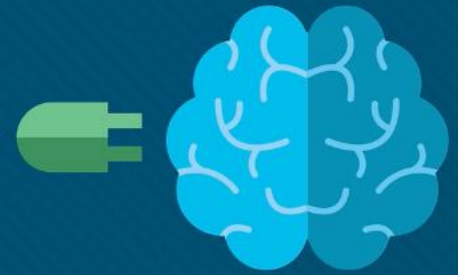


Module 6: Network Design and the Access Layer

Networking Essentials (NETESS)

Module Objectives

Module Title: Network Design and Access Layer
Module Objective: Explain how communication occurs on Ethernet networks.

Topic Title	Topic Objective
Encapsulation and the Ethernet Frame	Explain the process of encapsulation and Ethernet framing.
Hierarchical Network Design	Explain the function at each layer of the 3-layer network design model.
The Access Layer	Explain how to improve network communication at the access layer.
Broadcast Containment	Explain why it is important to contain broadcasts within a network.

6.1 Encapsulation and the Ethernet Frame

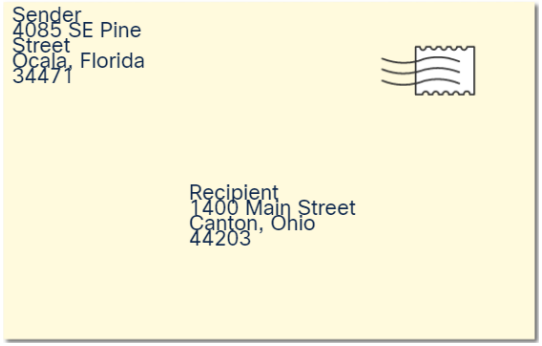
Video - The Fields of the Ethernet Frame

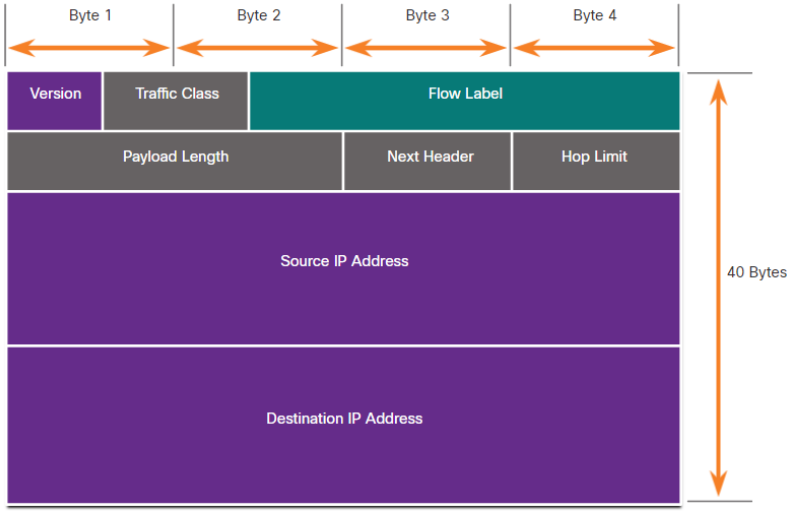
Encapsulation

Each message is encapsulated into a specific format, called a frame, that includes the source and destination addresses.

- An example is how a letter is put (encapsulated) inside an envelope.

For communication on an IP network, the format is very specific and includes a source and destination address.

