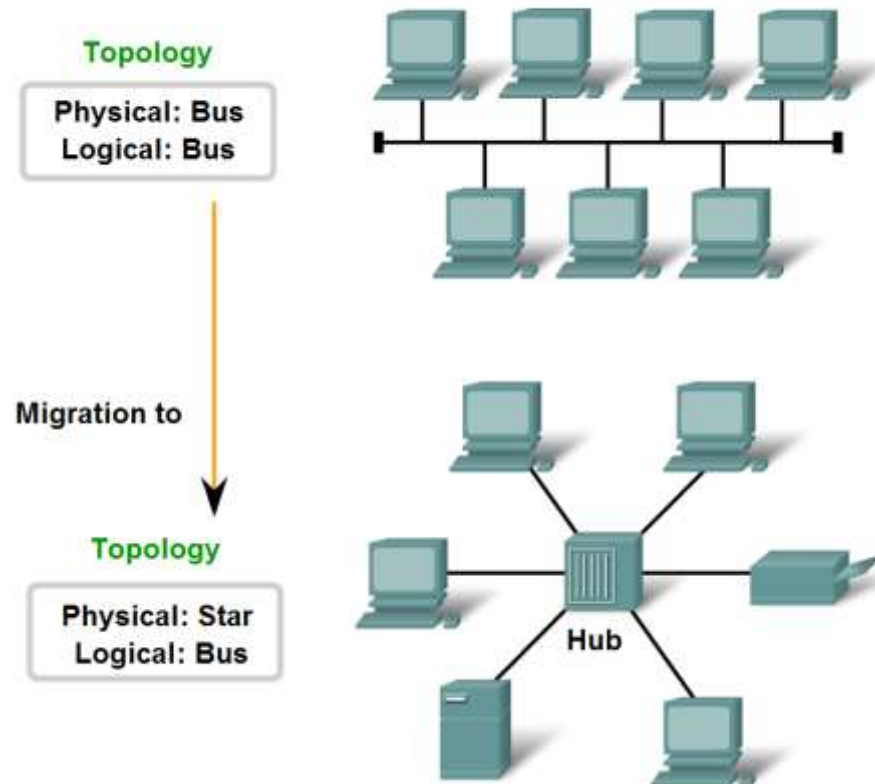# Ethernet

Network Fundamentals – Chapter 9

Objectives

- Identify the basic characteristics of network media used in Ethernet.

- Describe the physical and data link features of Ethernet.

- Describe the function and characteristics of the media access control method used by Ethernet protocol.

- Explain the importance of Layer 2 addressing used for data transmission and determine how the different types of addressing impacts network operation and performance.

- Compare and contrast the application and benefits of using Ethernet switches in a LAN as apposed to using hubs.

- Explain the ARP process.

Characteristics of Network Media used in Ethernet

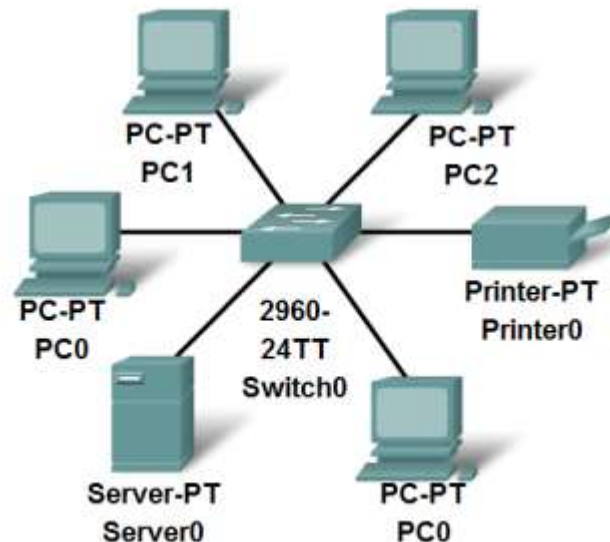- Identify several characteristics of Ethernet in its early years.

Early Ethernet Media and Topology

Topology

Physical: Bus
Logical: Bus

Migration to

Topology

Physical: Star
Logical: Bus

Hub

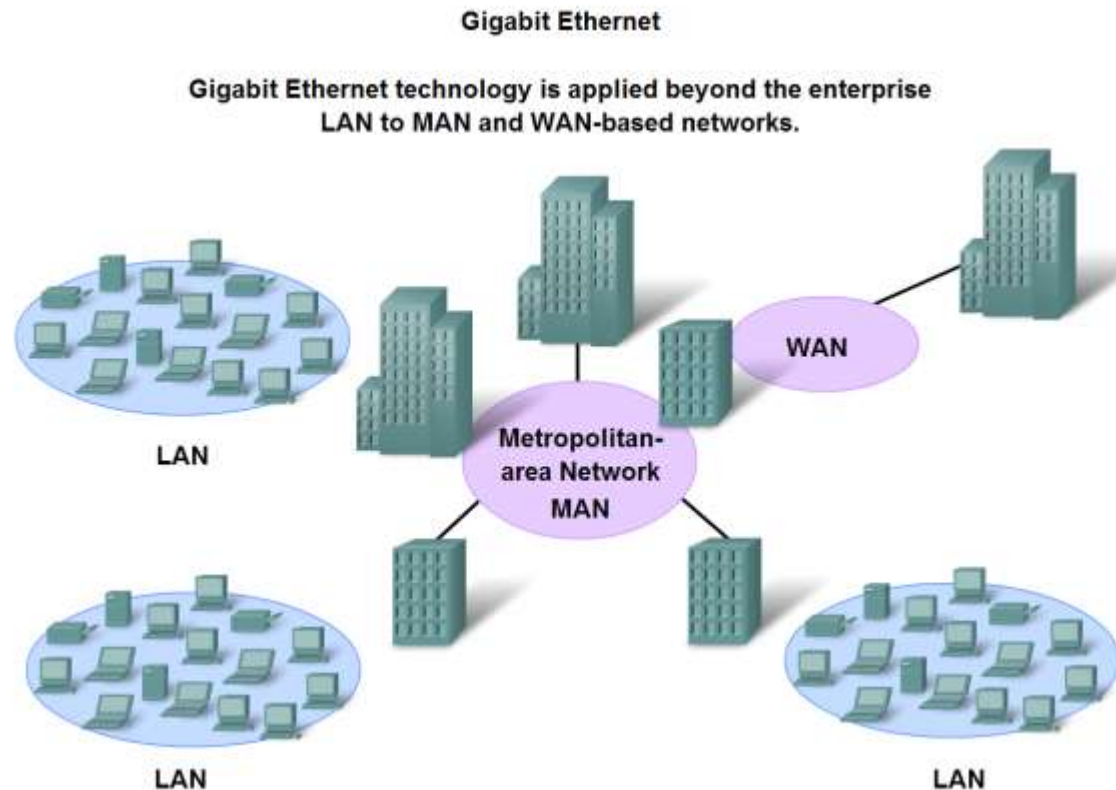# Characteristics of Network Media used in Ethernet

