

## Chapter 6 (CCNA1 - Modules 7 and 8)

### Ethernet Technologies and Ethernet Switching

Ethernet and its associated IEEE 802.3 protocols are part of the world's most important networking standards. Because of the great success of the original Ethernet and the soundness of its design, it has evolved over time. This evolution was in response to the developing needs of modern LANs. It is likely that Ethernet will continue to evolve in response to future demands for network capability.

In Chapter 5, "Ethernet Fundamentals," you were introduced to both the history of Ethernet and the standards associated with it. You also learned that the term *Ethernet* refers to a family of Ethernet technologies. This chapter discusses the Ethernet technologies in more detail.

In addition, this chapter introduces Layer 2 bridging and switching techniques. Switching and bridging are techniques that decrease congestion in LANs by reducing traffic and increasing bandwidth. Three switching modes can be used to forward a frame through a switch: store-and-forward, cut-through, and fragment-free switching. The latency of each switching mode depends on how the switch forwards the frames. The faster the switching mode is, the smaller the latency is in the switch.

Finally, this chapter introduces the Spanning Tree Protocol (STP), tells how STP works, and covers the STP switch port states.

#### Concept Questions

Demonstrate your knowledge of these concepts by answering the following questions in the space provided.

- One process that is particularly important at the physical layer level is the signal quality error (SQE) signal. This signal is typical of something we will see in many networking technologies. At the physical layer, the network is "alive" with communications other than our user data to ensure a properly functioning network. SQE is always used in half duplex; it is not required but is permitted in full-duplex operation. What are the reasons for SQE being active?**
  - Whenever there is a collision on the medium
  - Whenever there is an *improper* signal on the medium. Improper signals might include detected jabber, or the reflections that result from a cable fault such as a short. (There are separate conditions depending on which medium is attached.)
  - Whenever a transmission has been interrupted as jabber, that is, it has transmitted longer than allowed

- Within 4 to 8 microseconds following a normal transmission, to indicate that the outbound frame was successfully transmitted

**2. Describe the 5-4-3 rule.**

10 Mbps Ethernet operates within the timing limits offered by a series of not more than five segments separated by no more than four repeaters. That is, no more than four repeaters may be connected in series between any two distant stations. The coaxial implementations have a further requirement that there be no more than three populated segments between any two distant stations. The other two allowed coaxial segments are used to extend the diameter of the collision domain and are called link segments. The primary characteristic of a link segment is that it has exactly two devices attached.

**3. What are some reasons to use 100BASE-FX (introduced as part of the 802.3u-1995 standard) as opposed to other Ethernet standards?**

At the time copper-based Fast Ethernet was introduced, a fiber version was desired for backbone applications, connections between floors and buildings where copper is less desirable and high noise environments. 100BASE-FX was also positioned as an alternative to the then-popular FDDI (100 Mbps dual fiber optic token ring). However, the vast majority of Fast Ethernet installations today are 100BASE-TX. One reason for the relative lack of adoption of 100BASE-FX was the rapidity of the introduction of Gigabit Ethernet copper and fiber standards, which are now the dominant technology for backbone installations, high-speed cross-connects, and general infrastructure needs.

**4. Ethernet, Fiber Distributed Data Interface (FDDI), and Token Ring are widely used LAN technologies that account for virtually all deployed LANs. LAN standards specify cabling and signaling at the physical and data link layers of the OSI model. Because they are widely adhered to, this book covers the Ethernet and IEEE 802.3 LAN standards. Why do you suppose that Ethernet technology is so heavily used?**

Ethernet is well suited to applications in which a local communication medium must carry sporadic, occasionally heavy traffic at high-peak data rates. Ethernet was considered high-speed when it was first available.

**5. When it was developed, Ethernet was designed to fill the middle ground between long-distance, low-speed networks and specialized, computer-room networks carrying data at high speeds for limited distances. Ethernet is well suited to applications in which a local communication medium must carry sporadic, occasionally heavy traffic at high-peak data rates. Why is Ethernet so well suited to this kind of traffic?**

Ethernet was designed to fill the middle ground between long-distance, low-speed networks and specialized, computer-room networks carrying data at high speeds for very limited distances.

6. Today, the term *standard Ethernet* refers to all networks using Ethernet (a shared-medium technology) that generally conform to Ethernet specifications, including IEEE 802.3. To use this shared-medium technology, Ethernet uses the carrier sense multiple access collision detect (CSMA/CD) protocol to allow the networking devices to negotiate for the right to transmit. What are the major benefits of Ethernet?

