

## Chapter 2 (CCNA1 – Module 2)

### Networking Fundamentals

Data networks developed as a result of business applications that had been written for microcomputers. At the time, microcomputers were not connected as mainframe computer terminals were, so there was no efficient way of sharing data between multiple microcomputers. Businesses needed a solution that would successfully address the following three questions:

- How to avoid duplication of equipment and resources
- How to communicate efficiently
- How to set up and manage a network

Local-area networks (LANs) are high-speed, low-error data networks that cover a relatively small geographic area (up to a few thousand meters). LANs connect workstations, peripherals, terminals, and other devices in a single building or another geographically limited area. LANs provide multiple-connected desktop devices (usually PCs) with access to high-bandwidth media. LANs connect computers and services to a common Layer 1 media.

The OSI reference model is a descriptive network scheme whose standards ensure greater compatibility and interoperability between various types of network technologies. Further, the OSI reference model is a way of illustrating how information travels through networks. It is a conceptual framework specifying the network functions that occur at each layer. The OSI model describes how information or data makes its way from application programs (such as spreadsheets) through a network medium (such as wires) to another application program that is located on another computer on a network.

### Concept Questions

Demonstrate your knowledge of network fundamentals by answering the following questions in the space provided.

1. What are the major characteristics of a LAN?  
**A LAN is a high-speed, low-error data network covering a relatively small geographic area (up to a few thousand meters). LAN standards specify cabling and signaling at the physical and data link layers of the OSI model. Ethernet, FDDI, and Token Ring are widely used LAN technologies**
2. What are the major components of the average LAN?  
**LANs connect workstations, peripherals, terminals, and other devices in a single building or other geographically limited area.**

**The ISO recognized the need to create a network model that would help vendors create interoperable network implementations and released the OSI reference model in 1984.**

3. The OSI reference model is a descriptive network scheme whose standards ensure greater compatibility and interoperability between various types of network technologies. **Why is such a standard necessary?**

**In the early days of networking, it became harder for networks that used different specifications and implementations to communicate with each other. They realized that they needed to move away from proprietary networking systems. The ISO created a network model that could help vendors create networks that would be compatible with, and interoperate with, other networks.**

4. The OSI reference model organizes distinct functions of a network into seven numbered layers. **Briefly describe what each layer does.**

#### **Layer 7: The application layer**

**The application layer establishes the availability of intended communication partners. It also synchronizes and establishes an agreement on procedures for error recovery and control of data integrity. The application itself is not working at the application layer, rather it is the protocols in the background working at the application layer. For example Internet Explorer does not necessarily operate at the application layer rather it is HTTP, FTP and others that operate there. Examples of other applications at Layer 7 are spreadsheet programs, word processing programs, and bank terminal programs.**

#### **Layer 6: The presentation layer**

**The presentation layer ensures that the information that the application layer of one system sends out is readable by the application layer of another system. If necessary, the presentation layer translates between multiple data formats by using a common format. This layer also is responsible for compression and encryption.**

#### **Layer 5: The session layer**

**The session layer establishes, manages, and terminates sessions between two communicating hosts. The session layer provides its services to the presentation layer. It also synchronizes dialog between the two hosts' presentation layers and manages their data exchange. In addition to session regulation, the session layer offers provisions for efficient data transfer, class of service, and exception reporting of session layer, presentation layer, and application layer problems.**

#### **Layer 4: The transport layer**

**The transport layer segments data from the sending host's system and reassembles the data into a data stream on the receiving host's system. The transport layer attempts to provide a data transport service that shields the**

upper layers from transport implementation details. The transport layer establishes, maintains, and properly terminates connection-oriented circuits. To provide reliable service, transport error detection and recovery is used as well as information flow control.

### **Layer 3: The network layer**

The network layer is a complex layer that provides connectivity and path selection between two host systems that might be located on geographically separated networks. Path selection, routing, and logical addressing all take place at the network layer.

### **Layer 2: The data link layer**

The data link layer provides the transit of data across a physical link. In so doing, the data link layer is concerned with physical (as opposed to logical) addressing, network (sometimes called *logical*) topology, network media access, and error detection.

### **Layer 1: The physical layer**

The physical layer defines the electrical, mechanical, procedural, and functional specifications for activating, maintaining, and deactivating the physical link between end systems. Such characteristics as voltage levels, timing of voltage changes, physical data rates, maximum transmission distances, physical connectors, and other, similar, attributes are defined by physical layer specifications.

5. Session layer functions coordinate communication interactions between applications. **Give an example of how these communication interactions are coordinated.**

Communication sessions consist of service requests and service responses that occur between applications located in different network devices. These requests and responses are coordinated by protocols implemented at the session layer. Some examples of session layer implementations include Zone Information Protocol (ZIP); the AppleTalk protocol, which coordinates the name-binding process; and Session Control Protocol (SCP), the DECnet Phase IV session layer protocol.