- Describe the emergence of the LAN switch as a key innovation for managing collisions on Ethernet-based networks
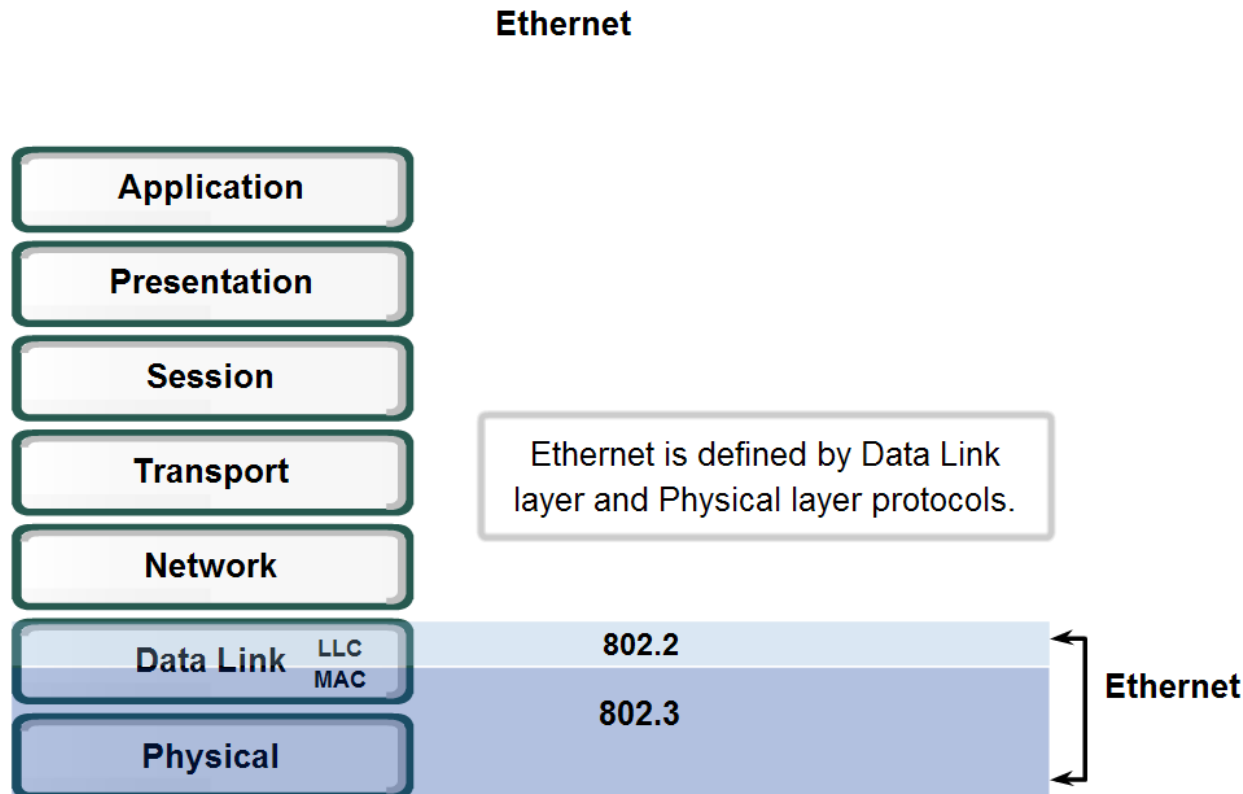
Migration to Ethernet Switches

Characteristics of Network Media used in Ethernet

- Identify the characteristics of state-of-the-art Ethernet and describe its utilization of cabling and point-to-point topography

Gigabit Ethernet

Gigabit Ethernet technology is applied beyond the enterprise LAN to MAN and WAN-based networks.

LAN

WAN

Metropolitan-area Network

MAN

LAN

LAN

Physical and Data Link Features of Ethernet

- Standards and Implementation

Ethernet

Application		
Presentation		
Session		
Transport	Ethernet is defined by Data Link layer and Physical layer protocols.	
Network		
Data Link — LLC / MAC	802.2	Ethernet
Physical	802.3	

Physical and Data Link Features of Ethernet

- Describe how the Ethernet operates across two layers of the OSI model

Layer 2 Addresses Layer 1 Limitations

Layer 1 Limitations	Layer 2 Functions
Cannot communicate with upper layers	Connects to upper layers via Logical Link Control (LLC)
Cannot identify devices	Uses addressing schemes to identify devices
Only recognizes streams of bits	Uses frames to organize bits into groups
Cannot determine the source of a transmission when multiple devices are transmitting	Uses Media Access Control (MAC) to identify transmission sources

Physical and Data Link Features of Ethernet

- Logic Link Control – Connecting the Upper Layers

Logical Link Control (LLC)

- Makes the connection with the upper layers
- Frames the Network layer packet
- Identifies the Network layer protocol
- Remains relatively independent of the physical equipment

Logical Link Control Sublayer							
802.3 Media Access Control							
Physical Signaling Sublayer	10BASE5 (500m) 50 Ohm Coax N-Style	10BASE2 (185m) 50 Ohm Coax BNC	10BASE-T (100m) 100 Ohm UTP RJ-45	100BASE-TX (100m) 100 Ohm UTP RJ-45	1000BASE-CX (25m) 150 Ohm STP mini-DB-9	1000BASE-T (100m) 100 Ohm UTP RJ-45	1000BASE-SX (220-550m) MM Fiber SC	1000BASE-LX (550-5000m) MM or SM Fiber SC
Physical Medium								

Physical and Data Link Features of Ethernet

- Media Access Control (MAC)

MAC—Getting Data to the Media

MEDIA ACCESS CONTROL

- Data Encapsulation
  - Frame delimiting
  - Addressing
  - Error detection

- Media Access Control
  - Control of frame placement on and off the media
  - media recovery

Physical and Data Link Features of Ethernet

- Physical Implementations of the Ethernet

Physical Devices Implementing Ethernet

UTP patch panels in a rack

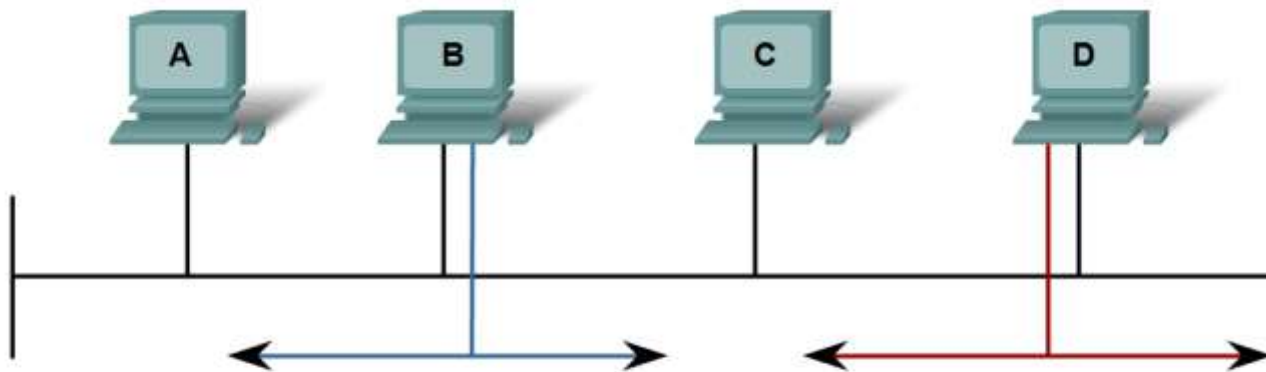

Ethernet switches

Ethernet fiber connectors

Ethernet switch

Function and Characteristics of the Media Access Control Method

- MAC in Ethernet

Media Access Control in Ethernet

**Carrier Sense Multiple Access with Collision Detection (CSMA/CD)**

CSMA/CD controls access to the shared media. If there is a collision, it is detected and frames are retransmitted.