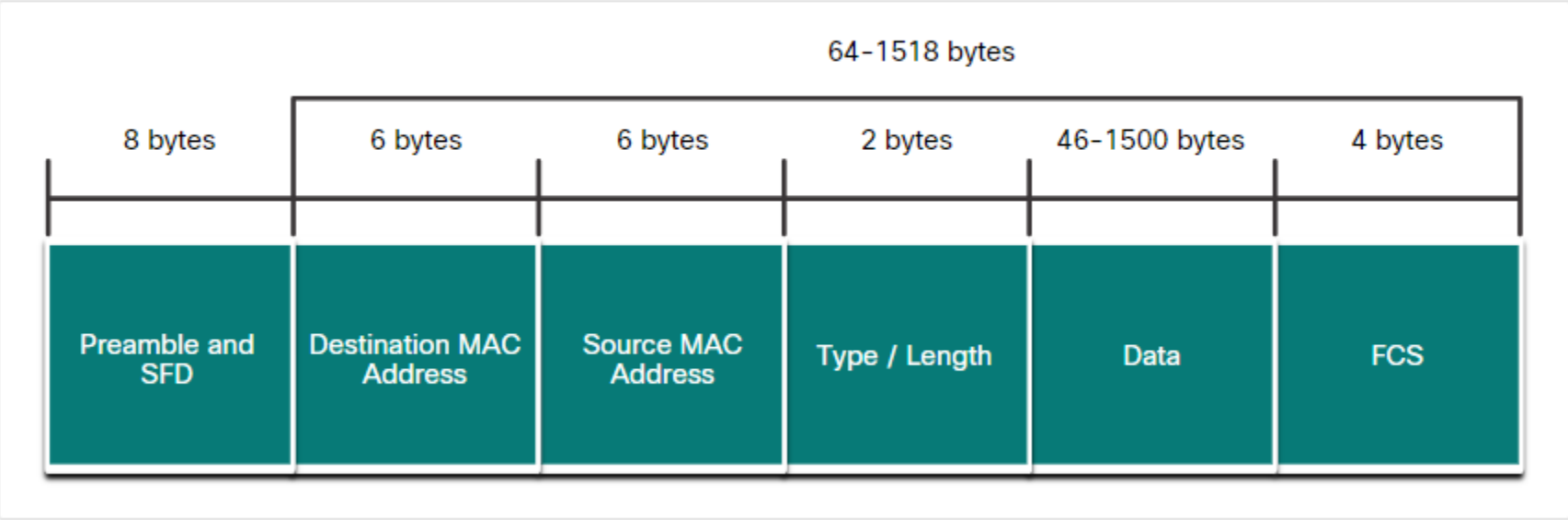




Ethernet Frame

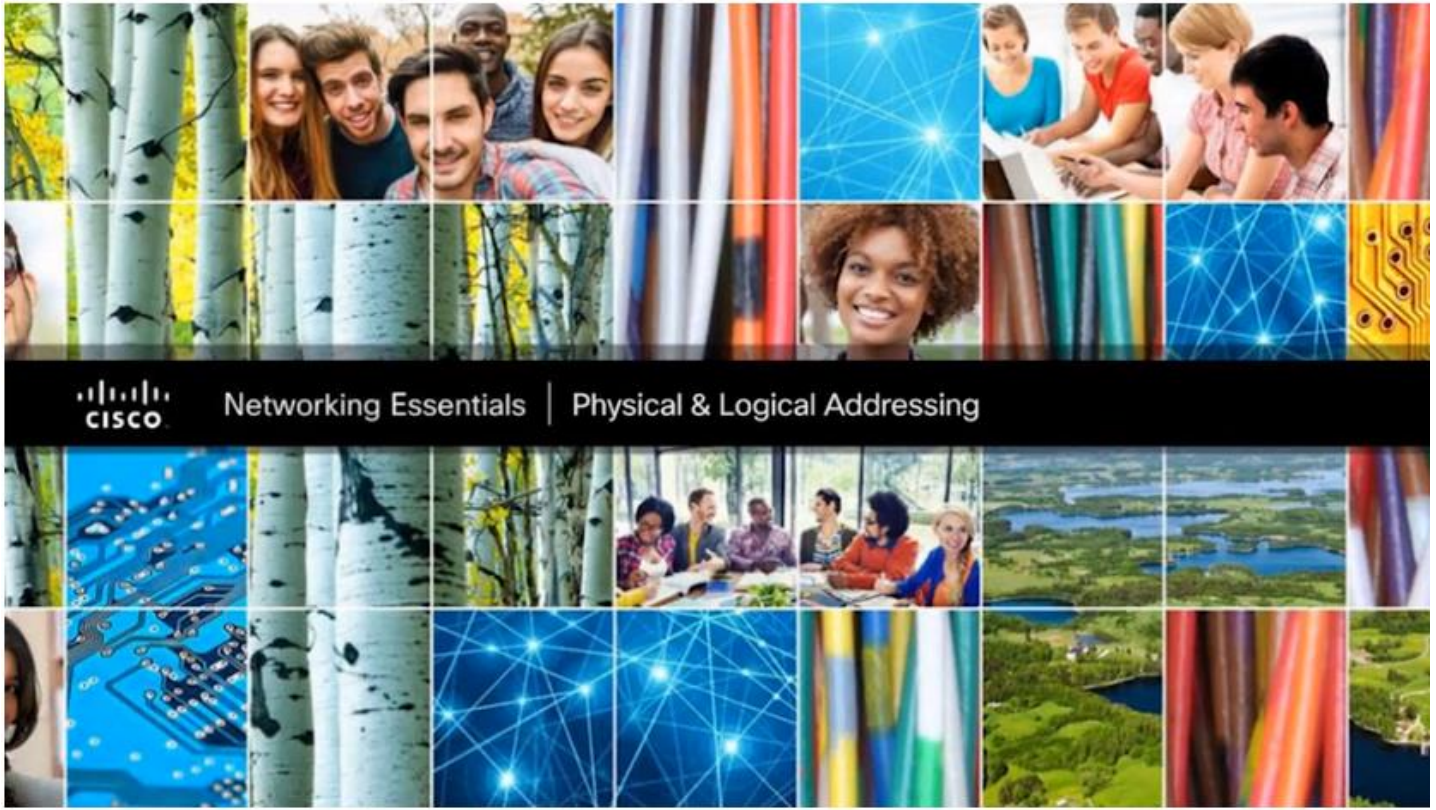
On an Ethernet network, messages are put into a frame or Layer 2 protocol data units (PDUs).

