

Ethernet and Network Layer

Introduction to Networks v6.0



Chapter 5: Ethernet

Pertemuan ke 5

Kompetensi Khusus

- Mahasiswa dapat menjelaskan bagaimana ethernet dapat berperan dalam pengiriman data dan menguraikan masing-masing fungsi pada setiap network layer (C2)
- Mahasiswa melakukan konfigurasi dasar perangkat jaringan cisco pada Network layer (C3)

Materi:

1. Ethernet Protocol
2. LAN Switches
3. Address Resolution Protocol

1. Ethernet Protocol

1.1 Ethernet Frame

- Ethernet Encapsulation
 - Ethernet operates in the data link layer and the physical layer.
 - Ethernet supports data bandwidths from 10Mbps through 100Gbps.
 - Ethernet standards define both the Layer 2 protocols and the Layer 1 technologies.
- MAC Sublayer
 - MAC constitutes the lower sublayer of the data link layer.
 - Responsible for Data encapsulation and Media access control.
- Ethernet Evolution
 - Ethernet has been evolving since its creation in 1973.
 - The Ethernet frame structure adds headers and trailers around the Layer 3 PDU to encapsulate the message being sent.

1.1 Ethernet Frame (Cont.)

- Ethernet Frame Fields
 - The minimum Ethernet frame size is 64 bytes and the maximum is 1518 bytes.
 - Frame smaller than the minimum or greater than the maximum are dropped.
 - Dropped frames are likely to be the result of collisions or other unwanted signals and are therefore considered invalid.



1.2 Ethernet MAC Addresses

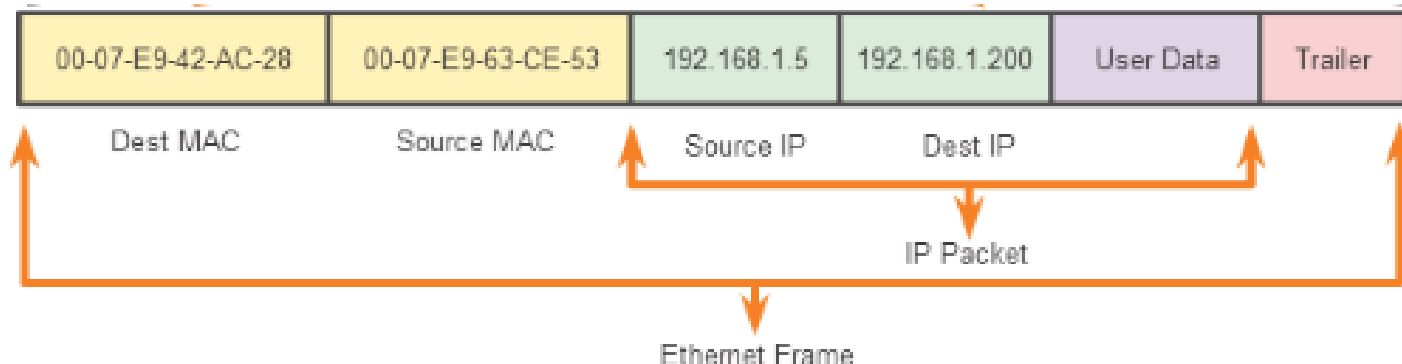
- MAC Addresses and Hexadecimal
 - MAC address is 48-bit long and expressed as 12 hexadecimal digits.
- MAC Addresses: Ethernet Identity
 - IEEE requires a vendor to follow two simple rules:
 1. Must use that vendor's assigned OUI as the first three bytes.
 2. All MAC addresses with the same OUI must be assigned a unique value in the last three bytes.
- Frame Processing
 - The NIC compares the destination MAC address in the frame with the device's physical MAC address stored in RAM.
 - If there is a match, the framed is passed up the OSI layers.
 - If there is no match, the device discards the frame.

1.2 Ethernet MAC Addresses (Cont.)

- MAC Address Representations
 - MAC addresses can be represented with colons, dashes or dots and are case-insensitive.
 - 00-60-2F-3A-07-BC, 00:60:2F:3A:07:BC, 0060.2F3A.07BC and 00-60-2f-3a-07-bc are all valid representations of the same MAC address.
- Unicast MAC Address
 - Unique address used when a frame is sent from a single transmitting device to a single destination device.
 - The source MAC address must always be a unicast.
- Broadcast MAC Address
 - Used to address all nodes in the segment.
 - The destination MAC address is the address of FF-FF-FF-FF-FF-FF in hexadecimal (48 ones in binary).