Function and Characteristics of the Media Access Control Method

- Carrier Sense Multiple Access with Collision Detection

Media Access Control in Ethernet
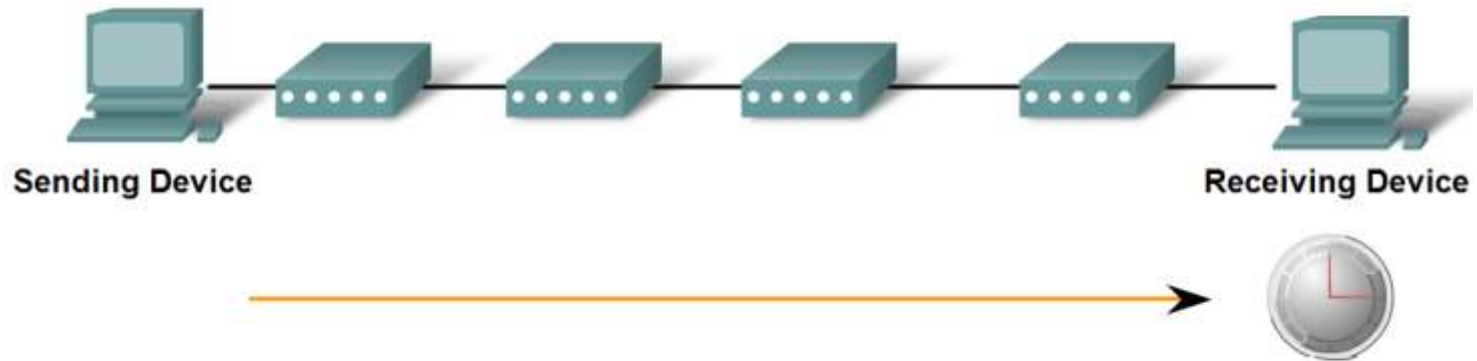
Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
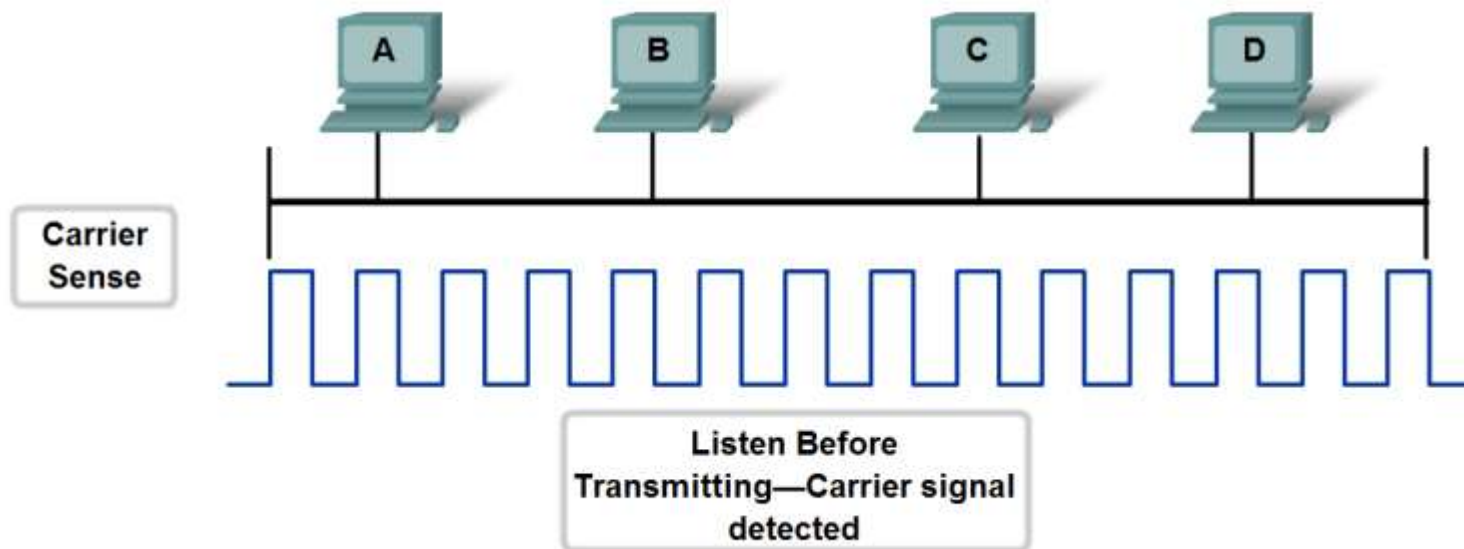
Function and Characteristics of the Media Access Control Method

- Ethernet Timing

Ethernet Delay (Latency)

Sending Device

Receiving Device

An Ethernet frame takes a measurable time to travel from the sending device to the receiver. Each intermediary device contributes to the overall latency.

Layer 2 addressing and its Impact on Network Operation and Performance

- The Frame – Encapsulating the Packet

Comparison of 802.3 and Ethernet Frame Structures and Field Size

Field size in bytes

IEEE 802.3

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

Ethernet

| 8		6	6	2	46 to 1500	4
Preamble		Destination Address	Source Address	Type	Data	Frame Check Sequence

Layer 2 addressing and its Impact on Network Operation and Performance

- The Ethernet MAC Address

The MAC Address—Addressing in Ethernet

All Ethernet nodes share the media.
To receive the data sent to it, each node needs a unique address.

Shared Media (Multiple Access)

Yes, that frame is for me.

FRAME FOR D
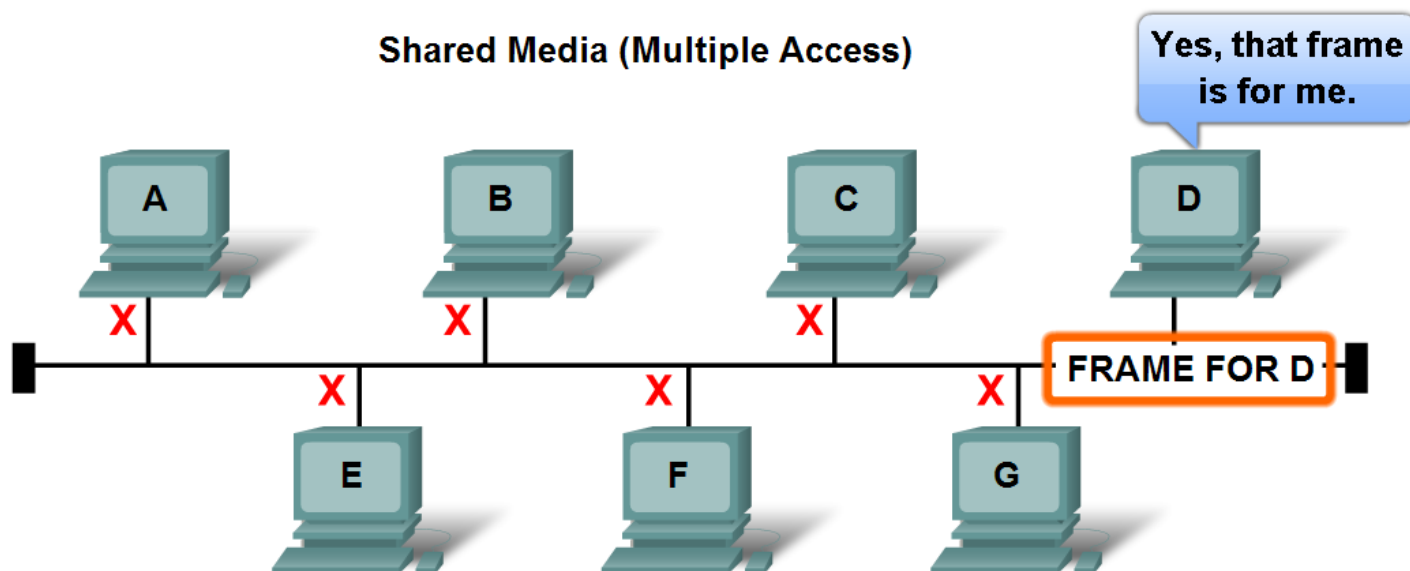
Layer 2 addressing and its Impact on Network Operation and Performance