Layer 6 of the OSI reference model, the presentation layer, provides code formatting and conversion. Code formatting is used to make sure that applications have meaningful information to process. If necessary, this layer can translate between different data formats.

The presentation layer is not only concerned with the format and representation of data. It also is concerned with the data structure that the programs used. Thus, Layer 6 arranges for Layer 7 how data will be organized when it is transferred.

6. Layer 6 standards also guide how graphic images are presented. What standards for graphic images do Layer 6 employ?

**PICT**—A picture format used to transfer QuickDraw graphics between programs on the MAC operating system

**Tagged Image File Format (TIFF)**—A format for high-resolution, bitmapped images

**Joint Photographic Experts Group (JPEG)**—A graphics format used most often to compress still images of complex pictures and photographs

**Musical Instrument Digital Interface (MIDI)**—Standard for digitized music

**Motion Picture Experts Group (MPEG)**—Standard for the compression and coding of motion video for CDs and digital storage

**QuickTime**—Standard that handles audio and video for programs on both MAC and PC operating systems

7. Explain how Layer 6 structures the data for Layer 7 to transfer.

**After receiving data from the application layer, the presentation layer performs one or all of its functions on the data before it sends it to the session layer. At the receiving station, the presentation layer takes the data from the session layer and performs the required functions before passing it to the application layer.**

- **Data formatting (presentation)**
- **Data encryption**
- **Data compression**

### Vocabulary Exercise

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

**ASCII (American Standard Code for Information Interchange)**—American Standard Code for Information Interchange. An 8-bit code for character representation (7 bits plus parity).

**AUI (attachment unit interface)**—IEEE 802.3 interface between a media attachment unit (MAU) and a network interface card (NIC). The term AUI also can refer to the rear panel port to which an AUI cable might attach, such as those found on a Cisco LightStream Ethernet access card. Also called *transceiver cable*.

**Bandwidth**—A bandwidth is the amount of information that can flow through a network connection in a given period of time.

**Bridge**—Device that connects and passes packets between two network segments that use the same communications protocol. Bridges operate at the data link layer (Layer 2) of

the OSI reference model. In general, a bridge will filter, forward, or flood an incoming frame based on the MAC address of that frame.

**Broadcast**—Data packet that are sent to all nodes on a network. Broadcasts are identified by a broadcast address.

**Broadcast domain**—Set of all devices that receive broadcast frames originating from any device within the set.

**Collision**—In Ethernet, the result of two nodes transmitting simultaneously. The frames from each device impact and are damaged when they meet on the physical media.

**Collision domain**—In Ethernet, the network area within which frames that have collided are propagated. Repeaters and hubs propagate collisions; LAN switches, bridges, and routers do not.

**Compression**—The running of a data set through an algorithm that reduces the space required to store or the bandwidth required to transmit the data set.

**content network (CN)**—A content network (CN) is a globally coordinated network of devices designed to accelerate the delivery of information over the Internet infrastructure.

**Datagram**—Logical grouping of information sent as a network layer unit over a transmission medium without prior establishment of a virtual circuit. IP datagrams are the primary information units in the Internet.

**Dialog separation**—The orderly initiation, termination, and management of communication.

**EBCDIC (Extended Binary Coded Decimal Interchange Code)**—Extended binary coded decimal interchange code. Any of a number of coded character sets developed by IBM consisting of 8-bit coded characters. This character code is used by older IBM systems and telex machines.

**Encapsulation**—The wrapping of data in a particular protocol header. For example, Ethernet data is wrapped in a specific Ethernet header before network transit. Also, when bridging dissimilar networks, the entire frame from one network is just placed in the header used by the data link layer protocol of the other network.

**Encryption**—The application of a specific algorithm to data so as to alter the appearance of the data making it incomprehensible to those who are not authorized to see the information.

**Extranet**—Refer to the applications and services that were intranet based, but that employed extended, secure access to external users or enterprise.

**Firewall**—A system designed to prevent unauthorized access to or from a private network. Firewalls can be implemented in both hardware and software, or a combination of both.

**Flooding**—Traffic passing technique used by switches and bridges in which traffic received on an interface is sent out all the interfaces of that device except the interface on which the information was received originally.

**Frame**—Logical grouping of information sent as a data link layer unit over a transmission medium. Often refers to the header and trailer that surround the user data contained in the unit (used for synchronization and error control).

**Hub**—1) Generally, a term used to describe a device that serves as the center of a star topology network. 2) Hardware or software device that contains multiple independent but connected modules of network and internetwork equipment. Hubs can be active (where they repeat signals sent through them) or passive (where they do not repeat, but merely split, signals sent through them). 3) In Ethernet and IEEE 802.3, an Ethernet multiport repeater, sometimes referred to as a *concentrator*.

