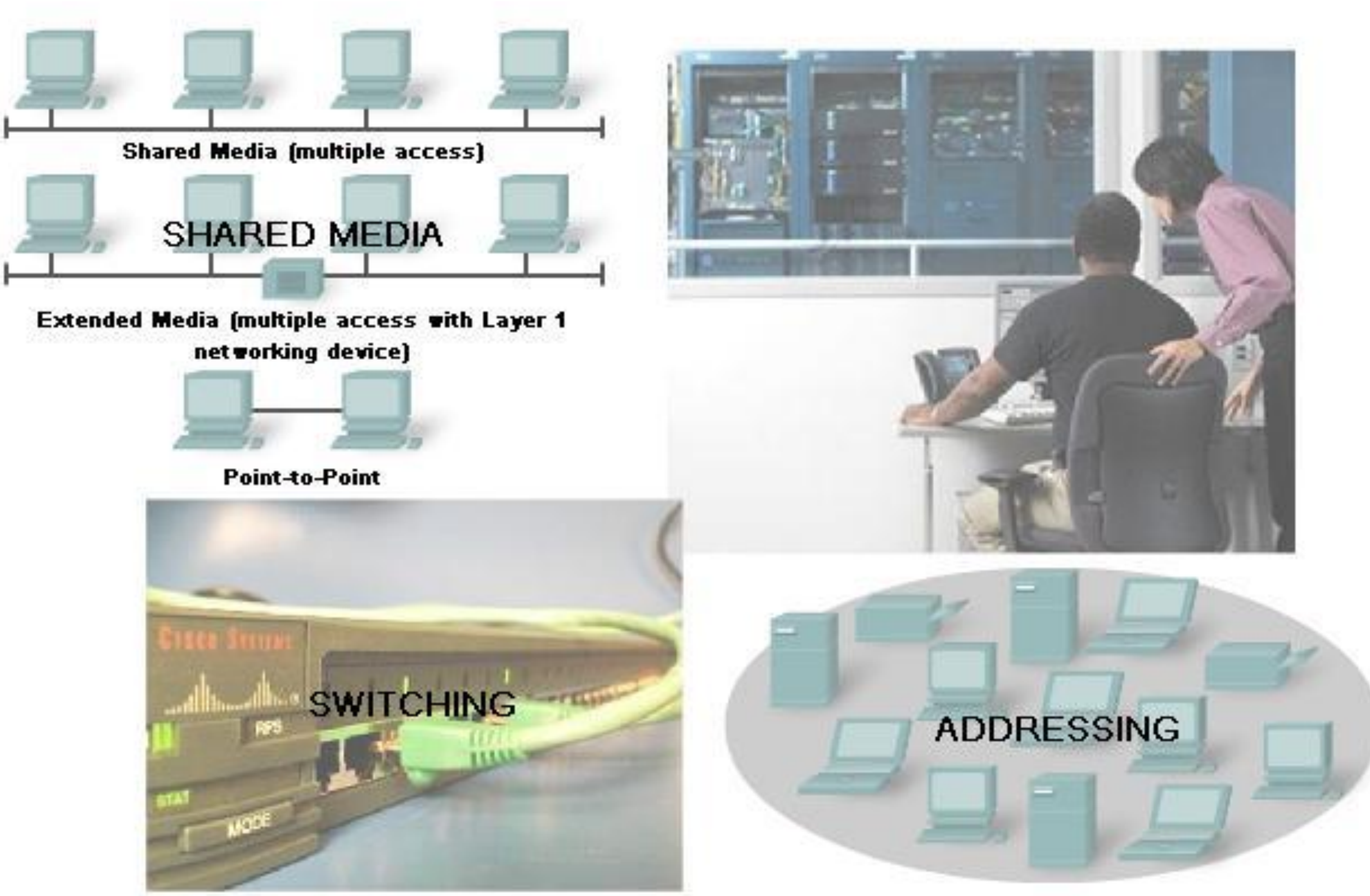
CCNA Exploration Network Fundamentals

Chapter 09

Ethernet

Updated: 07/07/2008

9.0.1 Introduction

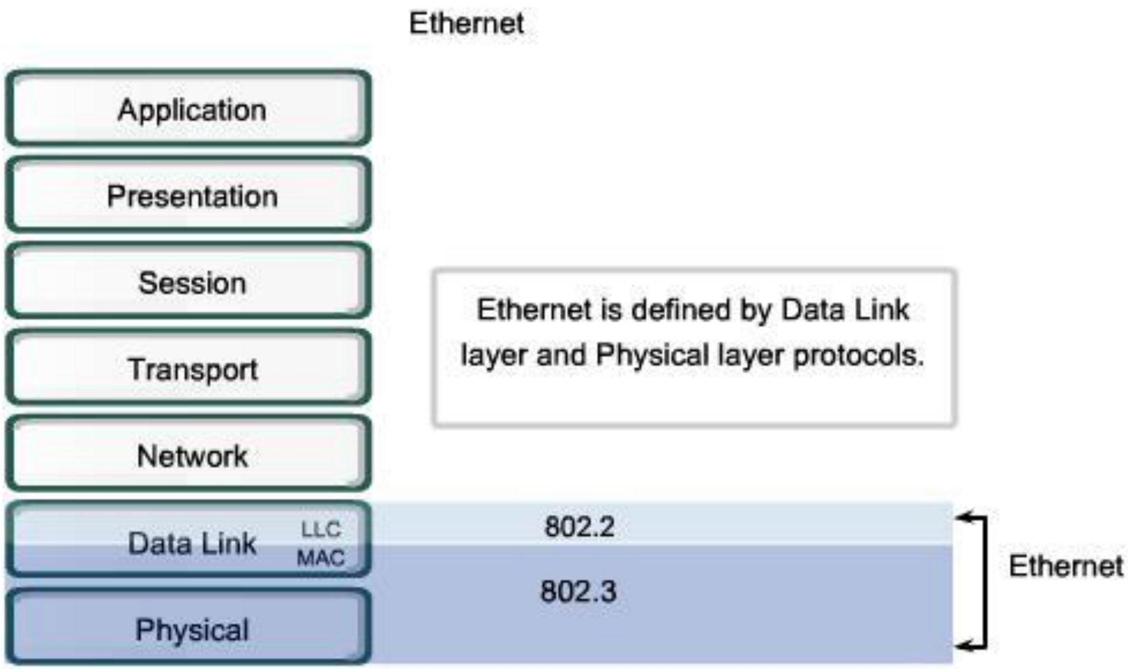


Ethernet is the predominant LAN technology in use today.

9.0.1 Introduction

- Internet Engineering Task Force (IETF) maintains the functional protocols and services for the TCP/IP protocol suite in the upper layers. However, the functional protocols and services at the OSI Data Link layer and Physical layer are described by various engineering organizations (IEEE, ANSI, ITU) or by private companies (proprietary protocols).
- Ethernet is comprised of standards at these lower layers, it may best be understood in reference to the OSI model. The OSI model separates the Data Link layer functionalities of addressing, framing and accessing the media from the Physical layer standards of the media. Ethernet standards define both the Layer 2 protocols and the Layer 1 technologies. Although Ethernet specifications support different media, bandwidths, and other Layer 1 and 2 variations, the basic frame format and address scheme is the same for all varieties of Ethernet.
- Ethernet has evolved from a shared media, contention-based data communications technology to today's high bandwidth, full-duplex technology.

9.1 Overview of Ethernet
9.1.1 Ethernet – Standards and Implementation



IEEE Standards

- The first LAN in the world was the original version of Ethernet. Robert Metcalfe and his coworkers at Xerox designed it more than thirty years ago. The first Ethernet standard was published in 1980 by a consortium of Digital Equipment Corporation, Intel, and Xerox (DIX). Metcalfe wanted Ethernet to be a shared standard from which everyone could benefit, and therefore it was released as an open standard. The first products that were developed from the Ethernet standard were sold in the early 1980s.