- Hexadecimal Numbering and Addressing

Hexadecimal Numbering

### Decimal and Binary equivalents of 0 to F Hexadecimal

Decimal	Binary	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Selected Decimal, Binary and Hexadecimal equivalents

Decimal	Binary	Hexadecimal
0	0000 0000	00
1	0000 0001	01
2	0000 0010	02
3	0000 0011	03
4	0000 0100	04
5	0000 0101	05
6	0000 0110	06
7	0000 0111	07
8	0000 1000	08
10	0000 1010	0A
15	0000 1111	0F
16	0001 0000	10
32	0010 0000	20
64	0100 0000	40
128	1000 0000	80
192	1100 0000	C0
202	1100 1010	CA
240	1111 0000	F0
255	1111 1111	FF

Layer 2 addressing and its Impact on Network Operation and Performance

- Another Layer of Addressing

Different Layers of Addressing
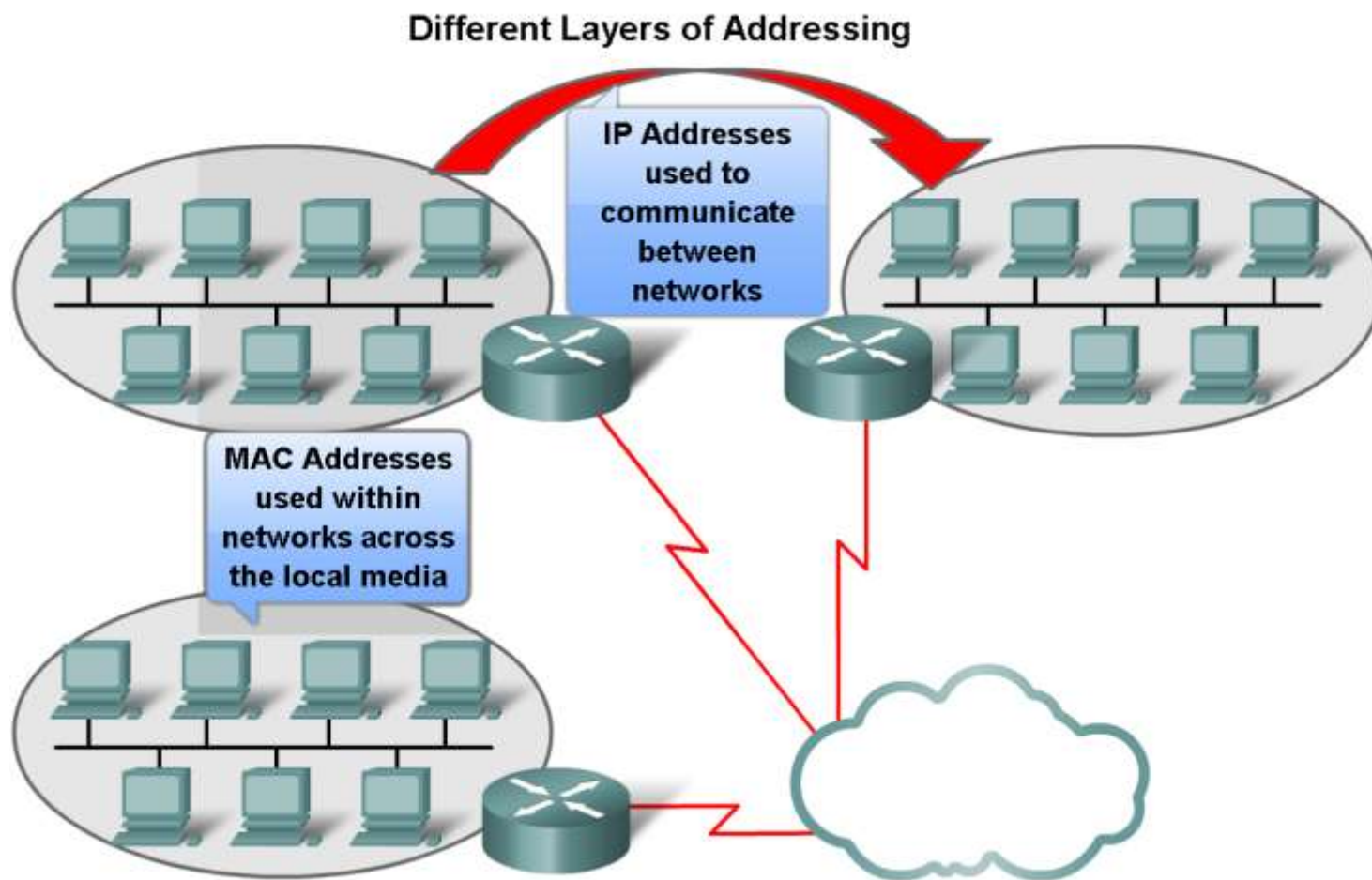
Layer 2 addressing and its Impact on Network Operation and Performance