It was designed to enable sharing resources on a local workgroup level. Design goals included simplicity, low cost, compatibility, fairness, low delay, and high speed.

### Vocabulary Exercise

Define the following terms as completely as you can. Use the online curriculum or Chapter 6 from the *Cisco Networking Academy Program CCNA 1 and 2 Companion Guide*, Third Edition, for help.

**4D-PAM5**—The symbol encoding method used in 1000BASE-T. The four dimensional quinary symbols (4D) received from the 8B1Q4 data encoding are transmitted using five voltage levels (PAM5). Four symbols are transmitted in parallel each symbol period.

**8B1Q4**—For IEEE802.3, the data encoding technique used by 1000BASE-T when converting GMII data (8B-8 bits) to four quinary symbols (Q4) that are transmitted during one clock (1Q4).

**bridge protocol data unit (BPDU)**—Spanning-Tree Protocol hello packet that is sent out at configurable intervals to exchange information among bridges in the network. See also PDU.

**cut-through switching**—A packet-switching approach that streams data through a switch so that the leading edge of a packet exits the switch at the output port before the packet finishes entering the input port. A device using cut-through packet switching reads, processes, and forwards packets as soon as the destination address is looked up and the outgoing port is determined. See also store-and-forward switching.

**encoding**—Process by which bits are represented by voltages.

**fragment-free switching**—Fragment-free switching filters out collision fragments, which are the majority of packet errors, before forwarding begins.

**latency**—Delay between the time when a device receives a frame and the time that frame is forwarded out the destination port.

**Manchester encoding**—Digital coding scheme, used by IEEE 802.3 and Ethernet, in which a mid-bit-time transition is used for clocking, and a 1 is denoted by a high level during the first half of the bit time.

**microsegmentation**—The division of a network into smaller segments, usually with the intention of increasing aggregate bandwidth to network devices.

**nonreturn to zero (NRZ)**—Signals that maintain constant voltage levels with no signal transitions (no return to a zero-voltage level) during a bit interval.

**nonreturn to zero inverted (NRZI)**—Signal that maintain constant voltage levels with no signal transitions (no return to a zero-voltage level) but interpret the presence of data at the beginning of a bit interval as a signal transition and the absence of data as no transition.

**signal-to-noise ratio (SNR)**—SNR is the ratio of useable signal being transmitted to the undesired signal (noise). It is a measure of transmission quality. The ratio of good data (signal) to bad (noise) on a line, expressed in decibels (dB).

**spanning tree**—Loop-free subset of a network topology. See also spanning-tree algorithm, Spanning Tree Protocol.

**Spanning Tree Protocol (STP)**—Bridge protocol that uses the spanning-tree algorithm, enabling a learning bridge to dynamically work around loops in a network topology by creating a spanning tree. Bridge exchange BPDU messages with other bridges to detect loops and then remove the loops by shutting down selected bridge interfaces.

**store-and-forward switching**—A packet-switching technique in which frames are processed completely before being forwarded out the appropriate port. This processing includes calculating the CRC and checking the destination address. In addition, frames must be stored temporarily until network resources (such as an unused link) are available to forward the message.

**Thinnet**—Term used to define a thinner, less expensive version of the cable specified in the IEEE 802.3 10BASE2 standard.

**Wavelength division multiplexing (WDM)**—Multiple optical wavelength can share the same transmission fiber. The spectrum occupied by each channel must be adequately separated from the other.

## Focus Questions

### 1. What is the size and composition of a token?

Tokens are 3 bytes in length and consist of a start delimiter, an access control byte, and an end delimiter.

### 2. What does the source address field in an FDDI frame identify?

The source address identifies the single station that sent the frame; source addresses are 6 bytes (like Ethernet and Token Ring).

### 3. Which field determines whether the frame contains asynchronous or synchronous data?

The Frame Control field indicates the size of the address fields, whether the frame contains asynchronous or synchronous data, and other control information

**4. What are two features that are both FDDI and Token Ring share?**

The two networks share a few features, such as topology (ring) and media access technique (token passing).

**5. What are the three advantages that optical fiber has over copper wiring?**

Optical fiber offers several advantages over traditional copper wiring, including such advantages as these:

- ⇒ Security. Fiber does not emit electrical signals that can be tapped.
- ⇒ Reliability. Fiber is immune to electrical interference.
- ⇒ Speed. Optical fiber has much higher throughput potential than copper cable.