9.1.2 Ethernet – Layer 1 and 2

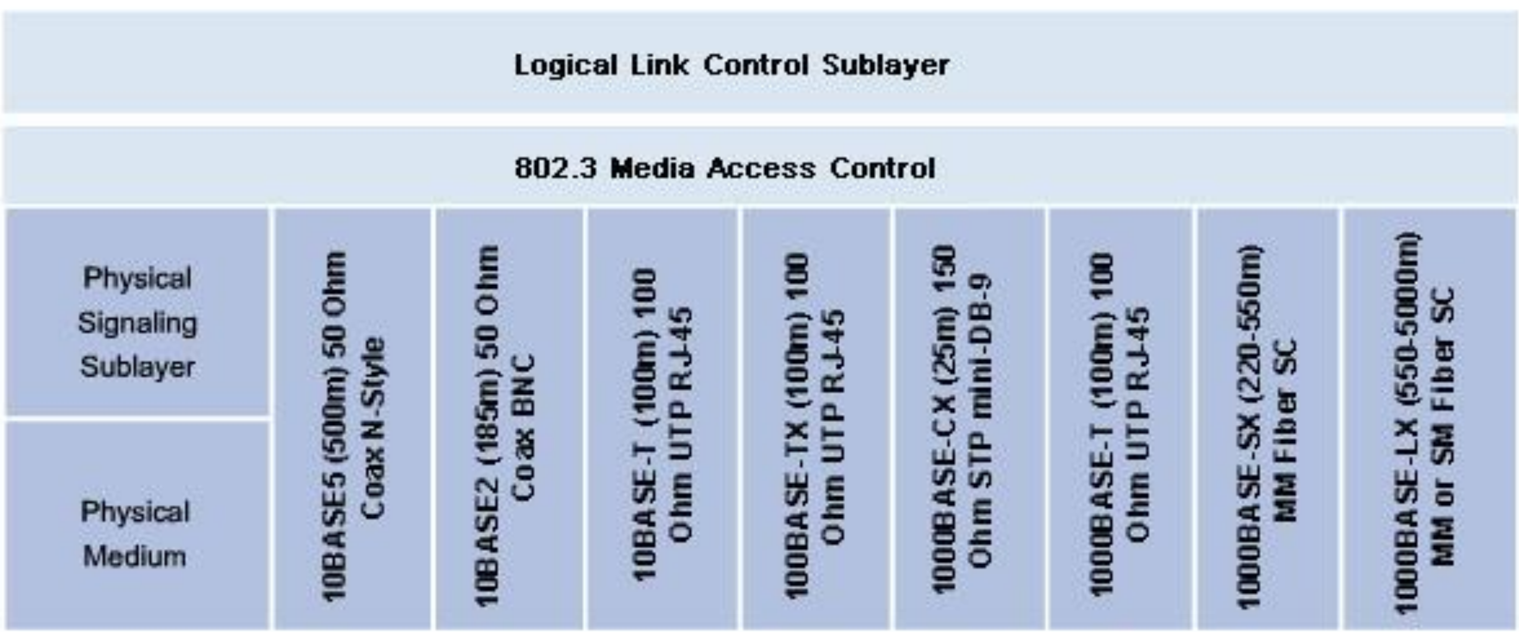
Layer 2 Addresses Layer 1 Limitations

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

9.1.3 Logical Link Control – Connecting to the Upper Layers

Logical Link Control (LLC)

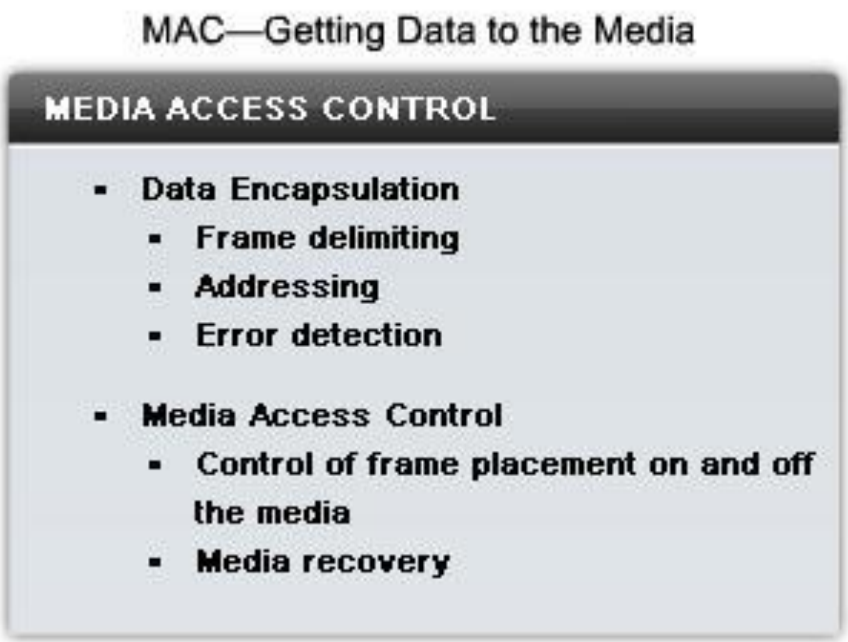
- Makes the connection with the upper layers
- Frames the Network layer packet
- Identifies the Network layer protocol
- Remains relatively independent of the physical equipment



9.1.3 Logical Link Control – Connecting to the Upper Layers

- LLC is implemented in software, and its implementation is independent of the physical equipment. In a computer, the LLC can be considered the driver software for the Network Interface Card (NIC). The NIC driver is a program that interacts directly with the hardware on the NIC to pass the data between the media and the Media Access Control sublayer.

9.1.4 MAC – Getting Data to the Media



9.1.4 MAC – Getting Data to the Media

Logical Topology

- The underlying logical topology of Ethernet is a multi-access bus. This means that all the nodes (devices) in that network segment share the medium. This further means that all the nodes in that segment receive all the frames transmitted by any node on that segment.
- Because all the nodes receive all the frames, each node needs to determine if a frame is to be accepted and processed by that node. This requires examining the addressing in the frame provided by the MAC address.
- Ethernet provides a method for determining how the nodes share access to the media. The media access control method for classic Ethernet is Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

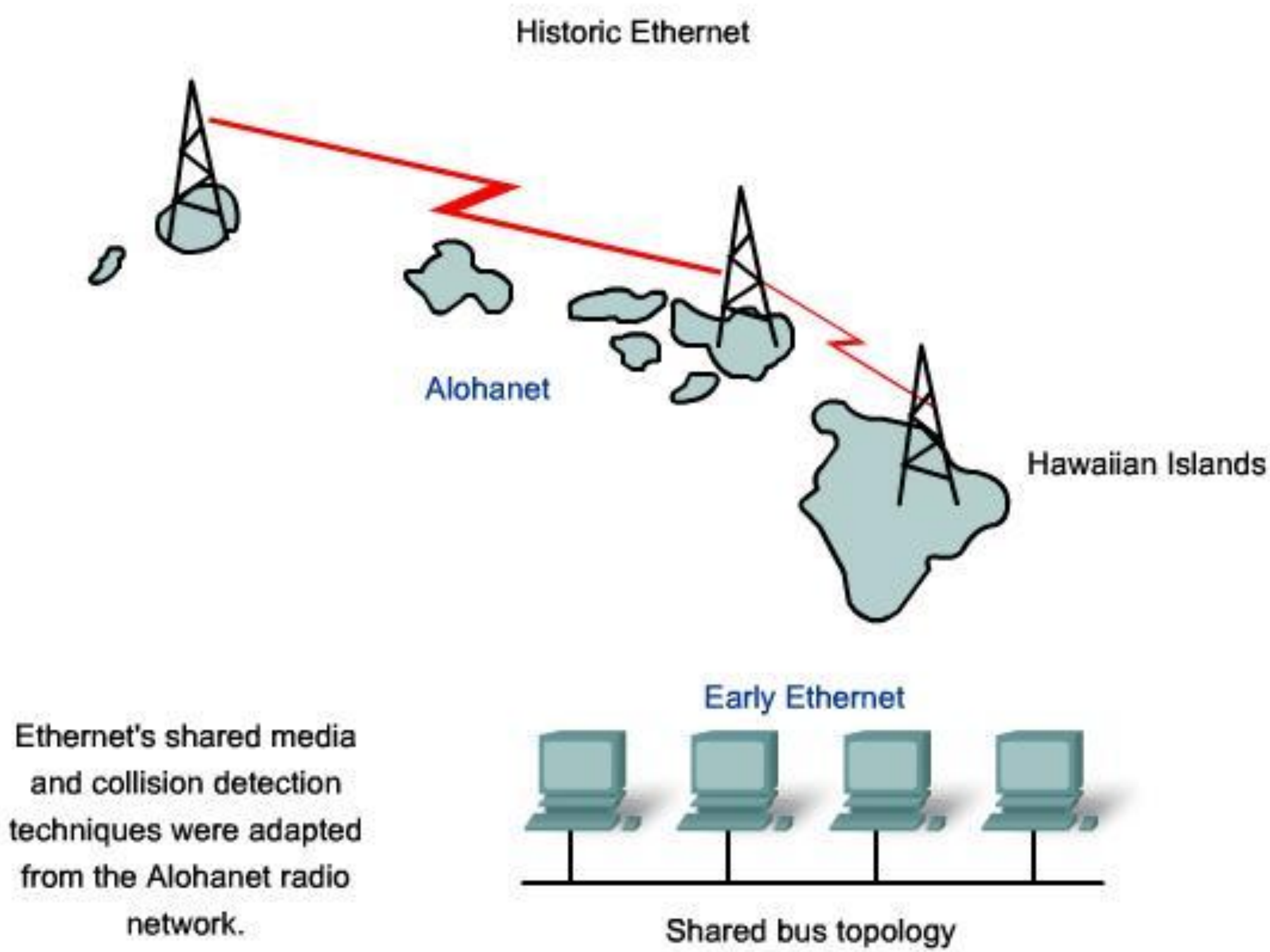
9.1.5 Physical Implementations of Ethernet

- Most of the traffic on the Internet originates and ends with Ethernet connections. Since its inception in the 1970s, Ethernet has evolved to meet the increased demand for high-speed LANs. When optical fiber media was introduced, Ethernet adapted to this new technology to take advantage of the superior bandwidth and low error rate that fiber offers. Today, the same protocol that transported data at 3 Mbps can carry data at 10 Gbps.
- The success of Ethernet is due to the following factors:
  - Simplicity and ease of maintenance
  - Ability to incorporate new technologies
  - Reliability
  - Low cost of installation and upgrade
- The introduction of Gigabit Ethernet has extended the original LAN technology to distances that make Ethernet a Metropolitan Area Network (MAN) and WAN standard.