Ethernet Frame Fields



6.2 Hierarchical Network Design

Video - Physical and Logical Addresses

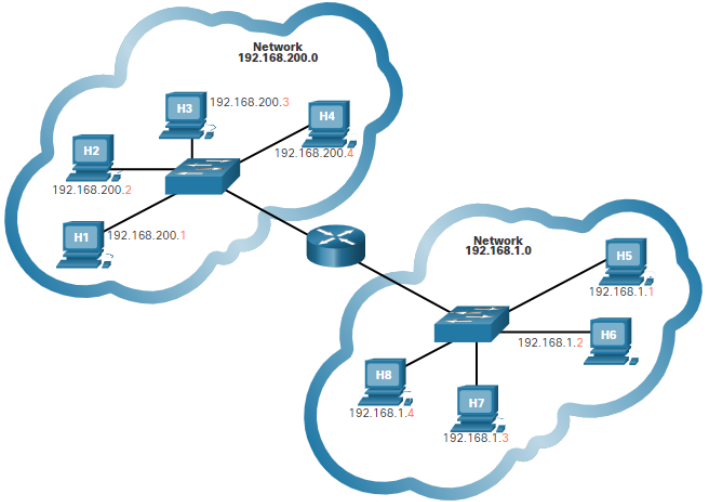


Physical and Logical Addresses

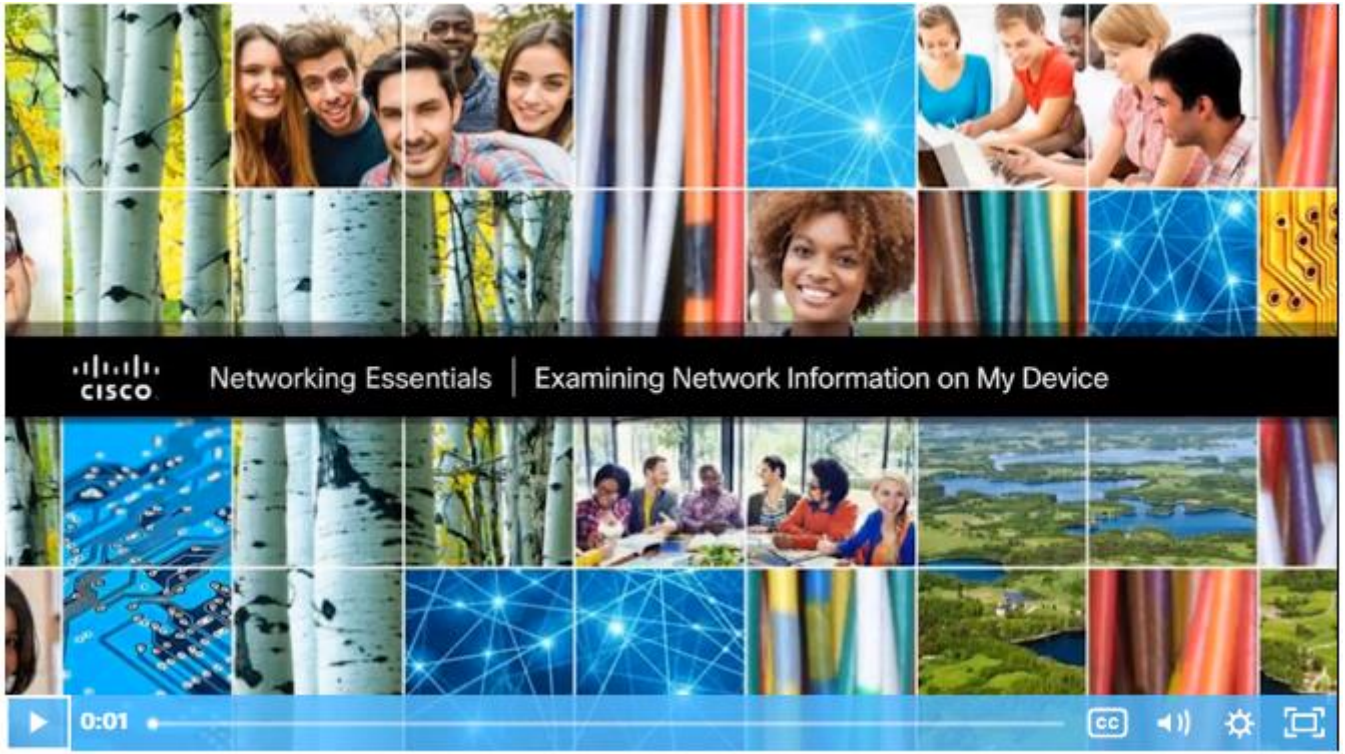
Both a physical address and logical IP address are needed for a device to communicate on an Ethernet network.