**6. What network device must all network traffic pass through on a star topology?**

When a star topology is used, communication between devices attached to the LAN is via point-to-point wiring to the central link or hub. All network traffic in a star topology passes through the hub.

**7. What is the purpose of a NIC?**

A network interface card is a Layer 2 device that plugs into a motherboard and provides ports for network connection. This card can be designed as an Ethernet card, a Token Ring card, or an FDDI card. Network cards communicate with the network through serial connections and with the computer through parallel connections. They are the physical connections from workstations to the network.

**8. What are two reasons why LANs are segmented?**

The primary reason for segmenting a LAN is to isolate traffic between segments and to achieve more bandwidth per user by creating smaller collision domains. Segmentation also accommodates communication between a larger number of devices than could be supported on any single LAN connection.

**9. Ethernet uses which access method to detect errors within data packets or on the network?**

Ethernet uses CSMA/CD, a media-access mechanism wherein devices ready to transmit data first check the channel for a carrier. If no carrier is sensed for a specific period of time, a device can transmit. If two devices transmit at once, a collision occurs and is detected by all colliding devices. This collision subsequently delays retransmissions from those devices for some random length of time. CSMA/CD access is used by Ethernet and IEEE 802.3.

**10. Why is it cost efficient to have a switched LAN environment?**

A switched Ethernet LAN allows a LAN topology to work faster and more efficiently than a standard Ethernet LAN can because it uses bandwidth so efficiently. In a switched Ethernet implementation, the available bandwidth can reach close to 100 percent.

11. What is the name of the method used in Ethernet that explains how Ethernet works?
- A. TCP/IP
  - B. CSMA/CD**
  - C. CMDA/CS
  - D. CSMA/CA
12. What is the maximum distance for thick Ethernet without using a repeater?
- A. 185 m (606.95 feet)
  - B. 250 m (820.2 feet)
  - C. 500 m (1640.4 feet)**
  - D. 800 m (2624.64 feet)
13. 10 Mbps Ethernet operates within the timing limits offered by a series of not more than \_\_\_\_\_ segments separated by no more than \_\_\_\_\_ repeaters.
- A. Three, two
  - B. Four, three
  - C. Five, four**
  - D. Six, five
14. Fast Ethernet supports up to what transfer rate?
- A. 5 Mbps
  - B. 10 Mbps
  - C. 100 Mbps**
  - D. 1000 Mbps
15. Identify two Gigabit Ethernet cable specifications.
- A. 1000BASE-TX
  - B. 1000BASE-FX
  - C. 1000BASE-CS**
  - D. 1000BASE-LX**
  - E. 1000BASE-X
16. What is the transmission medium for 1000BASE-SX?
- A. Long-wave laser over single-mode and multimode fiber
  - B. Category 5 UTP copper wiring
  - C. Balanced, shielded, 150 ohm, two-pair STP copper cable

- D. Short-wave laser over multimode fiber**
17. 4D-PAM5 encoding is used in which of the following Gigabit Ethernet standards?  
 A. 1000BASE-LX  
 B. 1000BASE-SX  
**C. 1000BASE-T**  
 D. 1000BASE-CX
18. What is the IEEE standard for 10-Gigabit Ethernet?  
 A. 802.3z  
 B. 802.3u  
**C. 802.3ae**  
 D. 803.3
19. Which of the following do LAN switches use to make the forwarding decision?  
 A. IP address  
**B. MAC address**  
 C. Network address  
 D. Host address
20. Which of the following is a feature of full-duplex transmission?  
 A. It offers two 10- to 1-Gbps data-transmission paths.  
 B. It doubles bandwidth between nodes.  
 C. It provides collision-free transmission.  
**D. All of the above.**
21. The three common types of switching methods are \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
- Answer: store-and-forward, cut-through, and fragment-free**
22. The STP allows which of the following?  
 A. Bridges to communicate Layer 3 information  
**B. A redundant network path without suffering the effects of loops in the network**  
 C. Static network paths for loop prevention  
 D. None of the above
23. Which of the following is *not* one of the STP port states?  
 A. Blocking  
 B. Learning  
 C. Listening  
**D. Transmitting**
24. Which of the following is true concerning a bridge and its forwarding decisions?  
 A. Bridges operate at OSI Layer 2 and use IP addresses to make decisions.