1.2 Ethernet MAC Addresses (Cont.)

- Multicast MAC Address
 - Used to address a group of nodes in the segment.
 - The multicast MAC address is a special value that begins with 01-00-5E in hexadecimal.
 - The remaining portion of the multicast MAC address is created by converting the lower 23 bits of the IP multicast group address into 6 hexadecimal characters.



2. LAN Switches

2.1 The MAC Address Table

- Switch Fundamentals
 - An Ethernet Switch is a Layer 2 device.
 - It uses MAC addresses to make forwarding decisions.
 - The MAC address table is sometimes referred to as a content addressable memory (CAM) table.
- Learning MAC Addresses
 - Switches dynamically build the CAM by monitoring source MACs.
 - Every frame that enters a switch is checked for new addresses.
 - The frame is forwarded based on the CAM.

2.1 The MAC Address Table (Cont.)

- Filtering Frames
 - Since the switch knows where to find a specific MAC address, it can filter the frames to that port only.
 - Filtering is not done if the destination MAC is not present in the CAM.

2.2 Switch Forwarding Methods

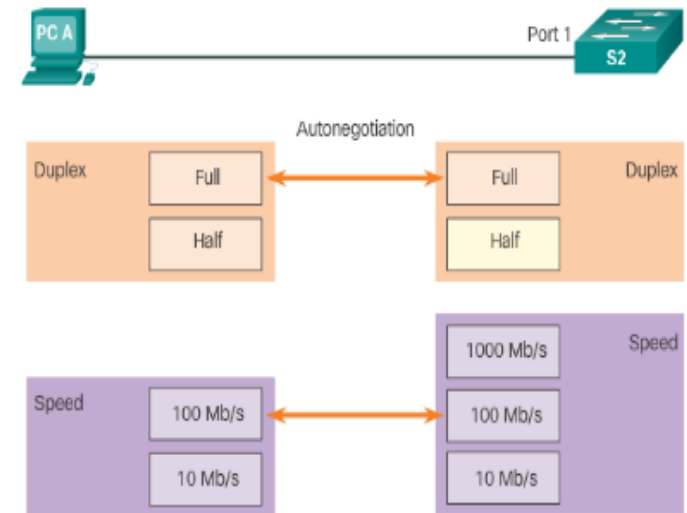
- Frame Forwarding Methods on Cisco Switches
 - Store-And-Forward
 - Cut-Through
- Cut-Through Switching
 - Fast-forward switching
 - Lowest level of latency immediately forwards a packet after reading the destination address.
 - Typical cut-through method of switching.
 - Fragment-free switching
 - Switch stores the first 64 bytes of the frame before forwarding.
 - Most network errors and collisions occur during the first 64 bytes.

2.2 Switch Forwarding Methods (Cont.)

- Memory Buffering on Switches
 - Port-based memory
 - Share memory

2.3 Switch Port Settings

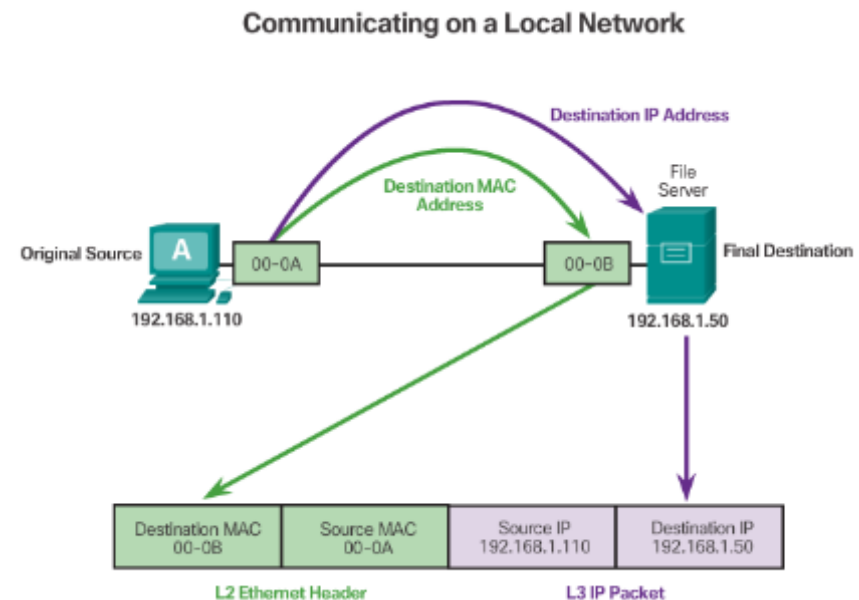
- Duplex and Speed Settings
 - Full-duplex – Both ends of the connection can send and receive simultaneously.
 - Half-duplex – Only one end of the connection can send at a time.
 - A common cause of performance issues on Ethernet links is when one port on the link operates at half-duplex and the other on full-duplex.
- Auto-MDX
 - Detects the type of connection required and configures the interface accordingly.
 - Helps reducing configuration errors.