- Ethernet Unicast, Multicast and Broadcast
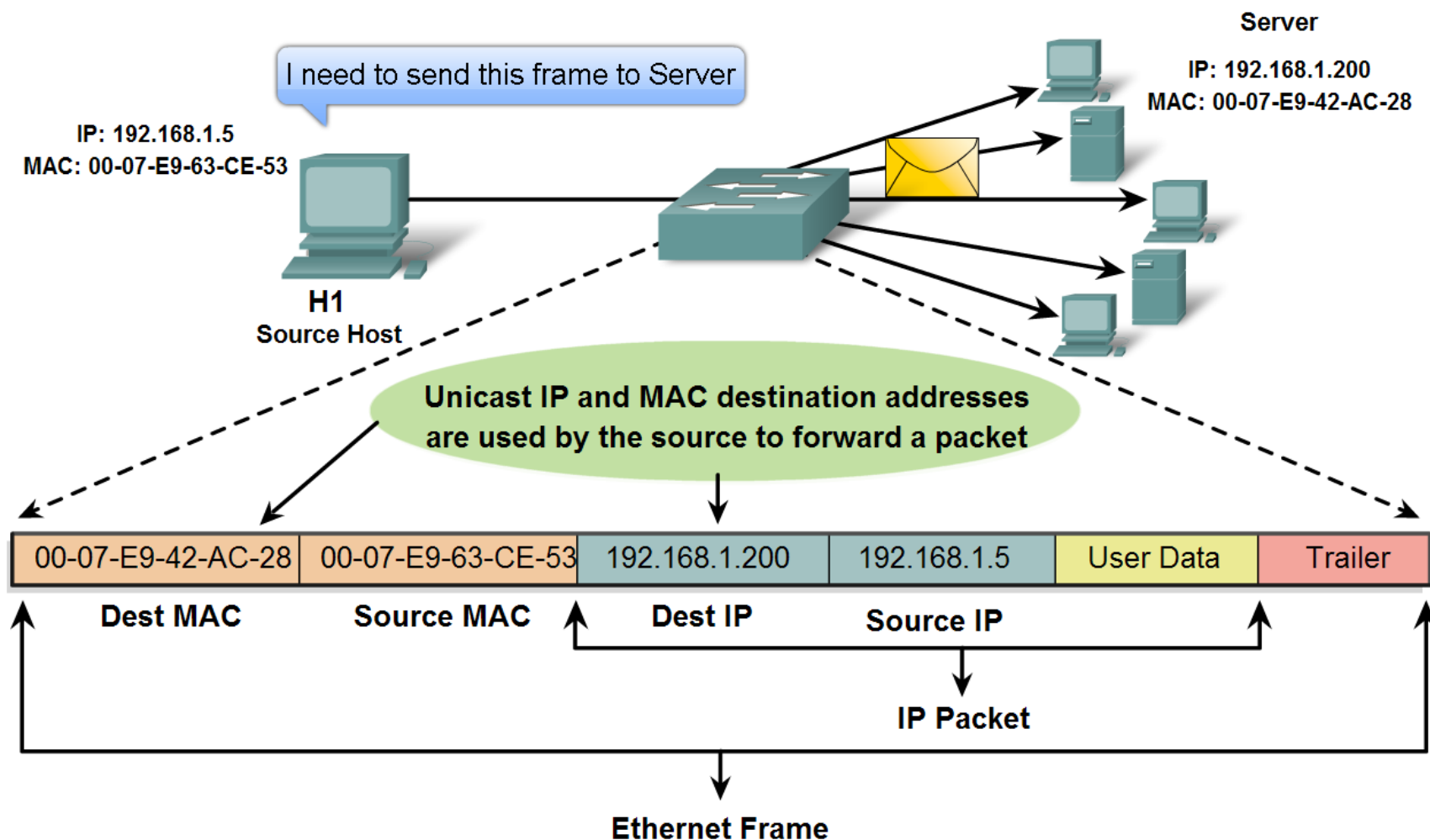
Compare and Contrast the Use of Ethernet Switches versus Hubs in a LAN.

- Legacy Ethernet – Using Hubs

Poor Performance of Hub-based LANs

Same network bandwidth shared by 12 hosts

Network collisions increase—still 1 collision domain
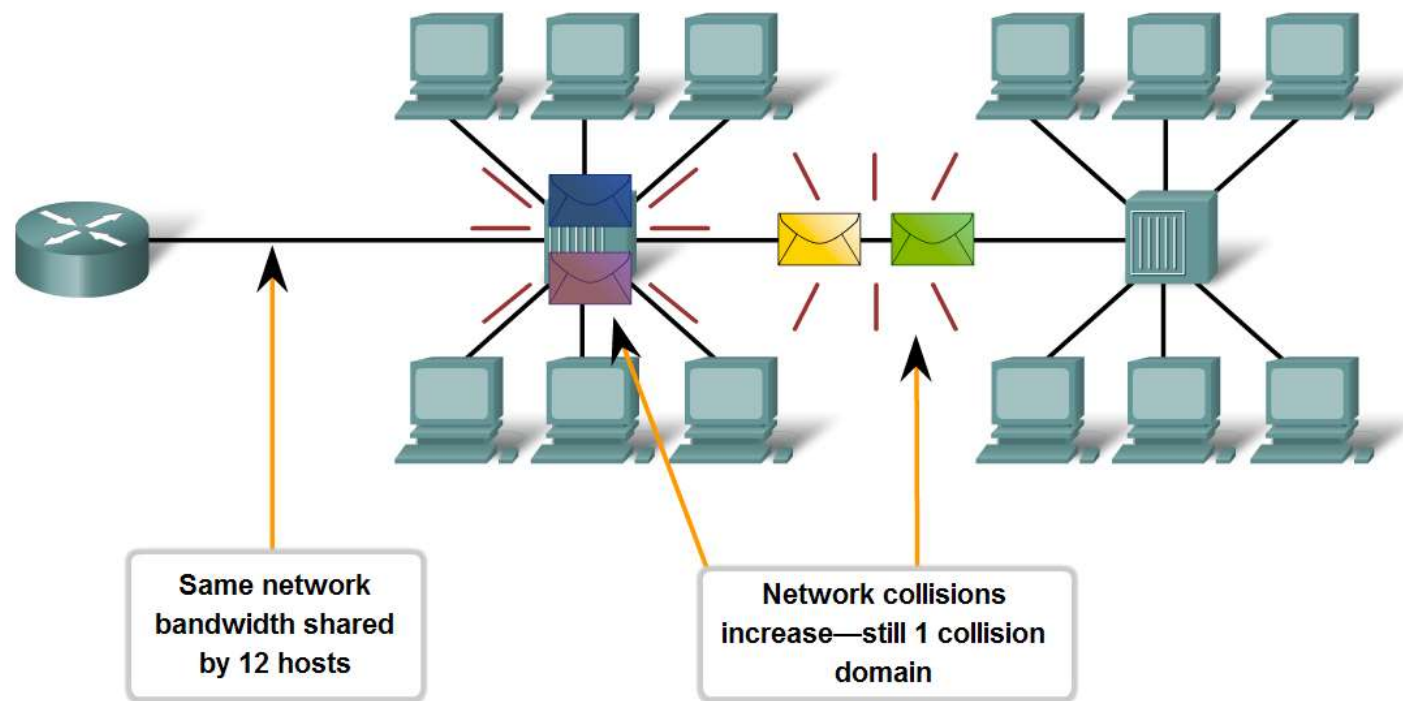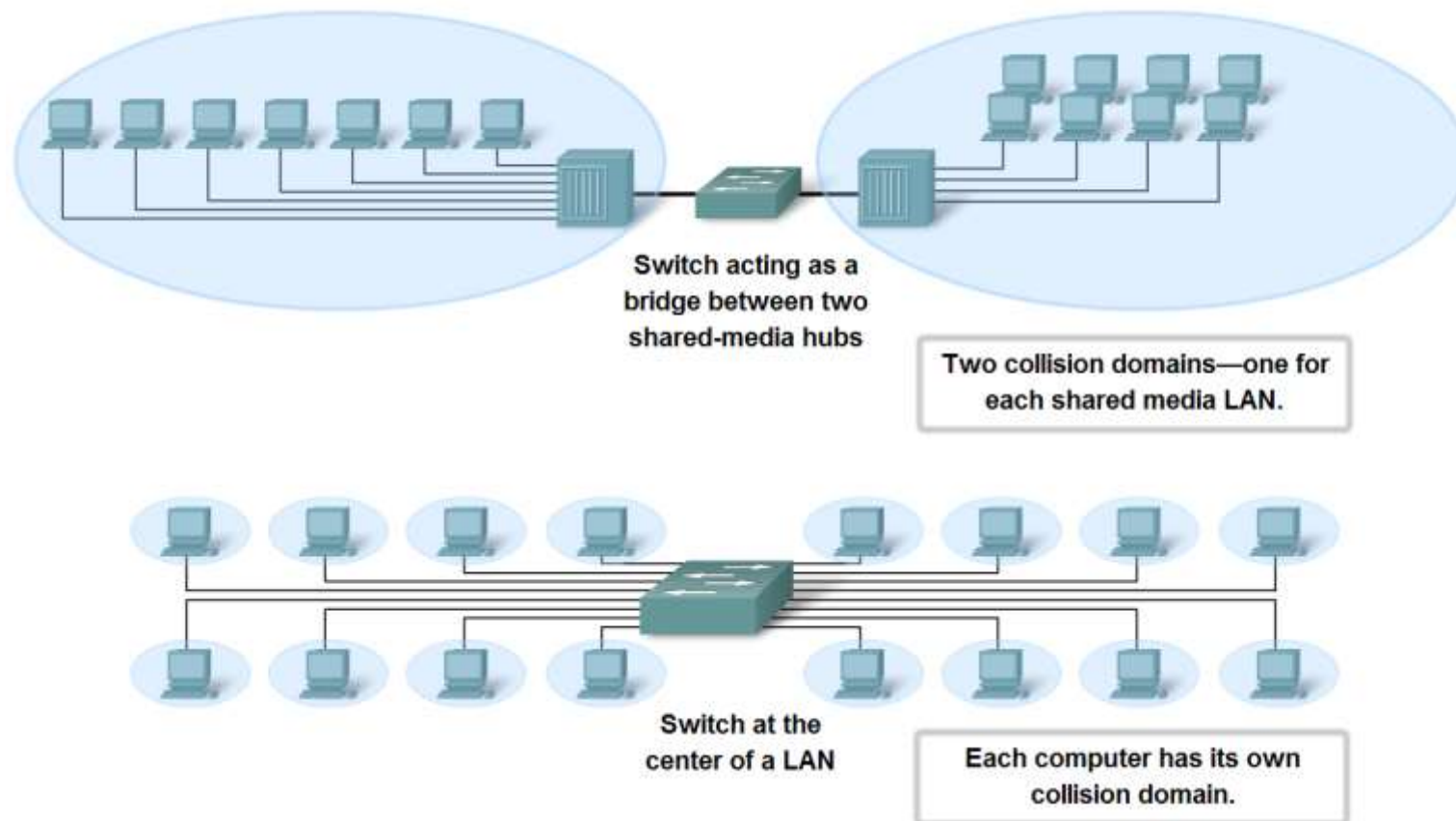
Compare and Contrast the Use of Ethernet Switches versus Hubs in a LAN.