- B. Bridges operate at OSI Layer 3 and use IP addresses to make decisions.
  - C. Bridges operate at OSI Layer 2 and use MAC addresses to make decisions.**
  - D. Bridges operate at OSI Layer 3 and use MAC addresses to make decisions.
25. Which of the following is *not* a feature of bridges?
- A. They operate at Layer 2 of the OSI model.
  - B. They are more intelligent than hubs.
  - C. They do not make forwarding decisions.**
  - D. They build and maintain address tables.
26. Which of the following statements is true of microsegmentation?
- A. Each workstation gets its own dedicated segment through the network.**
  - B. All the workstations are grouped as one segment.
  - C. Microsegmentation increases the number of collisions on a network.
  - D. None of the above.
27. Which of the following is true for LAN switches?
- A. They repair network fragments known as microsegments.
  - B. They are high-speed multiport bridges.**
  - C. Lower bandwidth makes up for higher latency.
  - D. They require new network interface cards on attached hosts.
28. **What does ASIC stand for?**
- A. Application-specific interface card
  - B. Asymmetrical integrated circuit
  - C. Application-specific integrated circuit**
  - D. Automatically scalable interchange circuit
29. Which of the following is *not* a feature of microsegmentation?
- A. It enables dedicated access.
  - B. It supports multiple conversations at any given time.
  - C. It increases the capacity for each workstation connected to the network.
  - D. It increases collisions.**

## CCNA Exam Review Questions

The following questions help you prepare for the CCNA exam. Answers appear in Appendix B, "CCNA Exam Review Questions Answer Key."

1. Which of the following best describes the data link layer of the OSI model?
  - A. It transmits data to other network layers.
  - B. It provides services to application processes.
  - C. It takes weak signals, cleans them, amplifies them, and sends them on their way across the network.
  - D. It provides reliable transit of data across a physical link.
  
2. Which layer provides reliable transit of data across a physical link?
  - A. Data link
  - B. Physical
  - C. Application
  - D. Transport
  
3. Which of the following processes is the data link layer concerned with?
  - A. Physical addressing, network topology, line discipline, error notification, ordered delivery of frames, and flow control
  - B. Establishing, managing, and terminating sessions between applications and managing data exchange between presentation layer entities
  - C. Synchronizing cooperating applications and establishing agreement on procedures for error recovery and control of data integrity
  - D. Providing mechanisms for the establishment, maintenance, and termination of virtual circuits, transport fault detection, recovery, and information flow control
  
4. Physical addressing and network topology are handled by which layer?
  - A. Physical
  - B. Presentation
  - C. Data link
  - D. Session
  
5. On a network, where does a device connect to the media?
  - A. Ethernet card
  - B. Hub
  - C. Router
  - D. Network interface card
  
6. What is another name for the MAC address?
  - A. Binary address
  - B. Octadecimal address

- C. Physical address
  - D. TCP/IP address
7. In which layer is the MAC address located?
- A. Session
  - B. Data link
  - C. Physical
  - D. Transport
8. What does MAC address stand for?
- A. Macintosh Access Capable
  - B. Mainframe Advisory Council
  - C. Media Access Control
  - D. Machine Application Communication
9. Which of the following items is located in the data link layer?
- A. Destination
  - B. Peripheral
  - C. Repeater
  - D. MAC address
10. What is required for every port or device that connects to a network?
- A. Repeater
  - B. Termination
  - C. MAC or physical address
  - D. ATM switch
11. Which of the following best describes MAC addressing?
- A. Addresses reside in the network interface card and the manufacturers assign them.
  - B. The IEEE committee assigns addresses and the network administrator must request them.
  - C. The distance of the computer from the network hub determines addresses.
  - D. Addresses are given to every computer when it is manufactured.
12. How does a source device locate the destination for data on a network?
- A. The network interface card at the destination identifies its MAC address in a data packet.
  - B. A data packet stops at the destination.
  - C. The network interface card at the destination sends its MAC address to the source.
  - D. The source sends a unique data packet to each MAC address on the network.

13. Which of the following best describes internetworking devices?
- A. Products that determine the optimal path along which network traffic should be forwarded
  - B. Products that contain multiple independent, connected modules of network equipment
  - C. Network connections or a junction that is common to two or more lines in a network
  - D. Products that are used to connect separate networks to each other