**IEEE 802.3**—IEEE LAN protocol that specifies an implementation of the physical layer and the MAC sublayer of the data link layer. IEEE 802.3 uses carrier sense multiple access collision detect (CSMA/CD) access at a variety of speeds over a variety of physical media. Extensions to the IEEE 802.3 standard specify implementations for Fast Ethernet.

**Intranet**—One common configuration of a LAN. Intranets are designed to be accessed by users who have access privileges to an organization's internal LAN.

**LAN (local-area network)**—A LAN is a high-speed, low-error data network covering a relatively small geographic area (up to a few thousand meters). LANs connect workstations, peripherals, terminals, and other devices in a single building or other geographically limited area. LAN standards specify cabling and signaling at the physical and data link layers of the OSI model. Ethernet, FDDI, and Token Ring are widely used LAN technologies.

**Layer 1: Physical**—The physical layer defines the electrical, mechanical, procedural, and functional specifications for activating, maintaining, and deactivating the physical link between end systems.

**Layer 2: Data Link**—This layer provides reliable transit of data across a physical link. The data link layer is concerned with physical addressing, network topology, line discipline, error notification, ordered delivery of frames, and flow control. The IEEE has divided this layer into two sublayers: the MAC sublayer and the LLC sublayer.

**Layer 3: Network**—This layer provides connectivity and path selection between two end systems. The network layer is the layer at which routing occurs.

**Layer 4: Transport**—This layer is responsible for reliable network communication between end nodes. The transport layer provides mechanisms for the establishment, maintenance, and termination of virtual circuits, transport fault detection and recovery, and information flow control.

**Layer 5: Session**—This layer establishes, manages, and terminates sessions between applications and manages data exchange between presentation layer entities.

**Layer 6: Presentation**—This layer ensures that information sent by the application layer of one system will be readable by the application layer of another. The presentation layer also is concerned with the data structures used by programs and therefore negotiates data transfer syntax for the application layer.

**Layer 7: Application**—This layer provides services to application processes (such as electronic mail, file transfer, and terminal emulation) that are outside of the OSI model. The application layer identifies and establishes the availability of intended communication partners (and the resources required to connect with them), synchronizes cooperating applications, and establishes agreement on procedures for error recovery and control of data integrity.

**MAC address**—Standardized data link layer address that is required for every port or device that connects to a LAN. Other devices in the network use these addresses to locate specific ports in the network and to create and update routing tables and data structures. MAC addresses are 6 bytes long and are controlled by the IEEE. Also known as a *hardware address*, a *MAC-layer address*, or a *physical address*.

**MAU (media attachment unit)**—Device used in Ethernet and IEEE 802.3 networks that provides the interface between the AUI port of a station and the common medium of the Ethernet. The MAU, which can be built into a station or can be a separate device, performs physical layer functions, including the conversion of digital data from the Ethernet interface, collision detection, and injection of bits onto the network. Sometimes referred to as a *transceiver*. In Token Ring, a MAU is known as a *multistation access unit* and is usually abbreviated *MSAU* to avoid confusion.

**Media**—Plural of *medium*. The various physical environments through which transmission signals pass. Common network media include twisted-pair, coaxial and fiber-optic cable, and the atmosphere (through which microwave, laser, and infrared transmission occurs). Sometimes called *physical media*.

**Medium**—Refers to various physical environments through which transmission signals pass. Common network media include twisted-pair, coaxial, and fiber-optic cable, and the atmosphere (through which microwave, laser, and infrared transmission occurs).

**Metropolitan-area network (MAN)**—A network that spans a metropolitan area. Generally, a MAN spans a larger geographic area than a LAN, but a smaller geographic area than a WAN.

**NIC (network interface card)** —Board that provides network communication capabilities to and from a computer system. Also called an *adapter*.

**Packet**—Logical grouping of information that includes a header containing control information and (usually) user data. Packets are most often used to refer to network layer units of data.

**Peer-to-peer**—Computing calls for each network device to run both client and server portions of an application. Also describes communication between implementations of the same OSI reference model layer in two different network devices.

**Protocol**—1) Formal description of a set of rules and conventions that govern how devices on a network exchange information. 2) Field within an IP datagram that indicates the upper-layer (Layer 4) protocol sending the datagram.

**RAM (random-access memory)**—Volatile memory that can be read and written by a microprocessor.

**ROM (read-only memory)**—Nonvolatile memory that can be read, but not written, by the microprocessor.

**Router**—Network layer device that uses one or more metrics to determine the optimal path along which network traffic should be forwarded. Routers forward packets from one network to another based on network layer information. Occasionally called a *gateway* (although this definition of gateway is becoming increasingly outdated).