- Ethernet – Using Switches

Switch Uses

Switch acting as a
bridge between two
shared-media hubs

Two collision domains—one for
each shared media LAN.

Switch at the
center of a LAN

Each computer has its own
collision domain.

Compare and Contrast the Use of Ethernet Switches versus Hubs in a LAN.

- Describe how a switch can eliminate collisions, backoffs and re- transmissions, the leading factors in ͻrk

Switches - Selective Forwarding

Flash

CPU

MAC Address Table

PORT	MAC
1	0A
3	0B
6	0C
9	0D

Switching Logic

Memory Buffers

Fa 0/1 | Fa 0/2 | Fa 0/3 | Fa 0/4 | Fa 0/5 | Fa 0/6 | Fa 0/7 | Fa 0/8 | Fa 0/9 | Fa 0/10 | Fa 0/11 | Fa 0/12
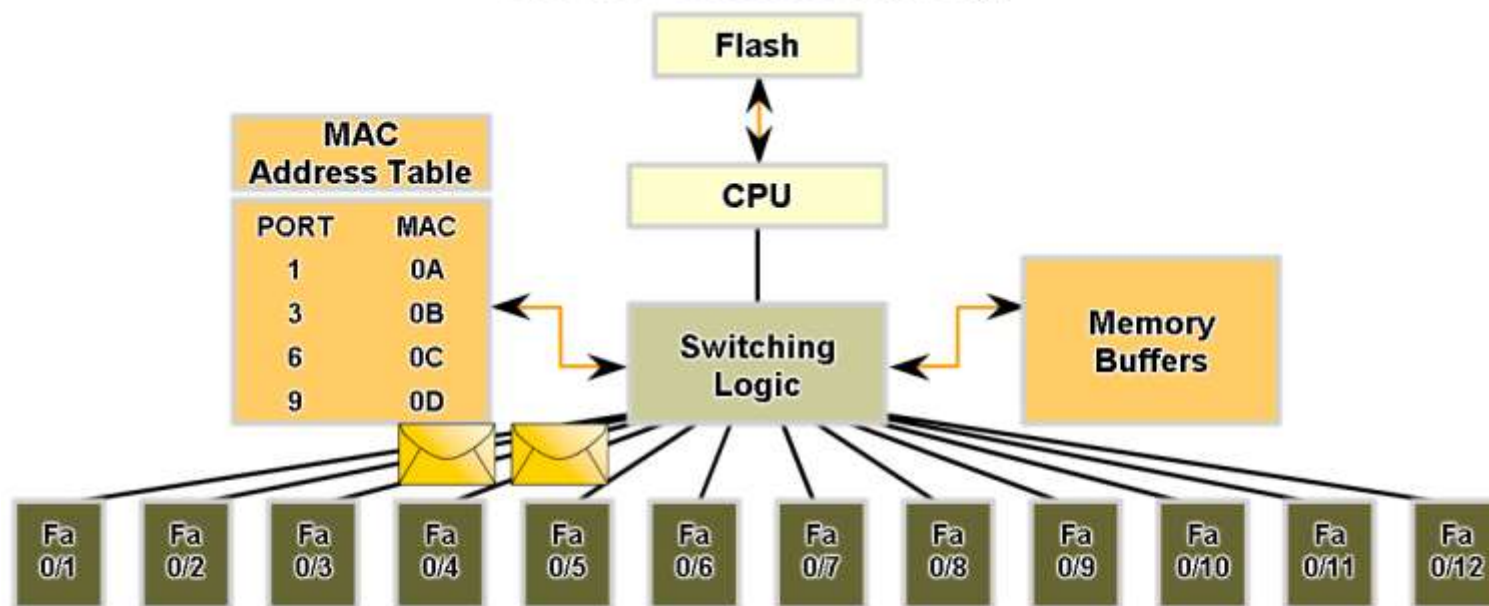
FRAME 1

Preamble	Destination Address	Source Address	Type	Data	Pad	CRC
	0C	0A				

FRAME 2

Preamble	Destination Address	Source Address	Type	Data	Pad	CRC
	0C	0B				

Explain the Address Resolution Protocol (ARP) process.

- Mapping IP to MAC Addresses

The ARP Process—ARP Entry Enables Frame to be Sent

A's ARP CACHE
10.10.0.3 = 00-0d-56-09-fb-d1

10.10.0.1	10.10.0.2	10.10.0.3	10.10.0.4
00-0D-88-C7-9A-24	00-08-a3-b6-ce-04	00-0d-56-09-fb-d1	00-12-3f-d4-6d-1b
FFFF.FFFF.FFFF	FFFF.FFFF.FFFF	FFFF.FFFF.FFFF	FFFF.FFFF.FFFF

A   B   C   D

I can now send the frame to 10.10.0.3 with the MAC address 00-0d-56-09-fb-d1.