3. Address Resolution Protocol

3.1 MAC and IP

- The combination of MAC and IP facilitate the End-to-End communication.
- Layer 2 addresses are used to move the frame within the local network
- Layer 3 addresses are used to move the packets through remote networks.
- Destination on Same Network
 - Physical address (MAC address) is used for Ethernet NIC to Ethernet NIC communications on the same network.
- Destination on Remote Network
 - Logical address (IP address) is used to send the packet from the original source to the final destination.



3.2 ARP

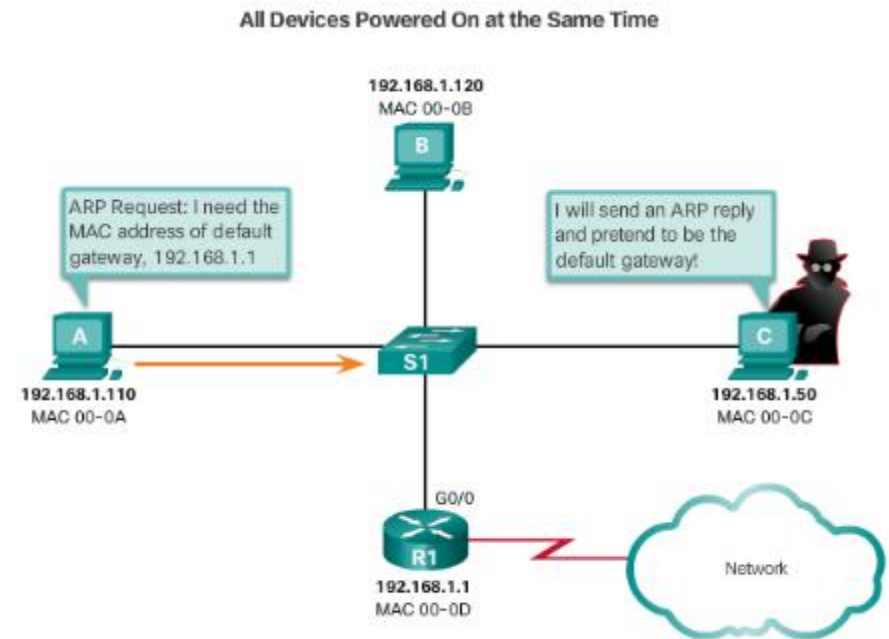
- Introduction to ARP
 - ARP allows the source to request the MAC address of the destination.
 - The request is based upon the layer 3 address of the destination (known by the source).
- ARP Functions
 - Resolving IPv4 addresses to MAC addresses
 - Maintaining a table of mappings
 - ARP uses ARP Request and ARP Reply to perform its functions.
- Removing Entries from an ARP Table
 - Entries are removed from the device's ARP table when its cache timer expires.
 - Cache timers are OS dependent.
 - ARP entries can be manually removed via commands.
- ARP Tables
 - On IOS: show ip arp
 - On Windows PCs: arp -a

```
Router# show ip arp
```

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	172.16.233.229	-	0000.0c59.f892	ARPA	Ethernet0/0
Internet	172.16.233.218	-	0000.0c07.ac00	ARPA	Ethernet0/0
Internet	172.16.168.11	-	0000.0c63.1300	ARPA	Ethernet0/0
Internet	172.16.168.254	9	0000.0c36.6965	ARPA	Ethernet0/0

3.3 ARP Issues

- ARP Broadcasts
 - ARP requests can flood the local segment.
- ARP Spoofing
 - Attackers can respond to requests and pretend to be providers of services. Example: default gateway



MAC addresses are shortened for demonstration purposes.

Chapter Summary

Summary

- Explain the operation of Ethernet.
- Explain how a switch operates.
- Explain how the address resolution protocol enables communication on a network.

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