**Switch**—1) Network device that filters, forwards, and floods frames based on the destination address of each frame. The switch operates at the data link layer of the OSI model. 2) General term applied to an electronic or mechanical device that allows a connection to be established as necessary and terminated when there is no longer a session to support.

**Segment**—1) Section of a network that is bounded by bridges, routers, or switches. 2) In a LAN using a bus topology, a segment is a continuous electrical circuit that is often connected to other such segments with repeaters. 3) Term used in the TCP specification to describe a single transport layer unit of information.

**Session**—1) Related set of communications transactions between two or more network devices. 2) In SNA, a logical connection enabling two MAUs to communicate.

**Storage-area network (SAN)** —A storage-area network (SAN) is a dedicated, high-performance network used to move data between servers and storage resources.

**Throughput**—refers to the rate of information arriving at, and possibly passing through, a particular point in a network system.

**TCP/IP (Transmission Control Protocol/Internet Protocol)**—Common name for the suite of protocols developed by the U.S. Department of Defense in the 1970s to support the construction of worldwide internetworks. TCP and IP are the two best-known protocols in the suite.

**TCP/IP application layer**—The designers of TCP/IP thought that the higher level protocols should include the session and presentation layer details. They just created an application layer that handles high-level protocols, issues of representation, encoding, and dialog control. The TCP/IP combines all application-related issues into one layer and ensures this data is properly packaged for the next layer. This is also referred to as the *process layer*.

**TCP/IP Internet layer**—The purpose of the Internet layer is to send source packets from any network on the internetwork and have them arrive at the destination independent of the path and networks they took to get there. The specific protocol that governs this layer is called the Internet Protocol (IP). Best path determination and packet switching occur at this layer. Think of it in terms of the postal system.

When you mail a letter, you do not know how it gets there (there are various possible routes), but you do care that it arrives.

**TCP/IP network layer**—The name of this layer is broad and somewhat confusing. It also is called the *host-to-network layer*. Sometimes, it's shown as two layers, as in the OSI

model. The network access layer is concerned with all the issues that an IP packet requires to actually cross a physical link from one device to a directly connected one. It includes the LAN and WAN technology details, and all the details in the OSI physical and data link layers.

**TWS (two-way simultaneous)**—Mode that allows a router configured as a primary SDLC station to achieve better utilization of a full-duplex serial line. When TWS is enabled in a multidrop environment, the router can poll a secondary station and receive data from that station while it sends data to or receives data from a different secondary station on the same serial line.

## Focus Questions

1. Briefly list six reasons why a layered network model is used in internetworking.
  - **It breaks network communication into smaller, simpler parts that are easier to develop.**
  - **It facilitates standardization of network components to allow multiple vendor development and support.**
  - **It allows different types of network hardware and software to communicate with each other.**
  - **It prevents changes in one layer from affecting the other layers so that they can develop more quickly.**
  - **It breaks network communication into smaller parts to make learning it easier to understand.**
  - **It accelerates the development of future networking products.**
  
2. From memory, list the seven layers of the OSI model and briefly describe their function.

**Layer 7: Application**—This layer provides services to application processes (such as electronic mail, file transfer, and terminal emulation) that are outside of the OSI model. The application layer identifies and establishes the availability of intended communication partners (and the resources required to connect with them), synchronizes cooperating applications, and establishes agreement on procedures for error recovery and control of data integrity.

**Layer 6: Presentation**—This layer ensures that information sent by the application layer of one system will be readable by the application layer of another. The presentation layer also is concerned with the data structures used by programs and therefore negotiates data transfer syntax for the application layer.

**Layer 5: Session**—This layer establishes, manages, and terminates sessions between applications and manages data exchange between presentation layer entities.

**Layer 4: Transport—This layer is responsible for reliable network communication between end nodes. The transport layer provides mechanisms for the establishment, maintenance, and termination of virtual circuits, transport fault detection and recovery, and information flow control.**

**Layer 3: Network—This layer provides connectivity and path selection between two end systems. The network layer is the layer at which routing occurs.**

**Layer 2: Data Link—This layer provides reliable transit of data across a physical link. The data link layer is concerned with physical addressing, network topology, line discipline, error notification, ordered delivery of frames, and flow control. The IEEE has divided this layer into two sublayers: the MAC sublayer and the LLC sublayer.**

**Layer 1: Physical—The physical layer defines the electrical, mechanical, procedural and functional specifications for activating, maintaining, and deactivating the physical link between end systems.**