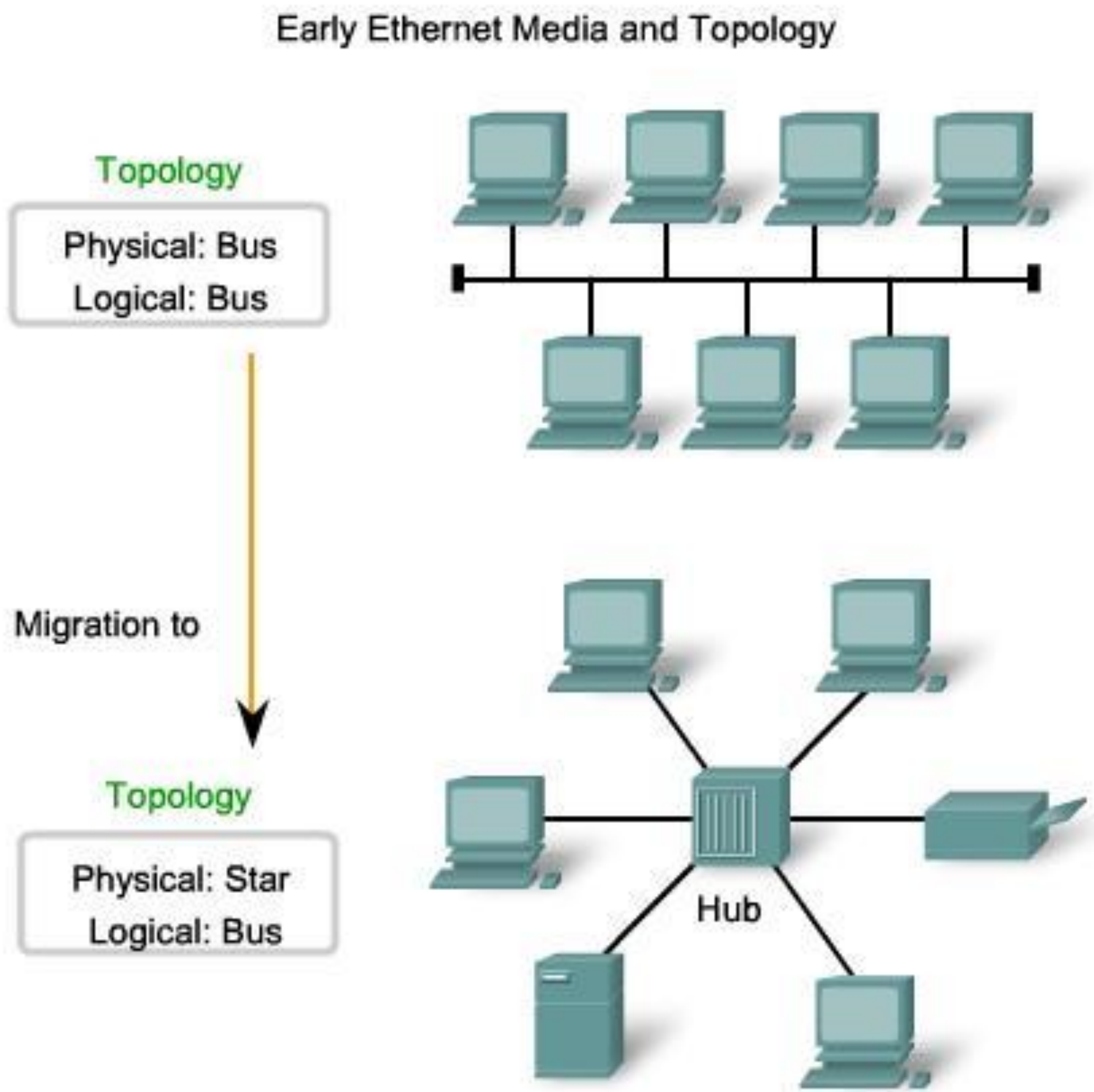
9.1.5 Physical Implementations of Ethernet

- As a technology associated with the Physical layer, Ethernet specifies and implements encoding and decoding schemes that enable frame bits to be carried as signals across the media. Ethernet devices make use of a broad range of cable and connector specifications.
- In today's networks, Ethernet uses UTP copper cables and optical fiber to interconnect network devices via intermediary devices such as hubs and switches. With all of the various media types that Ethernet supports , the Ethernet frame structure remains consistent across all of its physical implementations. It is for this reason that it can evolve to meet today's networking requirements.

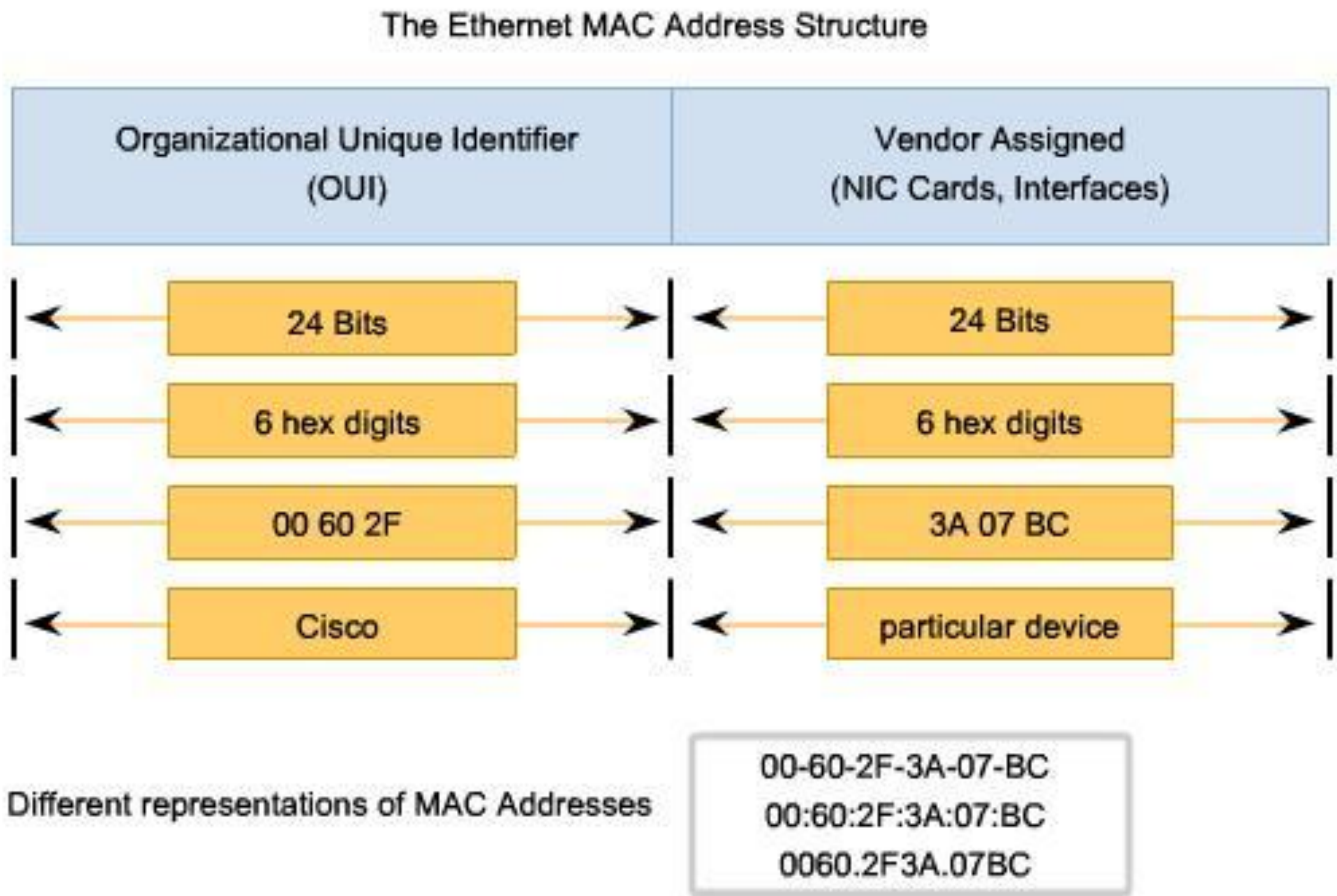
9.2 Ethernet – Communication through the LAN
9.2.1 Historic Ethernet