- A physical address (MAC address) does not change.
  - Burned into the NIC
- A logical address (IP address) can change and is commonly assigned by a network administrator.
  - Two parts: network and host

Logical addressing



Video - View Network Information on My Device



Lab - View Wireless and Wired NIC Information

In this lab, you will complete the following objectives:

- Identify and work with PC NICs.
- Identify and use the System Tray network icons.

Hierarchical Analogy

Network addressing is done in a hierarchical fashion.

North America

Canada

Nova Scotia

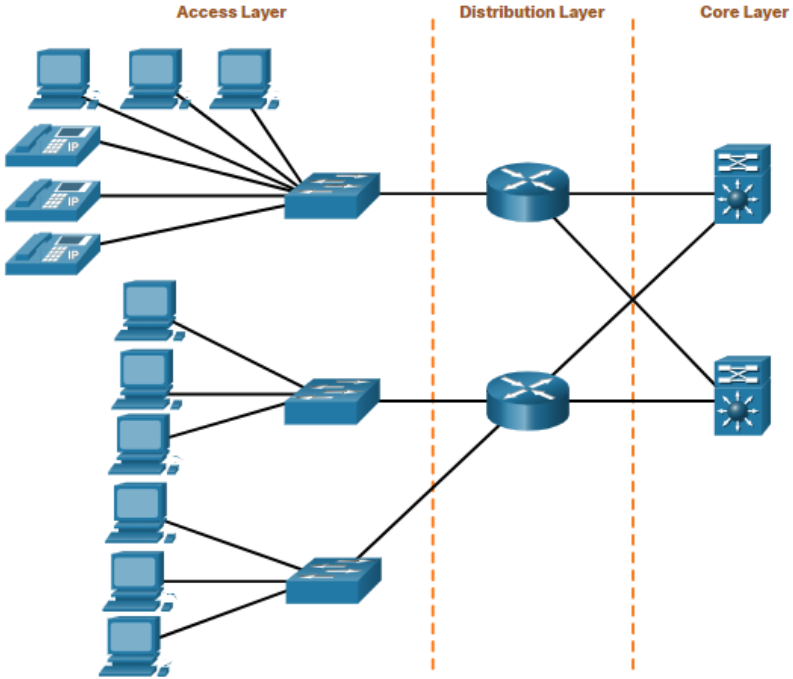
Halifax

Video - Benefits of a Hierarchical Network Design

Benefits of a Hierarchical Design

A hierarchical, layered design provides:

- Increased efficiency
- Optimization of function
- Increased speed
- A way in which to scale the network without impacting the performance of existing ones



Three layers:

- **Access Layer** - This layer provides connections to hosts in a local Ethernet network.
- **Distribution Layer** - This layer interconnects the smaller local networks.
- **Core Layer** - This layer provides a high-speed connection between distribution layer devices.

Access, Distribution, and Core

Cisco Catalyst 9600

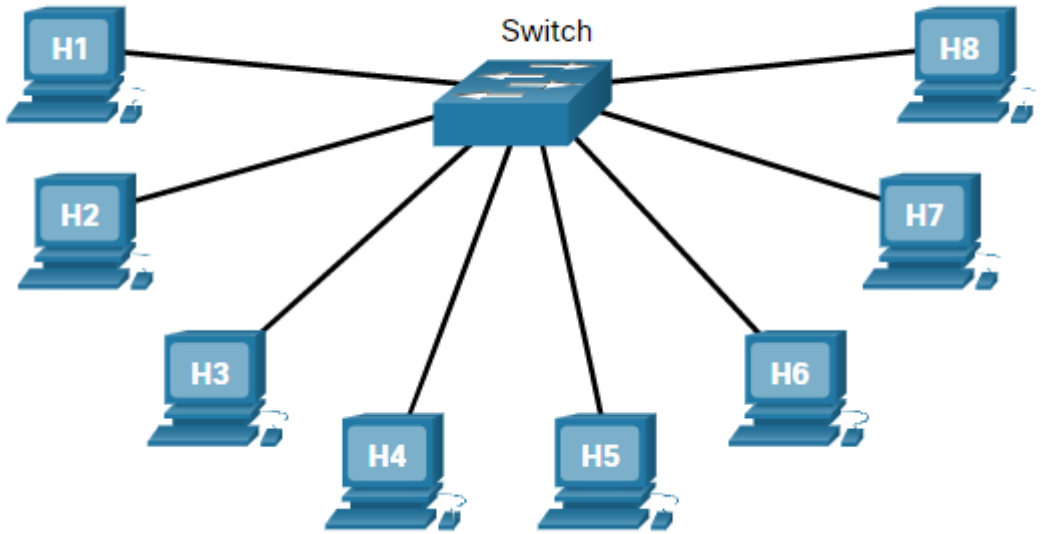
Cisco C9300 Series
Distribution Layer Switches

