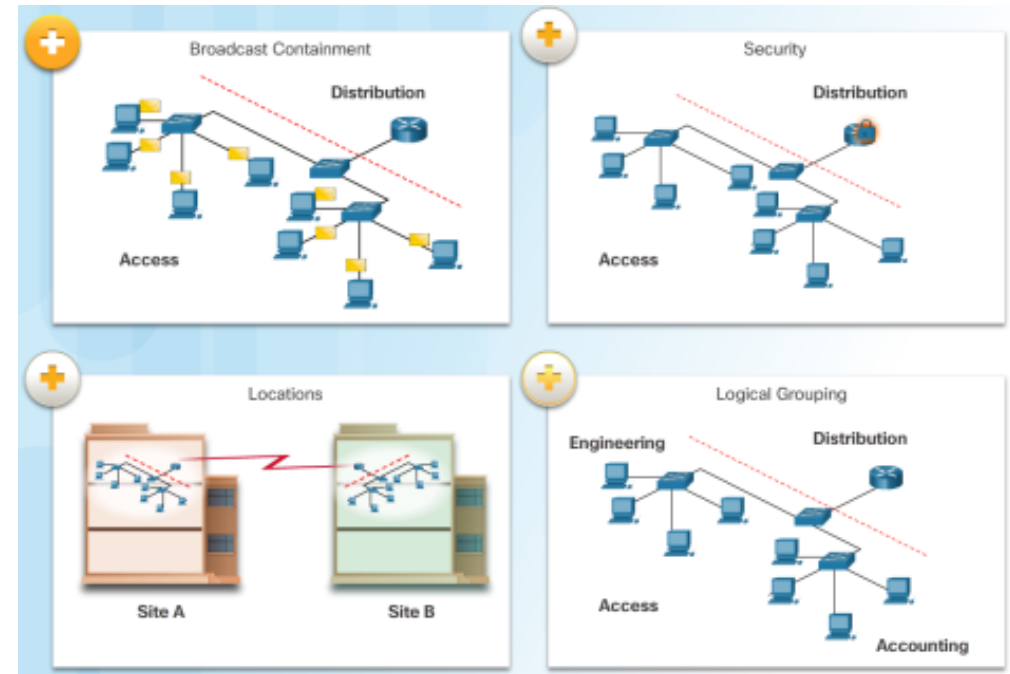


How are Networks Built?

Distributing Messages to Other Devices

■ Dividing the Local Network

- As networks evolve, it is necessary to divide one access layer network into multiple access layer networks.
- There are many ways to divide networks based on different criteria.



■ Now We Need Routing

- Routers and routing is required to reach remote hosts.
- Routing is the process of identifying the best path to a destination.



3.5 Routing Across Networks



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Routing Across Networks

Keeping a Table

■ Selecting a Path

- Every router creates a routing table containing all locally-connected and remote networks and the interfaces that connect to them.
- Routers use their routing tables and forward packets to either a directly connected network containing the actual destination host, or to another router on the path to reach the destination host.

■ Building the Tables

- Router build their routing tables by first adding their locally connected networks, and then learning about other networks using routing protocols.

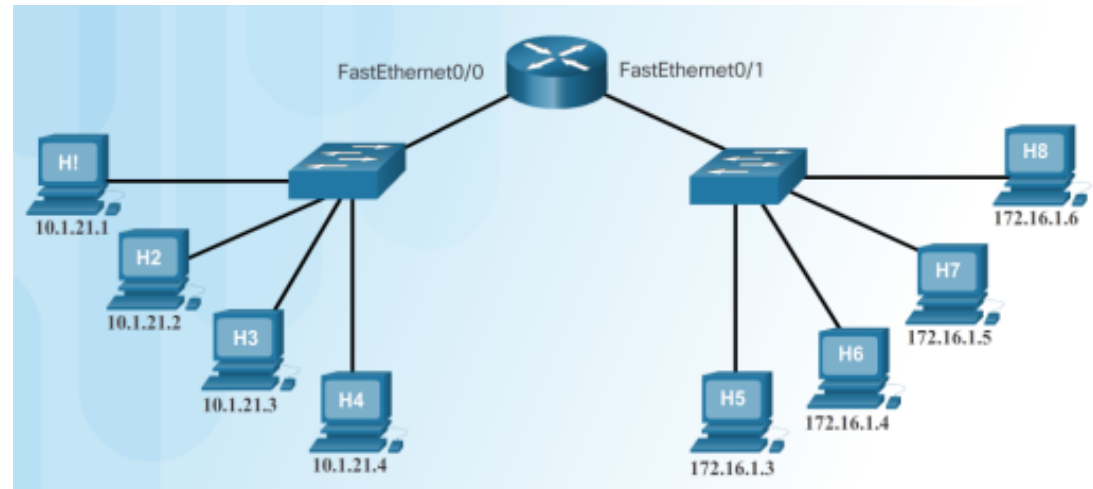


Routing Across Networks Keeping a Table

| Type | Network | Outgoing Port |
|------|---------------|------------------|
| C | 10.1.21.0/24 | FastEthernet 0/0 |
| C | 172.16.1.0/24 | FastEthernet 0/1 |

■ How Routers Use Tables

- The router has added its two directly connected networks to the routing table.



■ Sending to Remote Networks

- If H1 sent a packet to H7, the router would examine its routing table and determine that to reach network 172.16.1.0/24, it must forward the packet out of its Fa0/1 interface.
- Because the outgoing network is a directly connected Ethernet network, the router may also have to ARP the IP address.



Routing Across Networks

Creating a LAN

■ Local Area Networks

- Local Area Network (LAN) refers to a local network, or a group of interconnected local networks that are under the same administrative control.
- The term **Intranet** refers to a private LAN that belongs to an organization, and is accessible only by the organization's members, employees, or others with authorization.



Routing Across Networks

Creating a LAN

■ Assigning Hosts to a LAN

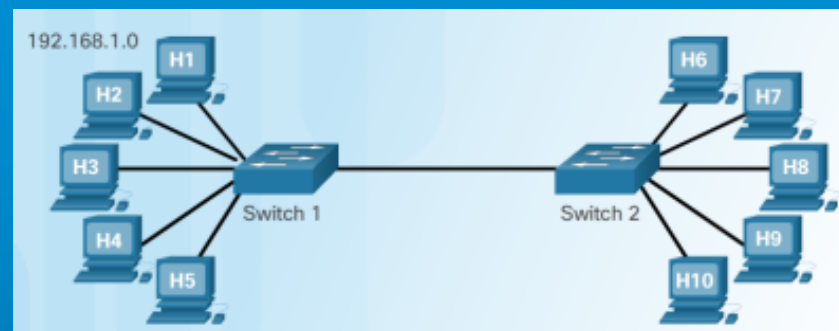
Placing All Hosts in One Local Network Segment

Advantages:

- Appropriate for simpler networks
- Less complexity and lower network cost
- Allows devices to be "seen" by other devices
- Faster data transfer - more direct communication
- Ease of device access

Disadvantages:

- All hosts are in one broadcast domain which causes more traffic on the segment and may slow network performance



Placing Hosts in Remote Network Segments

Advantages:

- More appropriate for larger, more complex networks
- Splits up broadcast domains and decreases traffic
- Can improve performance on each segment
- Makes the machines invisible to those on other local network segments
- Can provide increased security
- Can improve network organization

Disadvantages:

- Requires the use of routing (distribution layer)