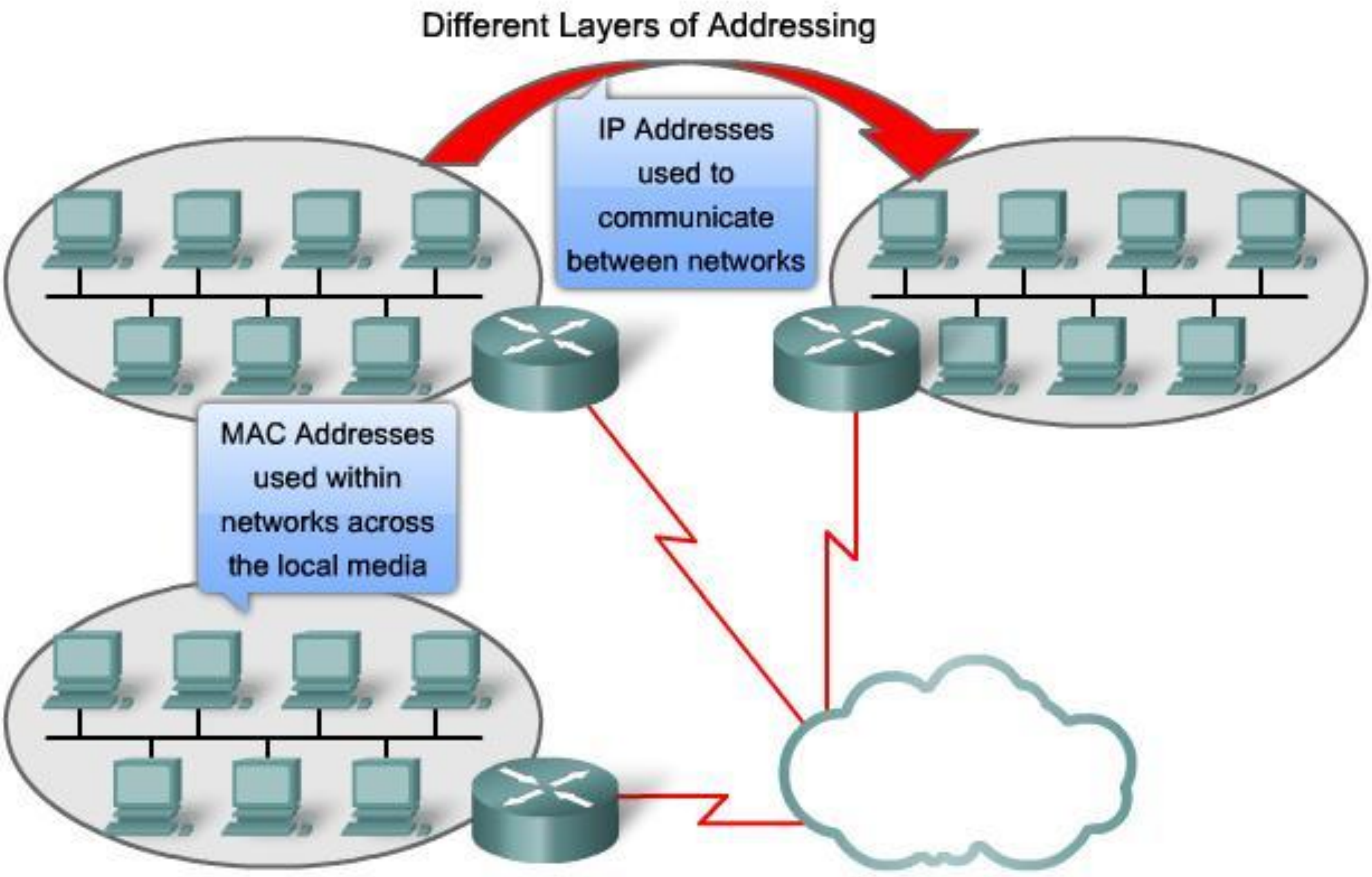
9.2.1 Historic Ethernet



9.3.2 The Ethernet MAC Address



9.3.4 Another Layer of Addressing



9.3.5 Ethernet Unicast, Multicast and Broadcast

- In Ethernet, different MAC addresses are used for Layer 2 unicast, multicast, and broadcast communications.

Unicast

- A unicast MAC address is the unique address used when a frame is sent from a single transmitting device to single destination device.
- For example, a host with IP address 192.168.1.5 (source) requests a web page from the server at IP address 192.168.1.200. For a unicast packet to be sent and received, a destination IP address must be in the IP packet header. A corresponding destination MAC address must also be present in the Ethernet frame header. The IP address and MAC address combine to deliver data to one specific destination host.

9.3.5 Ethernet Unicast, Multicast and Broadcast

Broadcast

- With a broadcast, the packet contains a destination IP address that has all ones (1s) in the host portion. This numbering in the address means that all hosts on that local network (broadcast domain) will receive and process the packet. Many network protocols, such as Dynamic Host Configuration Protocol (DHCP) and Address Resolution Protocol (ARP), use broadcasts. How ARP uses broadcasts to map Layer 2 to Layer 3 addresses is discussed later in this chapter.
- A broadcast IP address for a network needs a corresponding broadcast MAC address in the Ethernet frame. On Ethernet networks, the broadcast MAC address is 48 ones displayed as Hexadecimal FF-FF-FF-FF-FF-FF.

9.3.5 Ethernet Unicast, Multicast and Broadcast

Multicast

- Multicast addresses allow a source device to send a packet to a group of devices. Devices that belong to a multicast group are assigned a multicast group IP address. The range of multicast addresses is from 224.0.0.0 to 239.255.255.255. Because multicast addresses represent a group of addresses (sometimes called a host group), they can only be used as the destination of a packet. The source will always have a unicast address.
- Examples of where multicast addresses would be used are in remote gaming, where many players are connected remotely but playing the same game, and distance learning through video conferencing, where many students are connected to the same class.

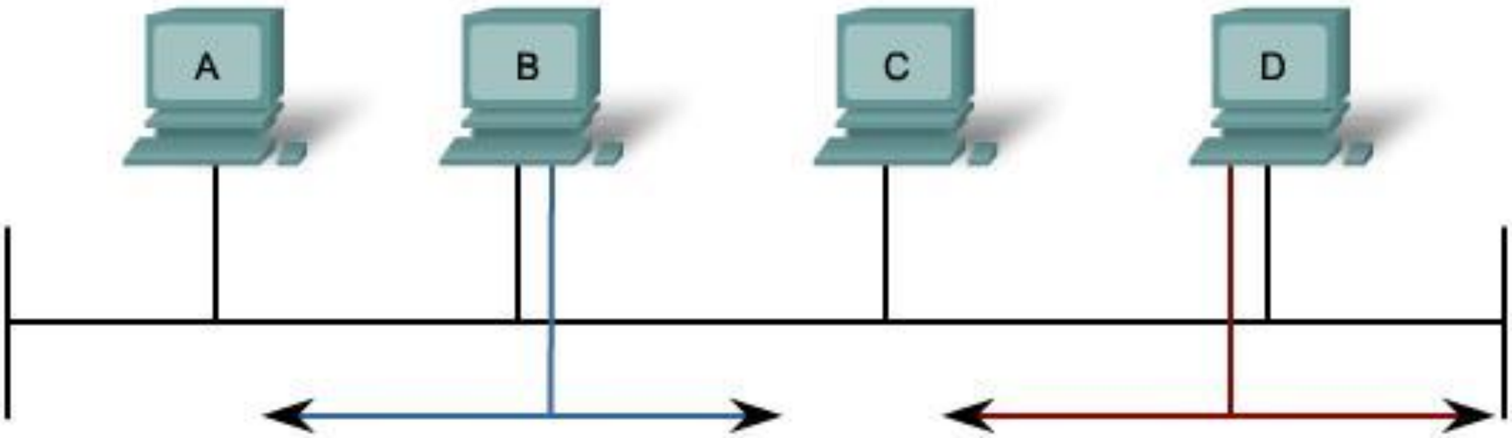
9.3.5 Ethernet Unicast, Multicast and Broadcast

- As with the unicast and broadcast addresses, the multicast IP address requires a corresponding multicast MAC address to actually deliver frames on a local network. The multicast MAC address is a special value that begins with 01-00-5E in hexadecimal. The value ends by converting the lower 23 bits of the IP multicast group address into the remaining 6 hexadecimal characters of the Ethernet address. The remaining bit in the MAC address is always a "0".
- An example is hexadecimal 01-00-5E-00-00-0A. Each hexadecimal character is 4 binary bits.