Cisco ME 2600X Access Layer Switch

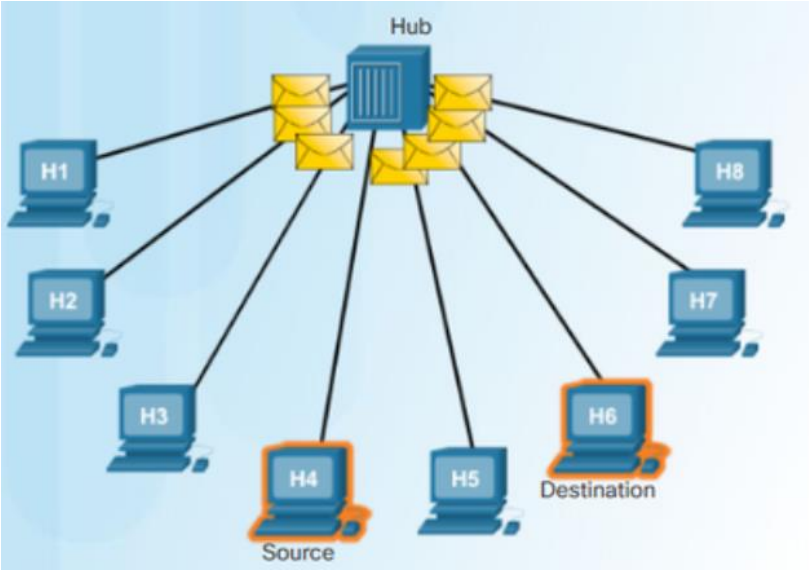
6.3 The Access Layer

Access Layer Devices

- Access layer devices provide access so hosts can join a wired (or wireless) network.
- In a wired network, each host connects to an access layer network device such as a switch.



Ethernet Hubs



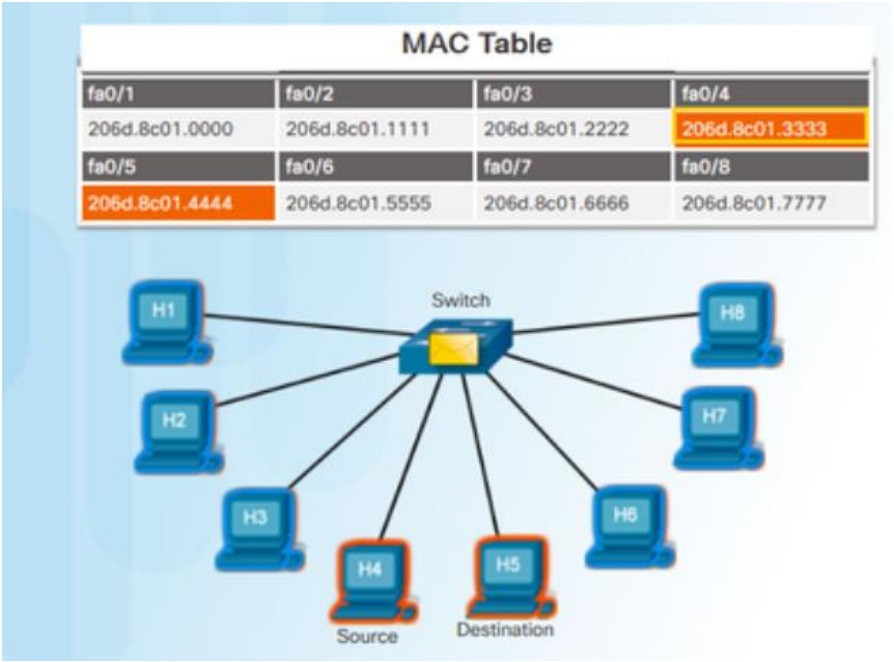
- Only one message can be sent through an Ethernet hub at a time.
- Hubs take signals from one port and sends the message out all of the other ports.

Video - Ethernet Switches

Ethernet Switches

An Ethernet switch is an access layer device.

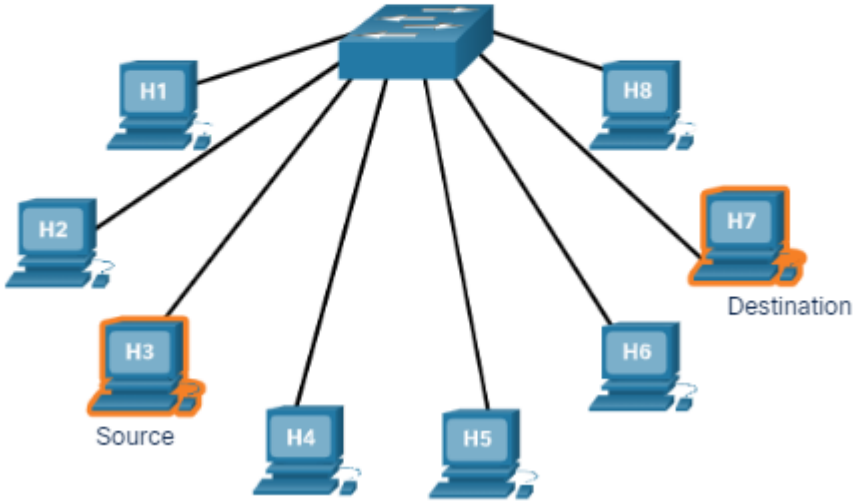
- A switch builds a MAC address table.
- A switch uses the MAC address table to send the message to a specific port.