10.10.0.254
00-10-7b-e7-fa-ef
FFFF.FFFF.FFFF
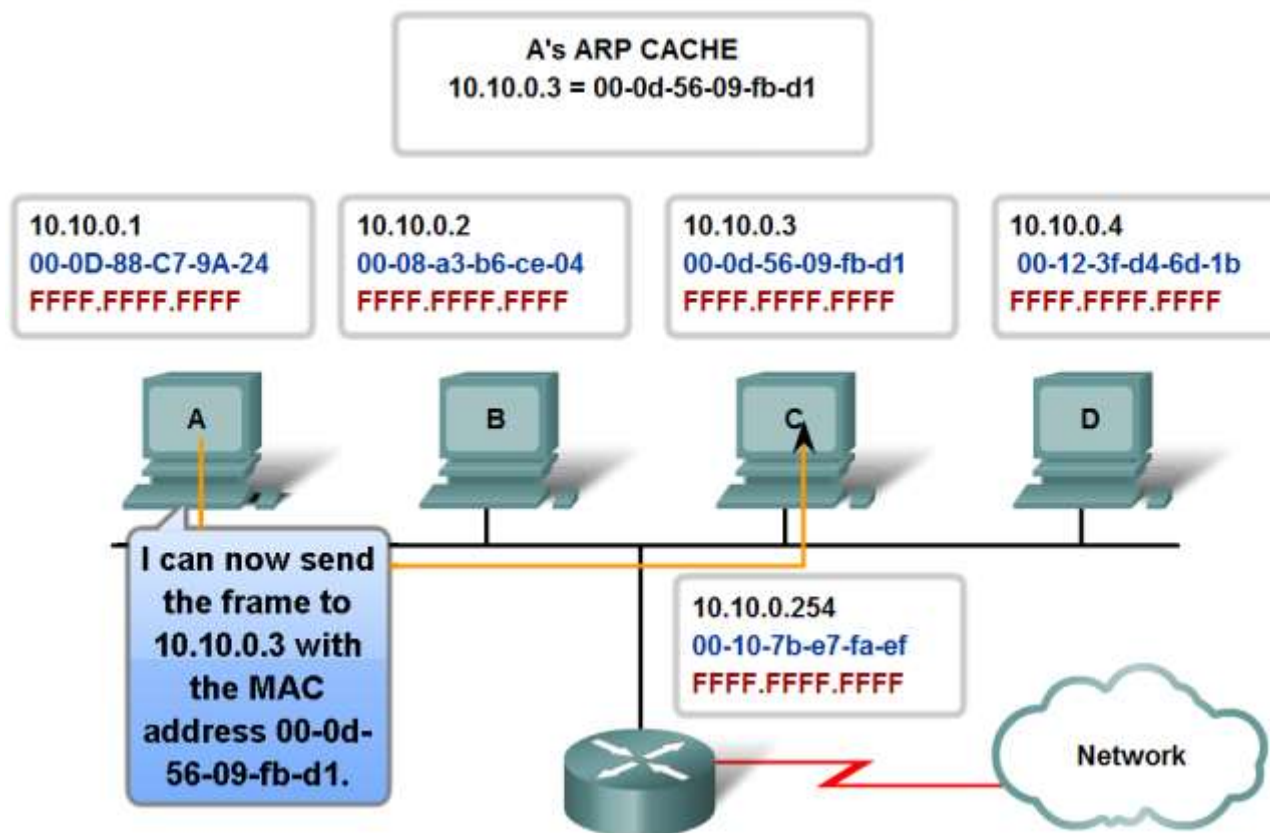
Network

Explain the Address Resolution Protocol (ARP) process.

- ARP – Destinations Outside the Local Network

The ARP Process—ARP Entry Enables Frame to be Sent

A's ARP CACHE
10.10.0.3 = 00-0d-56-09-fb-d1
10.10.0.254 = 00-10-7b-e7-fa-ef

10.10.0.1	10.10.0.2	10.10.0.3	10.10.0.4
00-0D-88-C7-9A-24	00-08-a3-b6-ce-04	00-0d-56-09-fb-d1	00-12-3f-d4-6d-1b
FFFF.FFFF.FFFF	FFFF.FFFF.FFFF	FFFF.FFFF.FFFF	FFFF.FFFF.FFFF

A   B   C   D

I can now send the frame with a packet to 172.16.0.10 with the MAC address 00-10-7b-e7-fa-ef.

I will forward the packet in this frame based on a route in my routing table.

-fa-ef
FFFF

Network
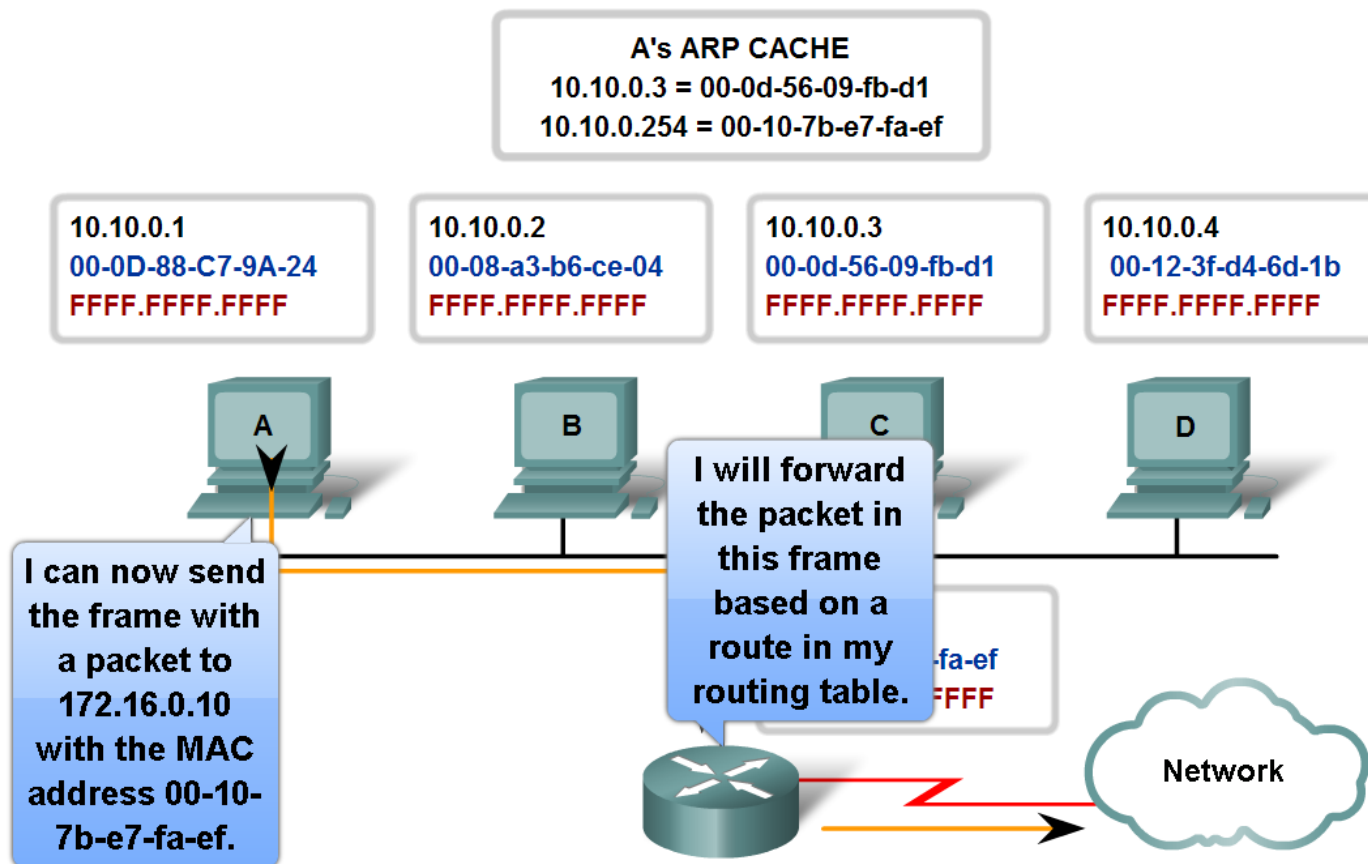
Explain the Address Resolution Protocol (ARP) process.