9.4 Ethernet Media Access Control
9.4.1 Media Access Control in Ethernet

Media Access Control in Ethernet

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

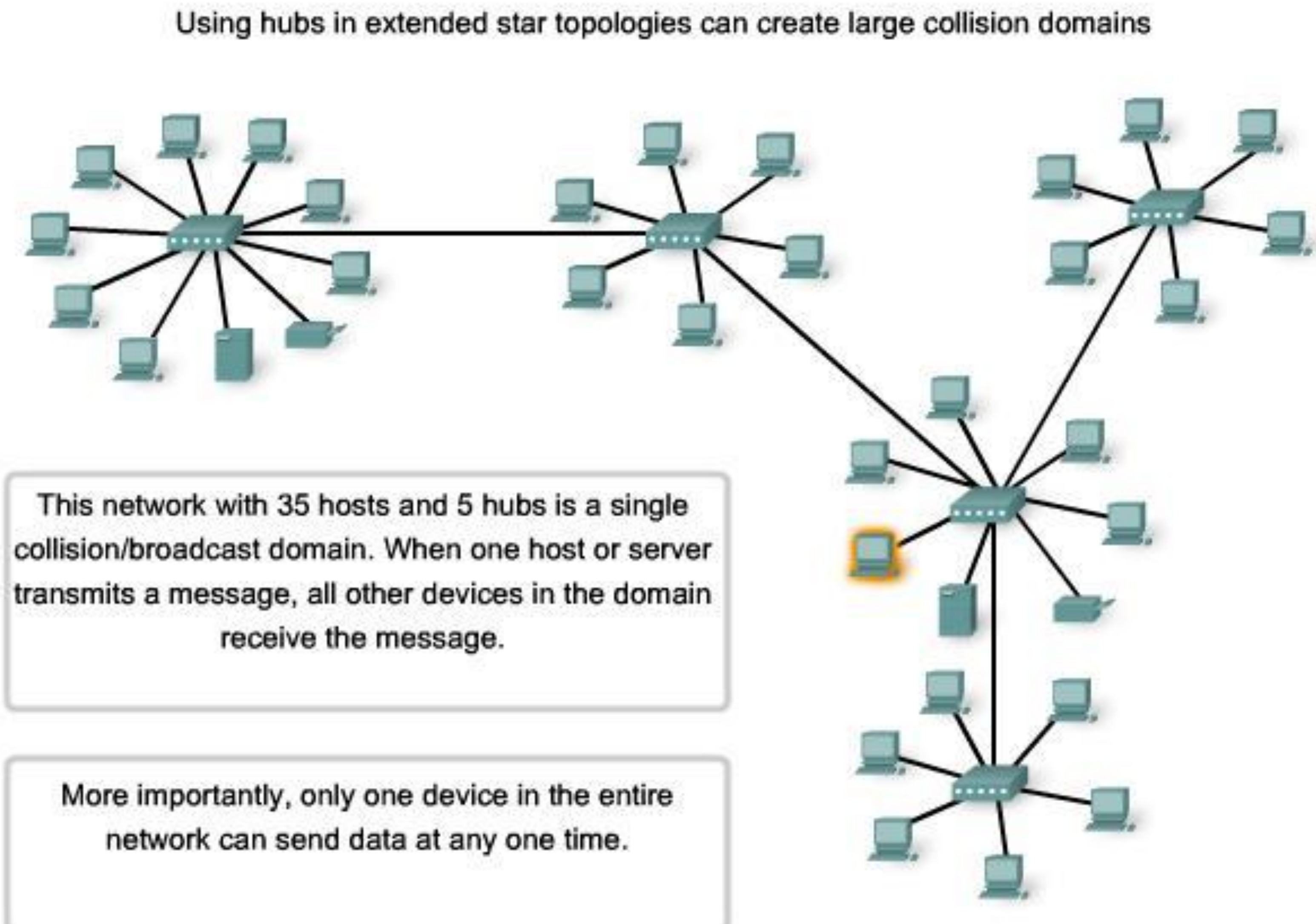


CSMA/CD controls access to the shared media. If there is a collision, it is detected and frames are retransmitted.

9.4.1 Media Access Control in Ethernet

- In a shared media environment, all devices have guaranteed access to the medium, but they have no prioritized claim on it. If more than one device transmits simultaneously, the physical signals collide and the network must recover in order for communication to continue.
- Collisions are the cost that Ethernet pays to get the low overhead associated with each transmission.
- Ethernet uses Carrier Sense Multiple Access with Collision Detection (CSMA/CD) to detect and handle collisions and manage the resumption of communications.
- Because all computers using Ethernet send their messages on the same media, a distributed coordination scheme (CSMA) is used to detect the electrical activity on the cable. A device can then determine when it can transmit. When a device detects that no other computer is sending a frame, or carrier signal, the device will transmit, if it has something to send.

9.4.2 CSMA/CD – The Process



9.4.2 CSMA/CD – The Process

Carrier Sense

- In the CSMA/CD access method, all network devices that have messages to send must listen before transmitting. If a device detects a signal from another device, it will wait for a specified amount of time before attempting to transmit. When there is no traffic detected, a device will transmit its message. While this transmission is occurring, the device continues to listen for traffic or collisions on the LAN. After the message is sent, the device returns to its default listening mode.

Multi-access

- If the distance between devices is such that the latency of one device's signals means that signals are not detected by a second device, the second device may start to transmit, too. The media now has two devices transmitting their signals at the same time. Their messages will propagate across the media until they encounter each other. At that point, the signals mix and the message is destroyed. Although the messages are corrupted, the jumble of remaining signals continues to propagate across the media.

9.4.2 CSMA/CD – The Process

Collision Detection

- When a device is in listening mode, it can detect when a collision occurs on the shared media. The detection of a collision is made possible because all devices can detect an increase in the amplitude of the signal above the normal level. Once a collision occurs, the other devices in listening mode - as well as all the transmitting devices - will detect the increase in the signal amplitude. Once detected, every device transmitting will continue to transmit to ensure that all devices on the network detect the collision.

9.4.2 CSMA/CD – The Process

Jam Signal and Random Backoff

- Once the collision is detected by the transmitting devices, they send out a jamming signal. This jamming signal is used to notify the other devices of a collision, so that they will invoke a backoff algorithm. This backoff algorithm causes all devices to stop transmitting for a random amount of time, which allows the collision signals to subside.
- After the delay has expired on a device, the device goes back into the "listening before transmit" mode. A random backoff period ensures that the devices that were involved in the collision do not try to send their traffic again at the same time, which would cause the whole process to repeat. But, this also means that a third device may transmit before either of the two involved in the original collision have a chance to re-transmit.

9.4.2 CSMA/CD – The Process

Hubs and Collision Domains

- Given that collisions will occur occasionally in any shared media topology - even when employing CSMA/CD - we need to look at the conditions that can result in an increase in collisions. Because of the rapid growth of the Internet:
  - More devices are being connected to the network.
  - Devices access the network media more frequently.
  - Distances between devices are increasing.
- Hubs were created as intermediary network devices that enable more nodes to connect to the shared media. Also known as multi-port repeaters, hubs retransmit received data signals to all connected devices, except the one from which it received the signals. Hubs do not perform network functions such as directing data based on addresses.

9.4.2 CSMA/CD – The Process

- Hubs and repeaters are intermediary devices that extend the distance that Ethernet cables can reach. Because hubs operate at the Physical layer, dealing only with the signals on the media, collisions can occur between the devices they connect and within the hubs themselves.
- Further, using hubs to provide network access to more users reduces the performance for each user because the fixed capacity of the media has to be shared between more and more devices.
- The connected devices that access a common media via a hub or series of directly connected hubs make up what is known as a collision domain. A collision domain is also referred to as a network segment. Hubs and repeaters therefore have the effect of increasing the size of the collision domain.

9.4.2 CSMA/CD – The Process

- The interconnection of hubs form a physical topology called an extended star. The extended star can create a greatly expanded collision domain.
- An increased number of collisions reduces the network's efficiency and effectiveness.
- Although CSMA/CD is a frame collision management system, it was designed to manage collisions for only limited numbers of devices and on networks with light network usage. Therefore, other mechanisms are required when large numbers of users require access and when more active network access is needed.
- Using switches in place of hubs can begin to alleviate this problem.

9.4.3 Ethernet Timings

- Latency - The electrical signal that is transmitted takes a certain amount of time (latency) to propagate (travel) down the cable. Each hub or repeater in the signal's path adds latency as it forwards the bits from one port to the next.
- Bit Time - For each different media speed, a period of time is required for a bit to be placed and sensed on the media. This period of time is referred to as the bit time.
- Slot Time - In half-duplex Ethernet, where data can only travel in one direction at once, slot time becomes an important parameter in determining how many devices can share a network. For all speeds of Ethernet transmission at or below 1000 Mbps, the standard describes how an individual transmission may be no smaller than the slot time.
- Interframe Spacing - The Ethernet standards require a minimum spacing between two non-colliding frames. This gives the media time to stabilize after the transmission of the previous frame and time for the devices to process the frame. Referred to as the interframe spacing, this time is measured from the last bit of the FCS field of one frame to the first bit of the Preamble of the next frame.