Video - MAC Address Tables

The MAC Address Table

MAC Table			
fa0/1	fa0/2	fa0/3	fa0/4
260d.8c01.0000	260d.8c01.1111	260d.8c01.2222	260d.8c01.3333
fa0/5	fa0/6	fa0/7	fa0/8
260d.8c01.4444	260d.8c01.5555		260d.8c01.7777



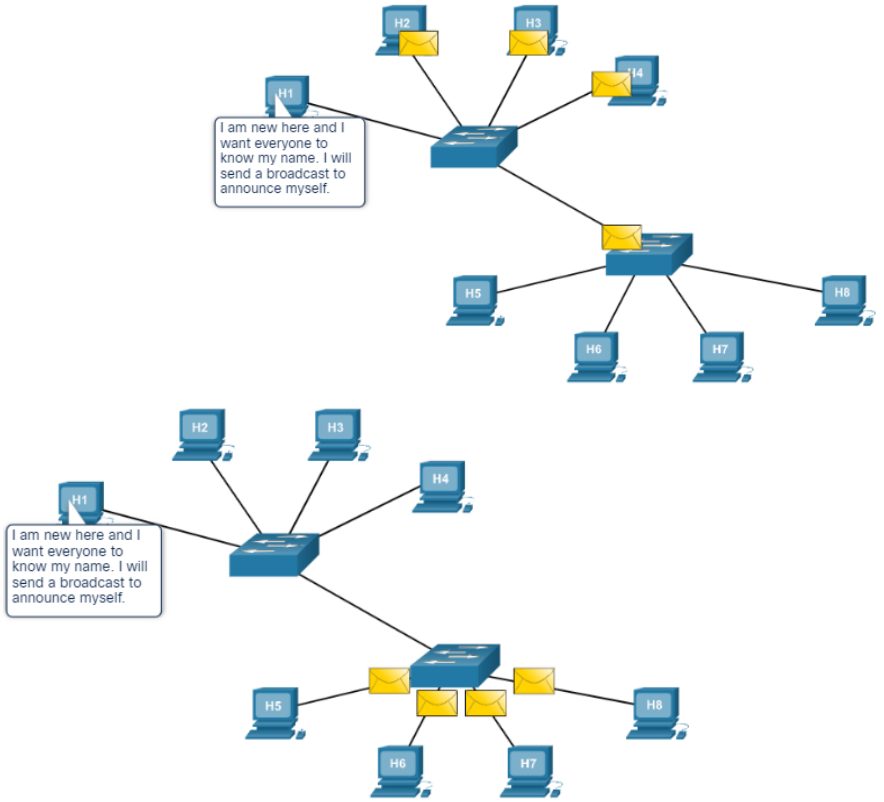
- A switch builds a MAC address table by examining a frame as it comes into the switch.
- A switch adds the source MAC address of the device connected to the port through which the frame came in on.
- A switch forwards a frame out to a specific port when the destination MAC address is in the MAC address table.
- A switch forwards a frame out to all hosts (except the sending host) when the destination MAC address is not in the MAC address table.