- ARP – Removing Address Mappings

The ARP Process - Removing Address Mappings

A's ARP CACHE
10.10.0.3 = 00-0d-56-09-fb-d1
10.10.0.254 = 00-10-7b-e7-fa-ef

10.10.0.1
00-0d-88-c7-9a-24
FFFF.FFFF.FFFF

10.10.0.2
00-08-a3-b6-ce-04
FFFF.FFFF.FFFF

Computer C removed from network.

10.10.0.4
00-12-3f-d4-6d-1b
FFFF.FFFF.FFFF

A   B   D

If C's IP and MAC addresses are not removed from A's ARP Cache, A may still try to communicate with C.
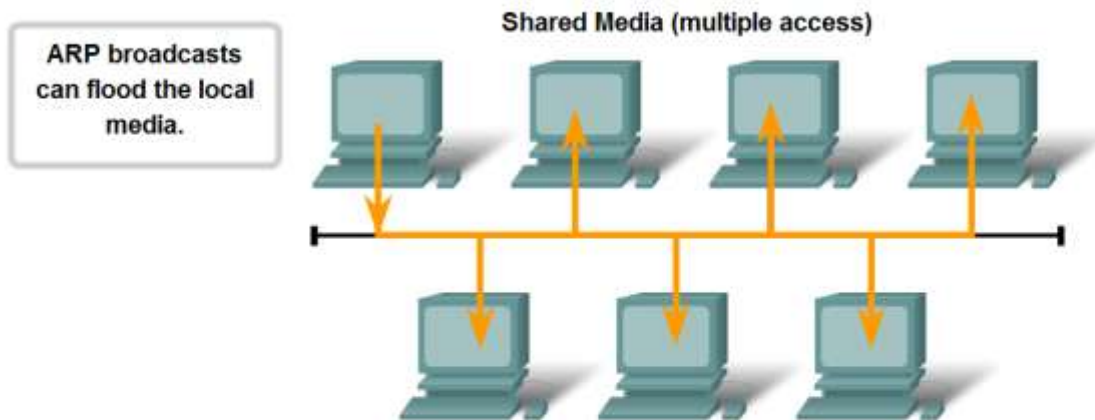
10.10.0.254
00-10-7b-e7-fa-ef
FFFF.FFFF.FFFF

Network
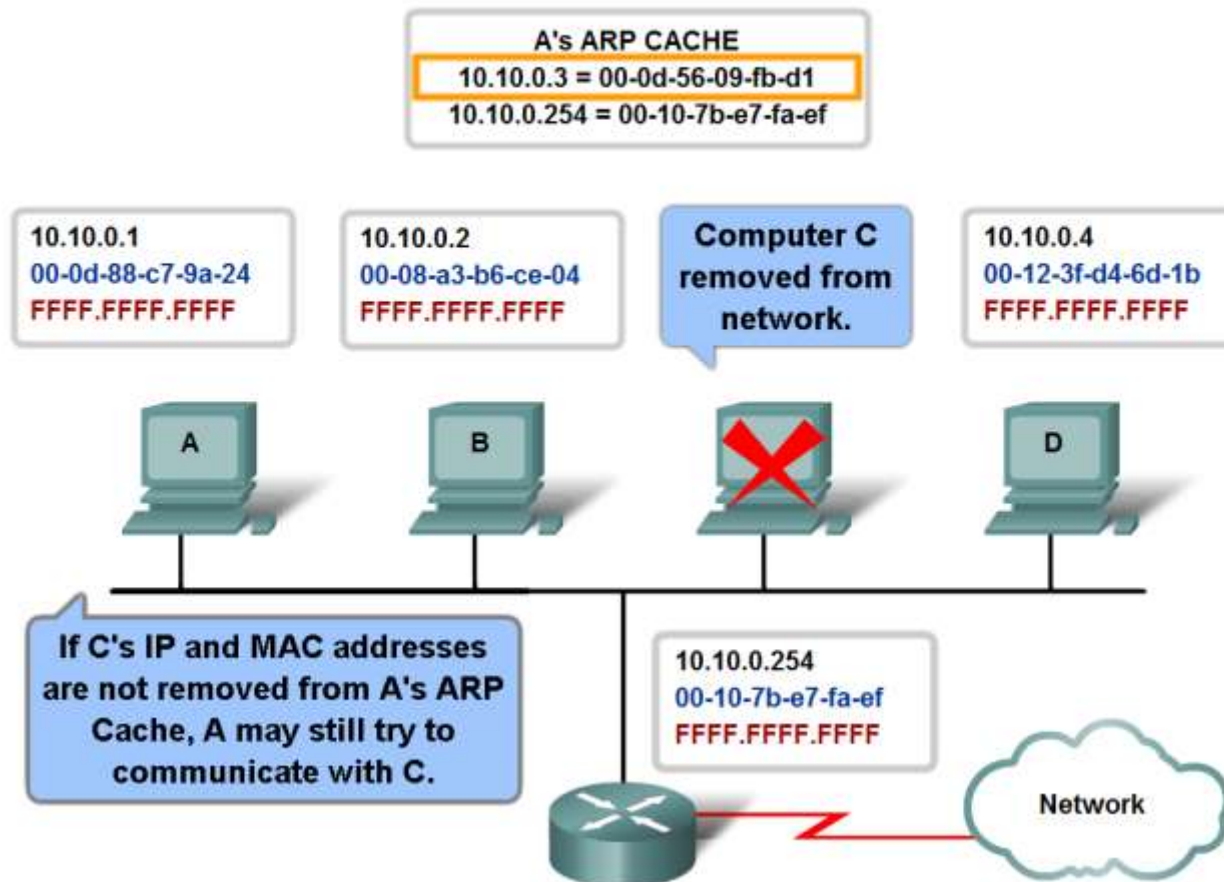
Explain the Address Resolution Protocol (ARP) process.

- ARP Broadcasts - Issues

ARP Issues:
- Broadcasts, overhead on the Media
- Security

Shared Media (multiple access)

ARP broadcasts can flood the local media.

A false ARP message can provide an incorrect MAC address that will then hijack frames using that address (called a spoof).

Ethernet					
8	6	6	2	46 to 1500	4
Preamble	Destination Address	Source Address	Type	Data	Frame Check Sequence

Summary

In this chapter, you learned to:

- Identify the basic characteristics of network media used in Ethernet.
- Describe the Physical and Data Link layer features of Ethernet.
- Describe the function and characteristics of the media access control method used by Ethernet protocol.
- Explain the importance of Layer 2 addressing used for data transmission and determine how the different types of addressing impacts network operation and performance.
- Compare and contrast the application and benefits of using Ethernet switches in a LAN as opposed to using hubs.
- Explain the ARP process.