9.5 Ethernet Physical Layer
9.5.1 Overview of Ethernet Physical Layer

Types of Ethernet

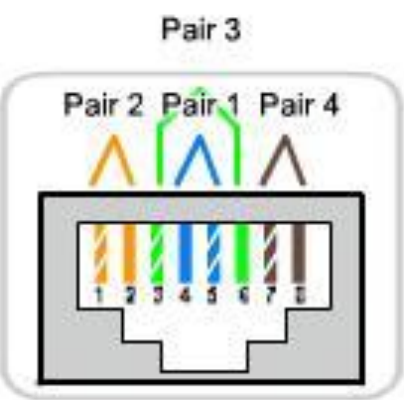
Ethernet Type	Bandwidth	Cable Type	Duplex	Maximum Distance
10Base-5	10 Mbps	Thicknet Coaxial	Half	500 m
10Base-2	10 Mbps	Thinnet Coaxial	Half	185 m
100Base-TX	10 Mbps	Cat3/Cat5 UTP	Half	100 m
100Base-TX	100 Mbps	Cat5 UTP	Half	100 m
100Base-FX	200 Mbps	Cat5 UTP	Full	100 m
100Base-FX	100 Mbps	Multimode Fiber	Half	400 m
1000Base-T	200 Mbps	Multimode Fiber	Full	2 km
1000Base-TX	1 Gbps	Cat5e UTP	Full	100 m
1000Base-SX	1 Gbps	Cat6 UTP	Full	100 m
1000Base-LX	1 Gbps	Multimode Fiber	Full	550 m
10GBase-CX4	1 Gbps	Single-Mode Fiber	Full	2 km
10GBase-T	10 Gbps	Twin-axial	Full	100 m
10GBase-LX4	10 Gbps	Cat6a/Cat7 UTP	Full	100 m
10GBase-LX4	10 Gbps	Multimode Fiber	Full	300 m
10 Mbps	10 Gbps	Single-Mode Fiber	Full	10 km

9.5.1 Overview of Ethernet Physical Layer

- The differences between standard Ethernet, Fast Ethernet, Gigabit Ethernet, and 10 Gigabit Ethernet occur at the Physical layer, often referred to as the Ethernet PHY.
- Ethernet is covered by the IEEE 802.3 standards. Four data rates are currently defined for operation over optical fiber and twisted-pair cables:
  - 10 Mbps - 10Base-T Ethernet
  - 100 Mbps - Fast Ethernet
  - 1000 Mbps - Gigabit Ethernet
  - 10 Gbps - 10 Gigabit Ethernet
- There are many different implementations of Ethernet at these various data rates, only the more common ones will be presented.

9.5.2 10 and 100 Mbps Ethernet

10Base-T Ethernet RJ-45 Pinouts



RJ-45 Connectors

Pin Number	Signal
1	TD+ (Transmit Data, positive-going differential signal)
2	TD- (Transmit Data, negative-going differential signal)
3	RD+ (Receive Data, positive-going differential signal)
4	Unused
5	Unused
6	RD- (Receive Data, negative-going differential signal)
7	Unused
8	Unused

9.5.2 10 and 100 Mbps Ethernet

10 Mbps Ethernet - 10BASE-T

- 10BASE-T uses Manchester-encoding over two unshielded twisted-pair cables. The early implementations of 10BASE-T used Cat3 cabling. However, Cat5 or later cabling is typically used today.
- 10 Mbps Ethernet is considered to be classic Ethernet and uses a physical star topology. Ethernet 10BASE-T links could be up to 100 meters in length before requiring a hub or repeater.
- 10BASE-T uses two pairs of a four-pair cable and is terminated at each end with an 8-pin RJ-45 connector. The pair connected to pins 1 and 2 are used for transmitting and the pair connected to pins 3 and 6 are used for receiving.
- 10BASE-T is generally not chosen for new LAN installations. However, there are still many 10BASE-T Ethernet networks in existence today. The replacement of hubs with switches in 10BASE-T networks has greatly increased the throughput available to these networks and has given Legacy Ethernet greater longevity. The 10BASE-T links connected to a switch can support either half-duplex or full-duplex operation.

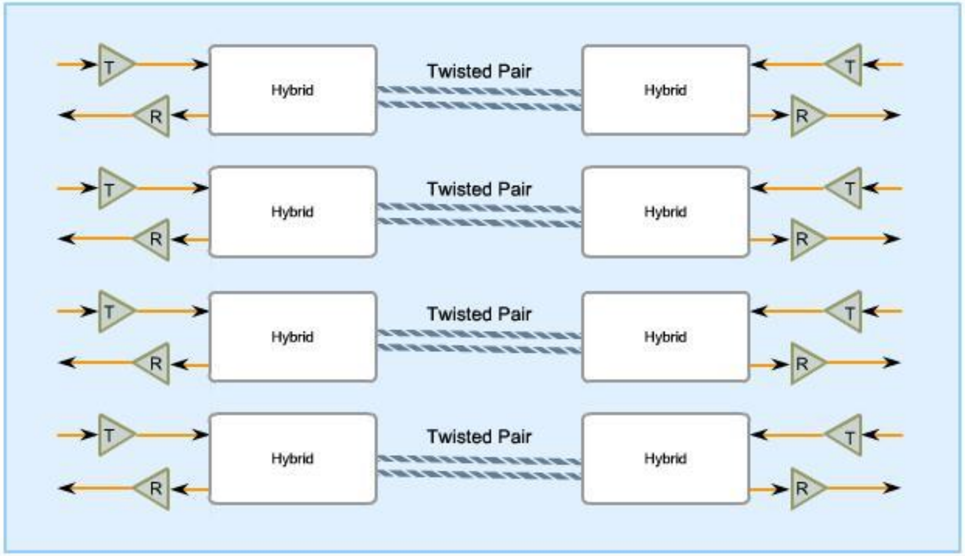
9.5.2 10 and 100 Mbps Ethernet

100 Mbps - Fast Ethernet

- In the mid to late 1990s, several new 802.3 standards were established to describe methods for transmitting data over Ethernet media at 100 Mbps. These standards used different encoding requirements for achieving these higher data rates.
- 100 Mbps Ethernet, also known as Fast Ethernet, can be implemented using twisted-pair copper wire or fiber media. The most popular implementations of 100 Mbps Ethernet are:
  - 100BASE-TX using Cat5 or later UTP
  - 100BASE-FX using fiber-optic cable
- Because the higher frequency signals used in Fast Ethernet are more susceptible to noise, two separate encoding steps are used by 100-Mbps Ethernet to enhance signal integrity.

9.5.3 1000 Mbps Ethernet

1000BASE-T Circuitry



9.5.4 Ethernet – Future Options: Future Ethernet Speeds

- Although 1-Gigabit Ethernet is now widely available and 10-Gigabit products are becoming more available, the IEEE and the 10-Gigabit Ethernet Alliance are working on 40-, 100-, or even 160-Gbps standards. The technologies that are adopted will depend on a number of factors, including the rate of maturation of the technologies and standards, the rate of adoption in the market, and the cost of emerging products

9.6.1 Legacy Ethernet – Using Hubs

- Classic Ethernet uses shared media and contention-based media access control. Classic Ethernet uses hubs to interconnect nodes on the LAN segment. Hubs do not perform any type of traffic filtering. Instead, the hub forwards all the bits to every device connected to the hub. This forces all the devices in the LAN to share the bandwidth of the media.
- Additionally, this classic Ethernet implementation often results in high levels of collisions on the LAN. Because of these performance issues, this type of Ethernet LAN has limited use in today's networks. Ethernet implementations using hubs are now typically used only in small LANs or in LANs with low bandwidth requirements.
- Sharing media among devices creates significant issues as the network grows.

9.6.1 Legacy Ethernet – Using Hubs

Scalability

- In a hub network, there is a limit to the amount of bandwidth that devices can share. With each device added to the shared media, the average bandwidth available to each device decreases. With each increase in the number of devices on the media, performance is degraded.

Latency

- Network latency is the amount of time it takes a signal to reach all destinations on the media. Each node in a hub-based network has to wait for an opportunity to transmit in order to avoid collisions. Latency can increase significantly as the distance between nodes is extended. Latency is also affected by a delay of the signal across the media as well as the delay added by the processing of the signals through hubs and repeaters. Increasing the length of media or the number of hubs and repeaters connected to a segment results in increased latency. With greater latency, it is more likely that nodes will not receive initial signals, thereby increasing the collisions present in the network.