6.4 Broadcast Containment

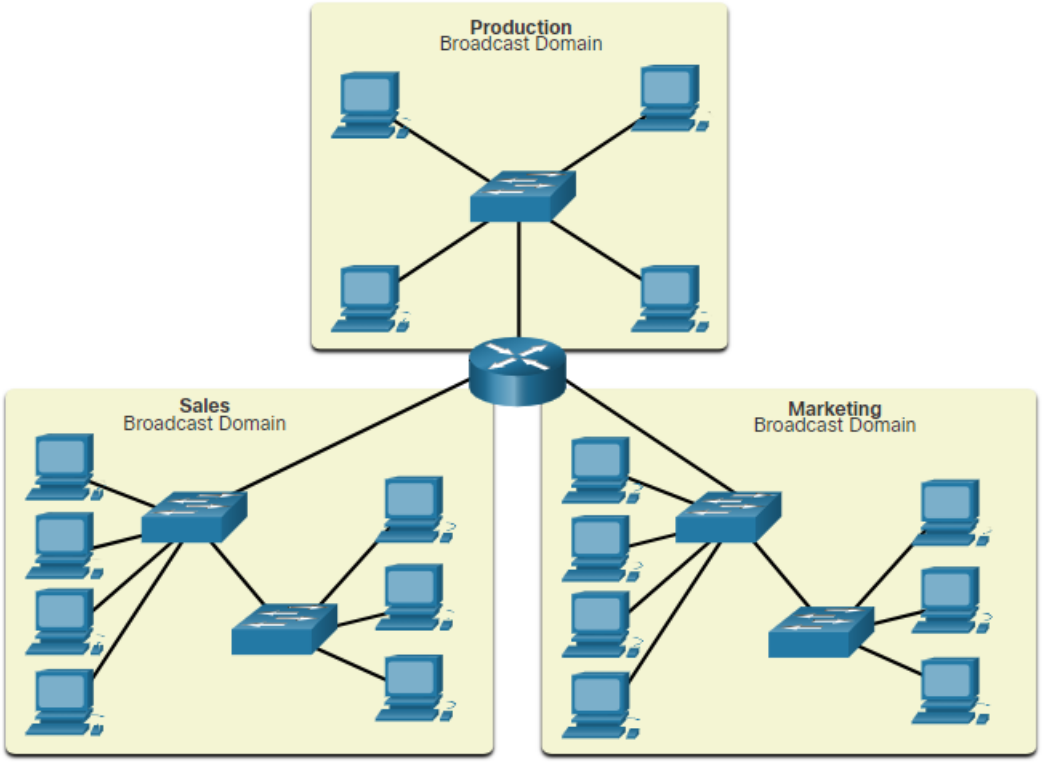
Video - The Ethernet Broadcast

Ethernet Broadcasts in the Local Network

- A broadcast message is used to contact every other device on the local network.
- An Ethernet broadcast is all 1s in the destination MAC address – FFFF.FFFF.FFFF.



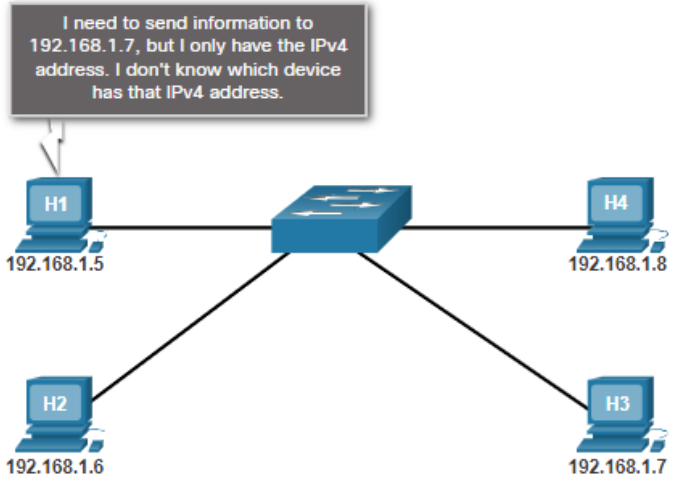
Broadcast Domains



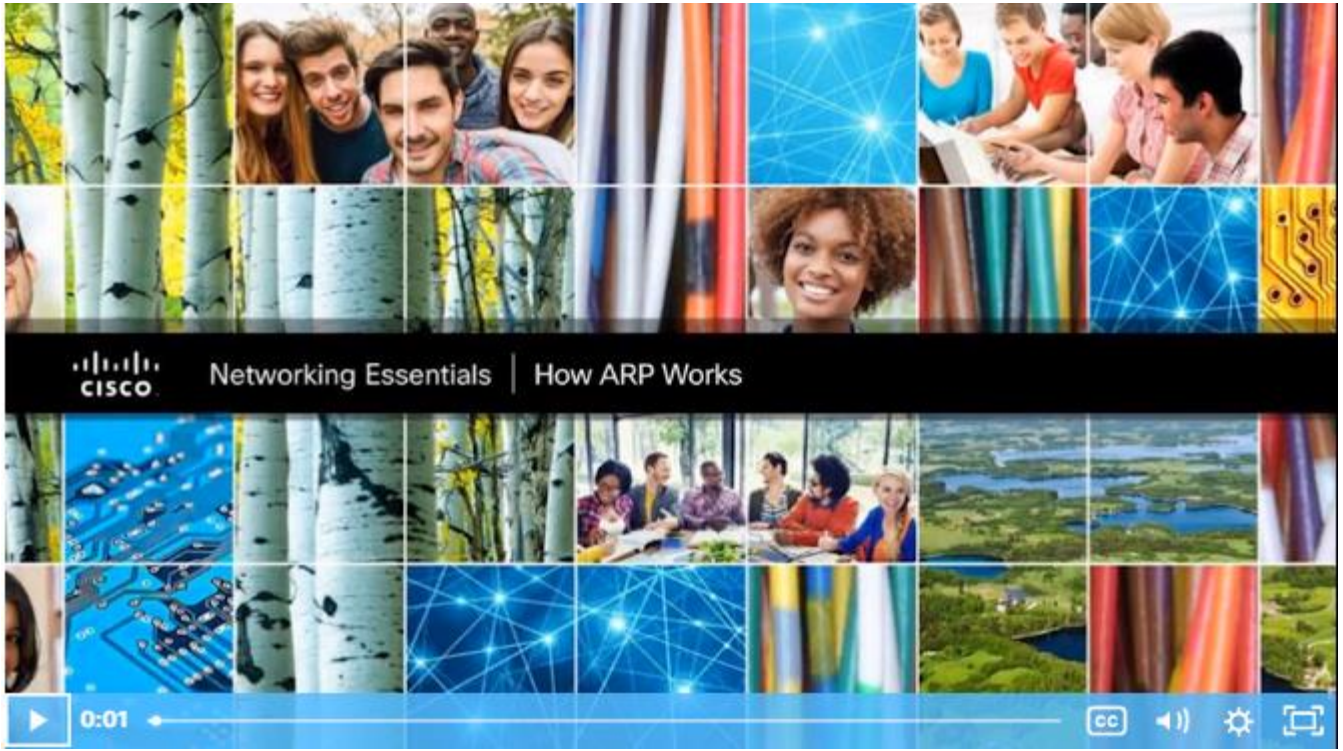
- A broadcast domain is the area through which a broadcast message can travel.
- Each local Ethernet network is a broadcast domain.
- Routers are used to divide the network into multiple broadcast domains.