3. What is meant by the term *peer-to-peer communication*?  
**Each layer of the OSI model at the source must communicate with its peer layer at the destination.**
4. Briefly describe the process of data encapsulation using the following terms: *data*, *segment*, *packet*, *frame*, and *bits*.
- **Build the data.** As a user sends an e-mail message, its alphanumeric characters are converted to data that can travel across the internetwork.
  - **Package the data for end-to-end transport.** The data is packaged for internetwork transport. By using segments, the transport function ensures that the message hosts at both ends of the e-mail system can reliably communicate.
  - **Add the network address to the header.** The data is put into a packet or a datagram that contains a network header with source and destination logical addresses. These addresses help network devices send the packets across the network along a dynamically chosen path.
  - **Append (add) the local address to the data link header.** Each network device must put the packet into a frame. The frame includes a header with the physical address of the next directly connected device in the path.
  - **Convert to bits for transmission.** The frame must be converted into a pattern of 1s and 0s (bits) for transmission on the medium (usually a wire). A clocking function enables the devices to distinguish these bits as they travel across the medium. The medium on the physical internetwork can vary along the path used. For example, the e-mail message can originate on a LAN, cross a campus backbone, and go out a WAN link on its way toward its destination on another remote LAN.

5. Describe the information that is added to the data packet as it is encapsulated in the transport, network, and data link layers.  
**Encapsulation wraps data with the necessary protocol information before network transit. Therefore, as the data packet moves down through the layers of the OSI model, it receives headers, trailers, and other information.**
  
6. What is the OSI reference model?  
**The Open System Interconnection reference model is a network architectural model developed by ISO and ITU-T. The model consists of seven layers, each of which specifies particular network functions such as addressing, flow control, error control, encapsulation, and reliable message transfer. The highest layer (the application layer) is closest to the user; the lowest layer (the physical layer) is closest to the media technology. The two lowest layers are implemented in hardware and software, whereas the upper five layers are implemented only in software. The OSI reference model is used universally as a way to teach and understand network functionality.**
  
7. Will networks that are built following the OSI model be identical? Explain.  
**Networks that are built following the OSI model will not be identical; however, there will be a much greater likelihood for interoperability. The OSI provides vendors with a set of standards that could enable greater compatibility and interoperability between the various types of network technologies. This will allow dissimilar networks to coexist.**
  
8. What process does the OSI model describe?  
**The OSI model describes the process of breaking down a complex process into smaller, more easily defined steps. This allows for the creation of standards that help provide greater compatibility and interoperability between various types of network technologies.**
  
9. What is the importance of the TCP/IP model?  
**The TCP/IP reference model and the TCP/IP protocol stack make data communication possible between any two computers, anywhere in the world, at nearly the speed of light. The TCP/IP model has historical importance, just like the standards that allowed the telephone, electrical power, railroad, television, and videotape industries to flourish.**
  
10. How does the OSI model compare with the TCP/IP model?  
**The OSI model attempts to explain how various network technologies work together to transport valuable data. The OSI model is protocol independent, unlike the TCP/IP reference model. The U.S. Department of Defense created the**

**TCP/IP reference model, which became the standard that facilitated the growth of the Internet.**

11. What are the functions and OSI layer of computers, clients, servers, printers, and relational databases?

**Devices that connect directly to a network segment often are referred to as *hosts*. These hosts include computers (both clients and servers), printers, scanners, and many other user devices. The host devices can exist without a network, but its capabilities are greatly limited. Host devices are not part of any layer. They have a physical connection to the network media by having a NIC, and the functions of the other OSI layers are performed in software inside the host. This means that they operate at all seven layers of the OSI model.**

**The basic function of computers on the LAN is to provide the user with an almost limitless set of opportunities. Modern software, microelectronics, and a relatively small amount of money enable you to run word processing, presentation, spreadsheet, and database programs. They also enable you to run a web browser, which gives you almost instant access to information via the World Wide web. You can send e-mail, edit graphics, save information in databases, play games, and communicate with other computers around the world.**

12. What is the purpose and OSI layer of network interface cards in a LAN?  
**NICs are considered Layer 2 devices because each individual NIC throughout the world carries a unique code, called a *Media Access Control (MAC)* address. This address is used to control data communication for the host on the network. The NIC is the basic hardware component of network communications. It translates the parallel signal produced by the computer into the serial format that is sent over the network cable.**
13. What are the different symbols used for media in a LAN?  
**The symbols for media vary. For example, the Ethernet symbol is typically a straight line with perpendicular lines projecting from it; the Token Ring network symbol is a circle with hosts attached to it; and for FDDI, the symbol is two concentric circles with attached devices. The basic functions of media are to carry a flow of information, in the form of bits, through a LAN. Other than wireless LANs (that use the atmosphere, or space, as the medium), networking media confine network signals to wire, cable, or fiber. Networking media are considered Layer 1 components of LANs.**
14. What is the symbol and purpose of a repeater?  
**The symbol for repeaters is not standardized. The purpose of a repeater is to regenerate and retime network signals at the bit level to allow them to travel a longer distance on the media.**
15. What is the function of a hub?  
**Generally speaking, the term *hub* is used rather than *repeater* when referring to the device that serves as the center of a network. The purpose of a hub is to regenerate and retime network signals. Whereas a repeater typically has only 2 ports, a hub generally has from 4 to 20 or more ports. Hubs are considered Layer 1 devices because they regenerate only the signal and repeat it out all of their ports (network connections). The symbol for a hub is not standardized.**
16. What is the purpose of a bridge?  
**A bridge is a Layer 2 device designed to create two or more LAN segments, each of which is a separate collision domain. The purpose of a bridge is to filter traffic on a LAN—to keep local traffic local—yet allow connectivity to other parts (segments) of the LAN for traffic that is directed there.**
17. What is the purpose of a switch?  
**A switch is a Layer 2 device just as a bridge is. In fact, a switch is sometimes called a *multiport bridge*, just like a hub is called a *multiport repeater*. The difference between the hub and the switch is the same as the difference between a repeater and a bridge: Switches make decisions based on MAC addresses, and**