9.6.1 Legacy Ethernet – Using Hubs

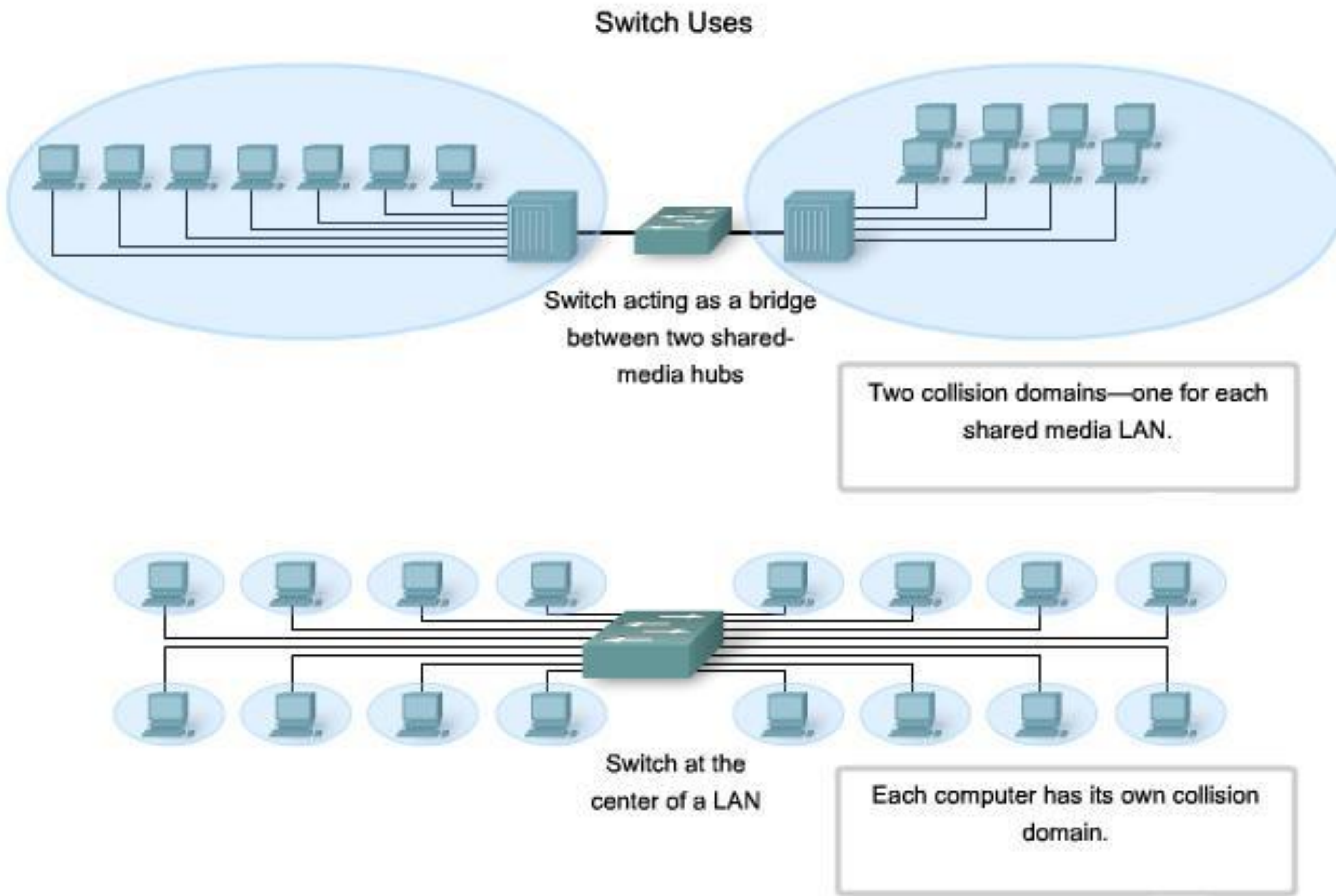
Network Failure

- Because classic Ethernet shares the media, any device in the network could potentially cause problems for other devices. If any device connected to the hub generates detrimental traffic, the communication for all devices on the media could be impeded. This harmful traffic could be due to incorrect speed or full-duplex settings on a NIC.

Collisions

- According to CSMA/CD, a node should not send a packet unless the network is clear of traffic. If two nodes send packets at the same time, a collision occurs and the packets are lost. Then both nodes send a jam signal, wait for a random amount of time, and retransmit their packets. Any part of the network where packets from two or more nodes can interfere with each other is considered a collision domain. A network with a larger number of nodes on the same segment has a larger collision domain and typically has more traffic. As the amount of traffic in the network increases, the likelihood of collisions increases.
- Switches provide an alternative to the contention-based environment of classic Ethernet.

9.6.2 Ethernet – Using Switches



9.6.2 Ethernet – Using Switches

- Nodes are Connected Directly
- In a LAN where all nodes are connected directly to the switch, the throughput of the network increases dramatically. The three primary reasons for this increase are:
  - Dedicated bandwidth to each port
  - Collision-free environment
  - Full-duplex operation
- These physical star topologies are essentially point to point links.

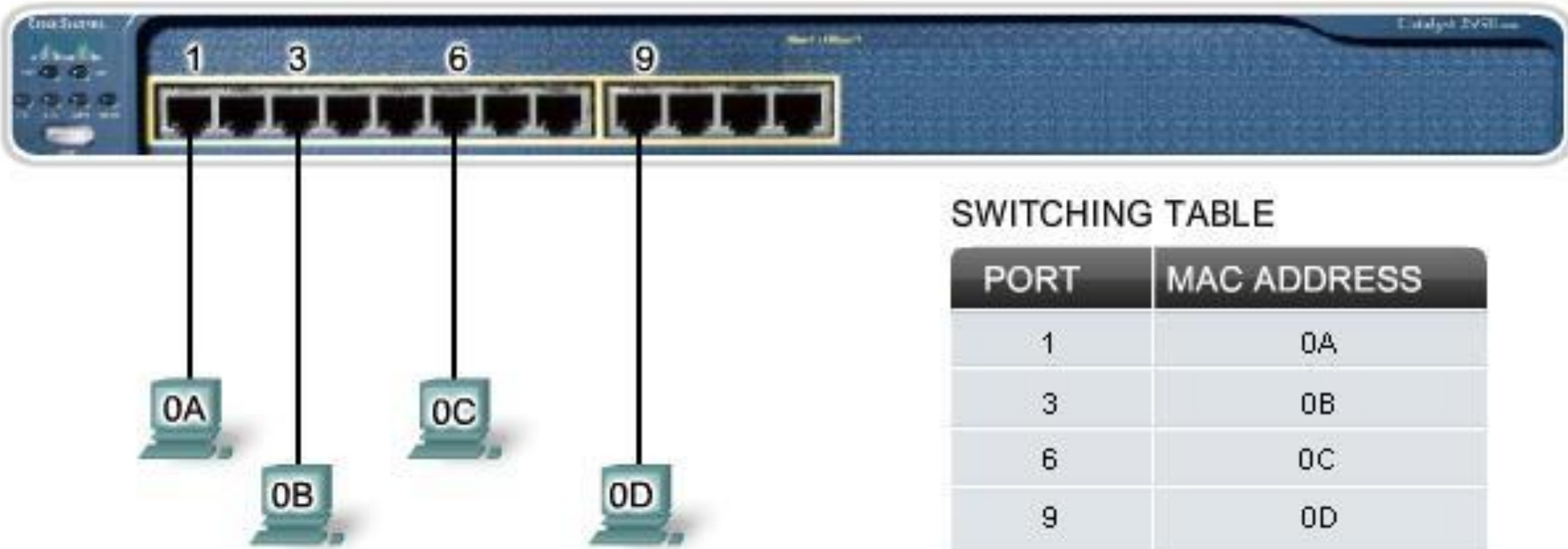
9.6.2 Ethernet – Using Switches

Using Switches Instead of Hubs

- Most modern Ethernet use switches to the end devices and operate full duplex. Switches provide so much greater throughput than hubs and increase performance so dramatically. However, there are three reasons why hubs are still being used.
  - Availability - LAN switches were not developed until the early 1990s and were not readily available until the mid 1990s. Early Ethernet networks used UTP hubs and many of them remain in operation to this day.
  - Economics - Initially, switches were rather expensive. As the price of switches has dropped, the use of hubs has decreased and cost is becoming less of a factor in deployment decisions.
  - Requirements - The early LAN networks were simple networks designed to exchange files and share printers. For many locations, the early networks have evolved into the converged networks of today, resulting in a substantial need for increased bandwidth available to individual users. In some circumstances, however, a shared media hub will still suffice and these products remain on the market.

9.6.3 Switches – Selective Forwarding

Switches - Selective Forwarding



SWITCHING TABLE

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

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	0D				

9.6.3 Switches – Selective Forwarding

- Ethernet switches selectively forward individual frames from a receiving port to the port where the destination node is connected. This selective forwarding process can be thought of as establishing a momentary point-to-point connection between the transmitting and receiving nodes. The connection is made only long enough to forward a single frame. During this instant, the two nodes have a full bandwidth connection between them and represent a logical point-to-point connection.
- To be technically accurate, this temporary connection is not made between the two nodes simultaneously. In essence, this makes the connection between hosts a point-to-point connection. In fact, any node operating in full-duplex mode can transmit anytime it has a frame, without regard to the availability of the receiving node. This is because a LAN switch will buffer an incoming frame and then forward it to the proper port when that port is idle. This process is referred to as store and forward.

9.6.3 Switches – Selective Forwarding

- With store and forward switching, the switch receives the entire frame, checks the FCS for errors, and forwards the frame to the appropriate port for the destination node. Because the nodes do not have to wait for the media to be idle, the nodes can send and receive at full media speed without losses due to collisions or the overhead associated with managing collisions.