Access Layer Communication

- In order to send information from a device that is on an Ethernet network, the device must supply its own source MAC address, a destination MAC address, its own source IP address, as well as a destination IP address.
- The address resolution protocol (ARP) is used to discover the MAC address of a device on the same local network.



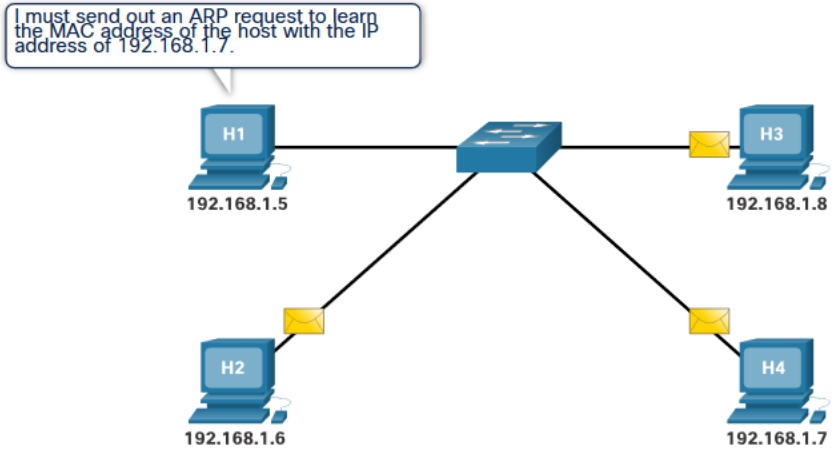
Video - Address Resolution Protocol



ARP

ARP uses 3 steps to discover and store the MAC address of a host on the local network when only the IPv4 address of that host is known.

1. The sending host creates and sends a frame addressed to a broadcast MAC address. Contained in the frame is a message with the IPv4 address of the intended destination host.
2. Each host on the network receives the broadcast frame and compares the IPv4 address contained in the message with its own IPv4 address. The host with the matching IPv4 address sends its own MAC address back to the original sending host.
3. The sending host receives the message and stores the MAC address and the IPv4 address in an ARP table.



Lab - View Captured Traffic in Wireshark

In this lab, you will complete the following objectives:

- Download and install Wireshark.
- Capture and analyze ARP data in Wireshark.
- View the ARP cache entries on the PC.

6.5 Network Design and Access Layer Summary

What Did I Learn in this Module?

- Encapsulation is the process of placing one message format inside another message format.
- A part of the encapsulation process on an Ethernet network is to create a frame that includes the source and destination MAC address.
- Networks have a hierarchical design of IP addressing that includes a network portion and a host portion.
- Networks can be designed using a hierarchical design model with three layers: access, distribution and core.
- An access layer device provides connections so hosts can get onto a network.
- The distribution layer connects networks.
- The core layer provides a high speed connection between distribution layer devices.
- Hubs takes signals from one port and sends the same message out all other ports. All connected devices share the bandwidth.
- Switches build a MAC address table by examining and saving the source MAC address from a received frame.

What Did I Learn in this Module? (Cont.)

- Switches build transmit messages based on the destination MAC address and comparing it to the addresses found in the MAC address table.
- If a destination MAC address is not in the MAC address table, flooding is used to forward the message out all ports except the port that has the sending host attached.
- ARP is used to send a broadcast message of all ones (FFFF.FFFF.FFFF) to discover the MAC address of a particular host.
- Routers divide the network into multiple broadcast domains.
- A broadcast can only be received on a local network.

Network Design and Access Summary

New Terms and Commands

- encapsulation
- frame
- Ethernet frame
- physical address
- MAC address
- logical address
- IP address
- hierarchical design
- hierarchical design model
- access layer
- distribution layer
- core layer
- Ethernet hub
- Ethernet switch
- MAC address table
- broadcast
- broadcast domain
- ARP
- broadcast containment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