**hubs don't make decisions at all. The arrows on top represent the separate paths data can take in a switch, unlike the hub, where all data flows on all paths.**

18. What is the purpose of a router?

**The purpose of a router is to examine incoming packets (Layer 3 data), choose the best path for them through the network, and then switch them to the proper outgoing port. Routers are the most important traffic-regulating devices on large networks.**

19. What does the cloud in a network topology suggest?  
**The cloud symbol suggests another network, or perhaps the entire Internet. It reminds you that there is a way to connect to that other network (for example, the Internet), but does not supply all the details of either the connection or the network. Because the cloud is not really a single device, but represents a collection of devices that operate at all levels of the OSI model, it could be classified as a Layer 1 through 7 device.**
20. What is the purpose of network segments?  
**A network segment is commonly defined as an area that makes up a collision domain. Historically, a segment identifies the Layer 1 media that is the common path for data transmission in a LAN. There is a maximum length for data transmission on each type of media. Each time an electronic device is used to extend the length or to manage data on the media, a new physical segment is created.**
21. What is a linear bus network topology?  
**The bus topology has all its nodes connected directly to one link, and has no other connections between nodes. Each host is wired to a common wire. One advantage of this topology is that all hosts are connected to each other, and thus can communicate directly. One disadvantage of this topology is that a break in the cable disconnects hosts from each other.**
22. What is a ring network topology?  
**A ring topology is a single closed ring consisting of nodes and links, with each node connected to only two adjacent nodes. The topology shows all devices wired directly to each other in what is called a *daisy-chain*.**
23. Are the rings of a dual-ring network topology connected? Why or why not?  
**The two rings are not connected. A dual-ring topology is the same as a ring topology, except that a second, redundant ring connects the same devices.**
24. Where is the node of a star network topology located?  
**A star topology has a central node with all links to other nodes radiating from it and allows no other links.**
25. Where does each node link in an extended star network topology?  
**An extended star topology has a core star topology, with each of the end nodes of the core topology acting as the center of its own star topology.**
26. Which of the following are Layer 5 protocols?  
A. (NFS) Network File System

- B. (SQL) Structured Query Language**
- C. (RPC) Remote Procedure Call**

- D. X Window System
  - E. (ASP) AppleTalk Session Protocol
  - F. DNA (Digital Network Architecture)
  - G. SCP (Session Control Protocol)
27. In a session, checkpoints are used for what?  
**Check points are used to separate parts of a session, previously referred to as dialogues.**
28. When in the session layer, what are the responsibilities of both hosts when sending a message?  
**Host A session layer sends a synchronization message to host B, at which time both hosts perform the following routine:**
- a. Back up the particular files
  - b. Save the network settings
  - c. Save the clock settings
  - d. Make note of the endpoint in the conversation
29. What type of two-way communication is the session layer most involved in?  
**If two-way simultaneous communication is allowed, the session layer does little in the way of managing the conversation, and allows the other layers of the communicating computers to manage the conversation.**  
**Two way-alternate communication involves the use of a session layer data token, which allows each host to take turns. This is similar to the way a Layer 2 Token Ring handles Layer 1 collisions.**
30. What is the responsibility of the session layer?  
**The session layer establishes, manages, and terminates sessions between applications.**
31. When computers communicate with each other, what is the dialog process called that determines which computer takes on the role of the client and which takes on the role of the server?  
**Communication between two computers involves many mini-conversations, thus ensuring that the two computers can communicate effectively. One requirement of these mini-conversations is that each host plays dual roles: requesting service, like a client; and, replying with service, like a server. Determining which role they are playing at any given moment is called *dialog control*.**
32. What are the three functions of the presentation layer?  
**Data formatting (presentation)**