Forwarding is Based on the Destination MAC

- The switch maintains a table, called a MAC table. that matches a destination MAC address with the port used to connect to a node. For each incoming frame, the destination MAC address in the frame header is compared to the list of addresses in the MAC table. If a match is found, the port number in the table that is paired with the MAC address is used as the exit port for the frame.

9.6.3 Switches – Selective Forwarding

- The MAC table can be referred to by many different names. It is often called the switch table. Because switching was derived from an older technology called transparent bridging, the table is sometimes called the bridge table. For this reason, many processes performed by LAN switches can contain bridge or bridging in their names.
- A bridge is a device used more commonly in the early days of LAN to connect - or bridge - two physical network segments. Switches can be used to perform this operation as well as allowing end device connectivity to the LAN. Many other technologies have been developed around LAN switching. One place where bridges are prevalent is in Wireless networks. Wireless Bridges are used to interconnect two wireless network segments. Both terms - switching and bridging – are in use by the networking industry.

9.6.3 Switches – Selective Forwarding

Switch Operation

- To accomplish their purpose, Ethernet LAN switches use five basic operations: Learning, Aging. Flooding, Selective Forwarding, Filtering,

Learning

- The MAC table must be populated with MAC addresses and their corresponding ports. The Learning process allows these mappings to be dynamically acquired during normal operation.
- As each frame enters the switch, the switch examines the source MAC address. Using a lookup procedure, the switch determines if the table already contains an entry for that MAC address. If no entry exists, the switch creates a new entry in the MAC table using the source MAC address and pairs the address with the port on which the entry arrived. The switch now can use this mapping to forward frames to this node.

9.6.3 Switches – Selective Forwarding

Aging

- The entries in the MAC table acquired by the Learning process are time stamped. This timestamp is used as a means for removing old entries in the MAC table. After an entry in the MAC table is made, a procedure begins a countdown, using the timestamp as the beginning value. After the value reaches 0, the entry in the table will be refreshed when the switch next receives a frame from that node on the same port.

Flooding

- If the switch does not know to which port to send a frame because the destination MAC address is not in the MAC table, the switch sends the frame to all ports except the port on which the frame arrived. The process of sending a frame to all segments is known as flooding. The switch does not forward the frame to the port on which it arrived because any destination on that segment will have already received the frame. Flooding is also used for frames sent to the broadcast MAC address.

9.6.3 Switches – Selective Forwarding

Selective Forwarding

- Selective forwarding is the process of examining a frame's destination MAC address and forwarding it out the appropriate port. This is the central function of the switch. When a frame from a node arrives at the switch for which the switch has already learned the MAC address, this address is matched to an entry in the MAC table and the frame is forwarded to the corresponding port. Instead of flooding the frame to all ports, the switch sends the frame to the destination node via its nominated port. This action is called forwarding.

Filtering

- In some cases, a frame is not forwarded. This process is called frame filtering. One use of filtering has already been described: a switch does not forward a frame to the same port on which it arrived. A switch will also drop a corrupt frame. If a frame fails a CRC check, the frame is dropped. An additional reason for filtering a frame is security. A switch has security settings for blocking frames to and/or from selective MAC addresses or specific ports.

9.6.4 Ethernet – Comparing Hubs and Switches

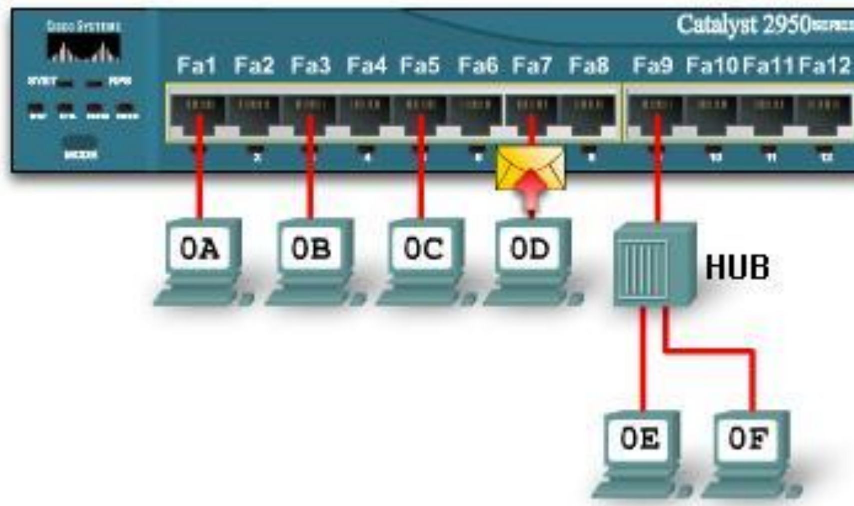
Activity

Determine how the switch forwards a frame based on the Source MAC and Destination MAC addresses and information in the switch MAC table.

Answer the questions below using the information

Preamble	Destination MAC 0E	Source MAC 0D	Length Type	Encapsulated Data	End of frame

MAC Table					
Fa1	Fa2	Fa3	Fa4	Fa5	Fa6
0A		0B			
Fa7	Fa8	Fa9	Fa10	Fa11	Fa12



1. Where will the switch forward the frame?

- [x] Fa1
- [ ] Fa2
- [x] Fa3
- [ ] Fa4
- [x] Fa5
- [ ] Fa6
- [ ] Fa7
- [ ] Fa8
- [x] Fa9
- [ ] Fa10
- [ ] Fa11
- [ ] Fa12

2. When the switch forwards the frame, which statement(s) are true?

- [x] Switch adds the source MAC address to the MAC table.
- [ ] Frame is a broadcast frame and will be forwarded to all port:
- [ ] Frame is a unicast frame and will be sent to specific port or
- [x] Frame is a unicast frame and will be flooded to all ports.
- [ ] Frame is a unicast frame but it will be dropped at the switch.

9.7.1 ARP Process – Mapping IP to MAC Addresses

- The ARP protocol provides two basic functions:
  - Resolving IPv4 addresses to MAC addresses
  - Maintaining a cache of mappings
- In the event that the gateway entry is not in the table, the normal ARP process will send an ARP request to retrieve the MAC address associated with the IP address of the router interface.
- Proxy ARP
- Using proxy ARP, a router interface acts as if it is the host with the IPv4 address requested by the ARP request. By "faking" its identity, the router accepts responsibility for routing packets to the "real" destination.
- Another case where a proxy ARP is used is when a host believes that it is directly connected to the same logical network as the destination host. This generally occurs when a host is configured with an improper mask.
- Yet another use for a proxy ARP is when a host is not configured with a default gateway. By default, Cisco routers have proxy ARP enabled on LAN interfaces.

9.7.3 The ARP Process – Removing Address Mappings

- For each device, an ARP cache timer removes ARP entries that have not been used for a specified period of time. The times differ depending on the device and its operating system. For example, some Windows operating systems store ARP cache entries for 2 minutes. If the entry is used again during that time, the ARP timer for that entry is extended to 10 minutes.
- Commands may also be used to manually remove all or some of the entries in the ARP table. After an entry has been removed, the process for sending an ARP request and receiving an ARP reply must occur again to enter the map in the ARP table.
- The arp command is used to view and to clear the contents of a computer's ARP cache. Note that this command, despite its name, does not invoke the execution of the Address Resolution Protocol in any way. It is merely used to display, add, or remove the entries of the ARP table. ARP service is integrated within the IPv4 protocol and implemented by the device. Its operation is transparent to both upper layer applications and users.

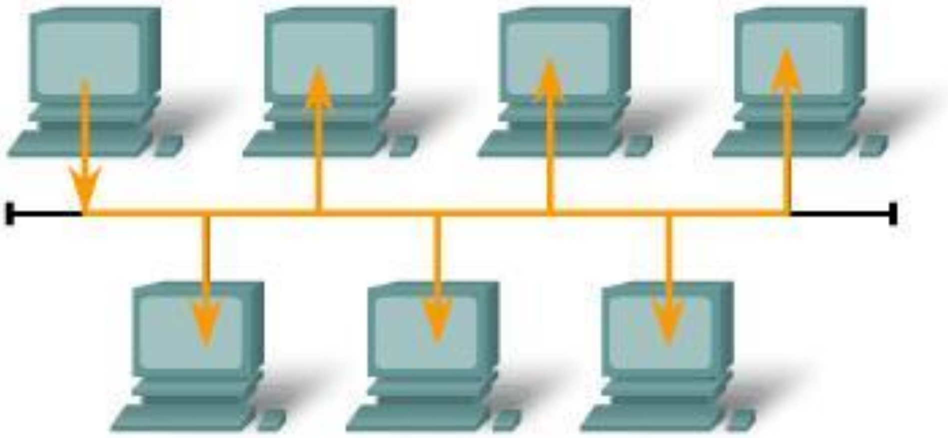
9.7.4 ARP Broadcasts - Issues

ARP Issues:

- Broadcasts, overhead on the Media
- Security

ARP broadcasts can flood the local media.

Shared Media (multiple access)



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