**Data encryption**

**Data compression**

33. At the receiving station, from which layer does the presentation layer get the data?  
**The presentation layer takes the data from the session layer and performs the required functions before passing it to the application layer.**

34. What types of computers most often use EBCDIC?  
**EBCDIC is used by older IBM systems and telex machines.**
35. What is a JPEG?  
**JPEG (Joint Photographic Experts Group) is a graphics format used most often to compress still images of complex pictures and photographs**
36. In the presentation layer, what does the algorithm search for to help shrink the size of a file?  
**The algorithm searches each file for repeating bit patterns and then replaces them with a token. A token is a much shorter bit pattern that represents the long pattern.**
37. What type of program uses binary files?  
**Programs such as FTP use the binary file type to transfer files. Networks use many different types of files.**
38. What two file formats does the Internet use to display images?  
**The Internet uses two binary file formats to display images: GIF and JPEG. Any computer with a reader for the GIF and JPEG file formats can read these file types, regardless of the type of computer.**
39. What type of file format is used as a set of directions for displaying a page on a web browser?  
**Hypertext Markup Language (HTML), the language of the Internet, tells a browser whether to display text or to provide a hyperlink to another URL. HTML is not a programming language, but it is a set of directions for displaying a page.**

## CCNA Exam Review Questions

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

1. What business problem resulting from the proliferation of standalone computers did networks solve?
  - A. Inability to communicate and lack of management
  - B. Losses due to lack of business by common carriers
  - C. Inefficient use of information technology professionals
  - D. Increasing level of electromagnetic interference
  
2. What did early networks allow?
  - A. Common carriers to finally make a profit
  - B. Workers to copy files onto floppy disks and then carry the disks to a coworker's PC to print
  - C. The duplication of resources to expand
  - D. The easy and efficient sharing of files and printers
  
3. Which of the following is *not* a problem that networking helped solve?
  - A. Lack of network management
  - B. Lack of new hardware and software products
  - C. Duplication of equipment and resources
  - D. Inability to communicate efficiently
  
4. Why is it desirable to network?
  - A. Don't have to duplicate equipment and resources
  - B. Makes it easy to communicate quickly and efficiently using standalone computers
  - C. Makes it easy to provide management for operating standalone computers
  - D. All of the above
  
5. Why is networking a variety of networks together difficult?
  - A. People try to network different types of computer systems together.
  - B. Emerging network technologies use different hardware and software specifications.
  - C. Incompatibility results from hardware changes.
  - D. Computer designers try to make their own protocols, and they are incompatible.
  
6. Why are networking standards needed?
  - A. Many networks now cover wide geographic areas.
  - B. Technologies must be compatible to allow communication.
  - C. Hardware and software are continually being redesigned.
  - D. LANs, MANs, and WANs use different kinds of equipment.

7. Why did networks experience problems in the mid-1980s?
  - A. Many new network technologies were incompatible.
  - B. Employees preferred sneaker net.
  - C. Common carriers went bankrupt.
  - D. Everyone used the same hardware and software.
  
8. Why did using different hardware and software cause problems after networks were established?
  - A. Networks cannot be formed if some people have Macs and others have PCs.
  - B. Different hardware and software did not provide auxiliary functions for the users.
  - C. Different hardware and software implementations used in the new technologies were incompatible.
  - D. Each department or business was unable to act as an electronic island; instead, the departments or businesses were forced to work together.
  
9. What is a LAN?
  - A. A network that connects workstations, terminals, and other devices in a geographically limited area
  - B. A network that connects workstations, terminals, and other devices in a metropolitan area
  - C. A network that serves users across a broad geographic area and often uses transmission devices that a common carrier provides
  - D. A network that covers a larger area than a MAN
  
10. Which of the following best describes a LAN?
  - A. A data network connecting workstations, peripherals, terminals, and other devices in a single building or other geographically limited area
  - B. A data network that connects workstations, peripherals, terminals, and other devices across a broad geographic area
  - C. A data network that connects workstations, peripherals, terminals, and other devices across a metropolitan area
  - D. A data network that connects workstations, peripherals, terminals and other devices within a single building
  
11. What is a network that connects computer equipment in a single building called?
  - A. LAN
  - B. WAN
  - C. MAN
  - D. DCN

12. Which of the following best defines *standards*?
- A. A set of rules or procedures that are either widely used or officially specified
  - B. A connection of computers, printers, and other devices for purposes of communication
  - C. A set of rules that govern how computer workstations exchange information
  - D. A device that is connected to a computer to provide auxiliary functions
13. What is the OSI model?
- A. A conceptual framework that specifies how information travels through networks
  - B. A model that describes how data makes its way from one application program to another through a network
  - C. A conceptual framework that specifies which network functions occur at each layer
  - D. All of the above
14. As described by the OSI model, how does data move across a network?
- A. Directly from each layer at one computer to the corresponding layers at another computer
  - B. Through wires connecting each layer from computer to computer
  - C. Down through the layers at one computer and up through the layers at another
15. Which best defines the function of the lower layers (called the media layers) of the OSI model?
- A. Provide for the accurate delivery of data between computers
  - B. Convert data into the 1s and 0s that a computer understands
  - C. Receive data from peripheral devices
  - D. Control the physical delivery of messages over the network
16. Which of the following describes the host layers of the OSI model?
- A. Control the physical delivery of messages over the network
  - B. Make up the lower layers in the OSI model
  - C. Contain data that is more like 1s and 0s than like human language
  - D. Provide for accurate delivery of data between computers
17. Which of the following best describes the purpose of the physical layer?
- A. Defines the electrical, mechanical, procedural, and functional specifications for activating, maintaining, and deactivating the link between end systems
  - B. Provides reliable transit of data across a physical link

- C. Provides connectivity and path selection between two end systems
  - D. Establishes, manages, and terminates sessions between applications and manages data exchange between presentation layer entities
18. Which layer of the OSI model is concerned with physical addressing, network topology, line discipline, and flow control?
- A. Physical layer
  - B. Data link layer
  - C. Transport layer
  - D. Network layer
19. Which layer of the OSI model provides connectivity and path selection between two end systems where routing occurs?
- A. Physical layer
  - B. Data link layer
  - C. Network layer
  - D. Transport layer
20. Which layer of the OSI model is responsible for reliable network communication between end nodes and provides mechanisms for the establishment, maintenance, and termination of virtual circuits, transport fault detection and recovery, and information flow control?
- A. Physical layer
  - B. Data link layer
  - C. Network layer
  - D. Transport layer
21. Which layer of the OSI model establishes, manages, and terminates sessions between applications and manages data exchange between presentation layer entities?
- A. Transport layer
  - B. Session layer
  - C. Presentation layer
  - D. Application layer
22. Which layer of the OSI model ensures that information sent by the application layer of one system will be readable by the application layer of another system, is concerned with the data structures used by programs, and negotiates data transfer syntax for the application layer?
- A. Transport layer
  - B. Session layer
  - C. Presentation layer
  - D. Application layer

23. Which layer of the OSI model identifies and establishes the availability of intended communication partners, synchronizes cooperating applications, and establishes agreement on procedures for error recovery and control of data integrity?
- A. Transport layer
  - B. Session layer
  - C. Presentation layer
  - D. Application layer
24. Which of the following best defines *encapsulation*?
- A. Segmenting data so that it flows uninterrupted through the network
  - B. Compressing data so that it moves more quickly
  - C. Moving data in groups so that it stays together
  - D. Wrapping of data in a particular protocol header
25. What analogy might be used to describe encapsulation?
- A. Encapsulation is like a blueprint for building a car.
  - B. Encapsulation is like sending a package through the mail.
  - C. Encapsulation is like building a fence around your backyard.
  - D. Encapsulation is like driving a car to the store to buy groceries.
26. What is a data packet?
- A. Logically grouped units of information
  - B. Transmission devices
  - C. Auxiliary function provided by peripherals
  - D. Virtual circuits
27. Which layer of the OSI model establishes, manages, and terminates communication between applications?
- A. Application
  - B. Presentation
  - C. Session
  - D. Transport
28. Which best describes the function of session layer?
- A. Establishes, manages, and terminates communications between applications
  - B. Supports communication between programs like electronic mail, file transfer, and web browsers
  - C. Provides transport services from the host to the destination
  - D. Translates between different data formats such as ASCII and EBCDIC

29. Which layer of the OSI model layer can translate between different data formats, such as ASCII and EBCDIC?
- A. Application
  - B. Presentation
  - C. Session
  - D. Transport
30. Which layer of the OSI model layer guides how graphic images, sound, and video are presented?
- A. Application
  - B. Presentation
  - C. Session
  - D. Transport
31. Which best describes the function of the presentation layer?
- A. Establishes, manages, and terminates applications
  - B. Supports communication between programs like electronic mail, file transfer, and web browsers
  - C. Guides how graphic images, sound, and video are handled
  - D. Provides transport services from the host to the destination
32. Which best describes the function of the presentation layer?
- A. Establishes, manages, and terminates applications
  - B. Supports communication between programs like electronic mail, file transfer, and web browsers
  - C. Provides transport services from the host to the destination
  - D. Translates between different data formats such as ASCII and EBCDIC
33. Which layer of the OSI model layer handles data encryption?
- A. Application
  - B. Presentation
  - C. Session
  - D. Transport
34. ASCII, encryption, QuickTime, and JPEG are all typical of which layer?
- A. Presentation
  - B. Transport
  - C. Application
  - D. Session