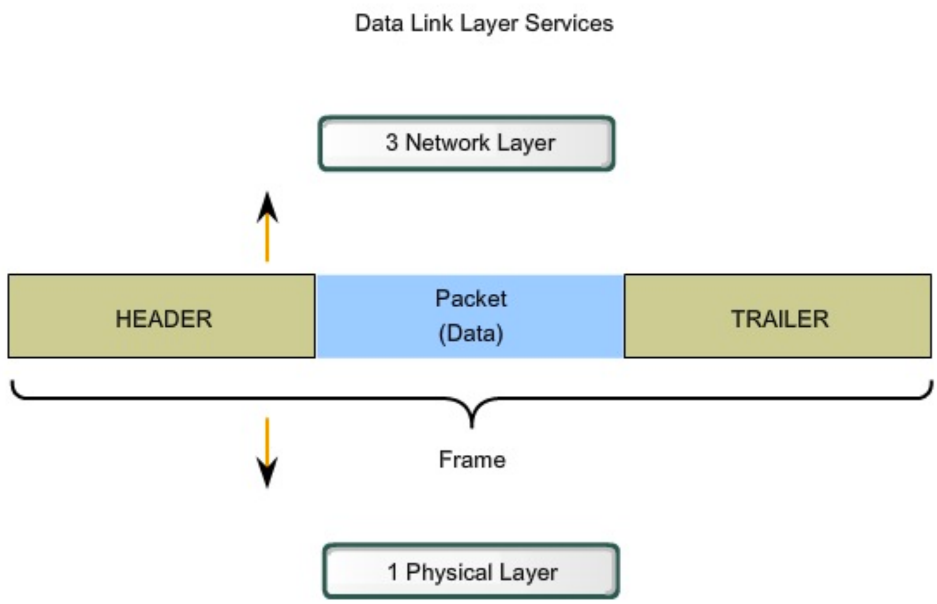
CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.1 Data Link Layer - Accessing the Media
7.1.3 Data Link Layer - Creating a Frame

Page 1:
The description of a frame is a key element of each Data Link layer protocol. Data Link layer protocols require control information to enable the protocols to function. Control information may tell:
- Which nodes are in communication with each other
- When communication between individual nodes begins and when it ends
- Which errors occurred while the nodes communicated
- Which nodes will communicate next

The Data Link layer prepares a packet for transport across the local media by encapsulating it with a header and a trailer to create a frame.

Unlike the other PDUs that have been discussed in this course, the Data Link layer frame includes:
- Data - The packet from the Network layer
- Header - Contains control information, such as addressing, and is located at the beginning of the PDU
- Trailer - Contains control information added to the end of the PDU

These frame elements will be discussed in more detail later in this chapter.



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7 Data Link Layer
7.1 Data Link Layer - Accessing the Media
7.1.3 Data Link Layer - Creating a Frame

Page 2:
Formatting Data for Transmission

When data travels on the media, it is converted into a stream of bits, or 1s and 0s. If a node is receiving long streams of bits, how does it determine where a frame starts and stops or which bits represent the address?

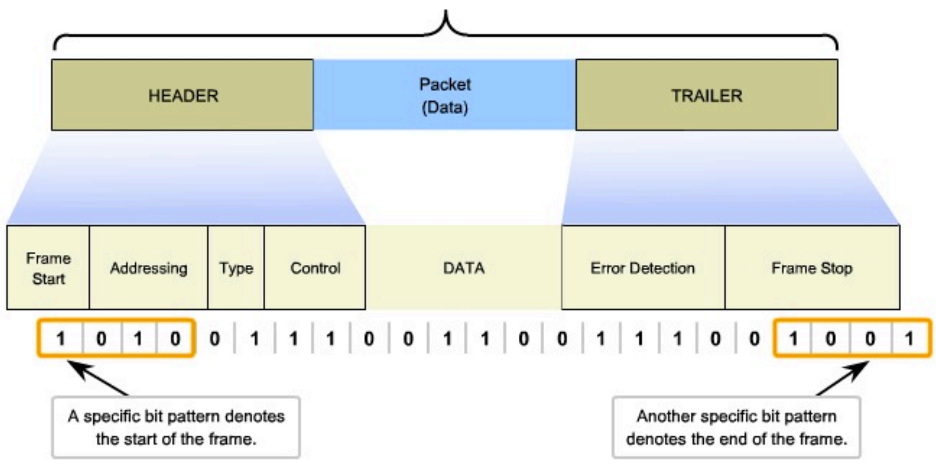
Framing breaks the stream into decipherable groupings, with control information inserted in the header and trailer as values in different fields. This format gives the physical signals a structure that can be received by nodes and decoded into packets at the destination.

Typical field types include:
- Start and stop indicator fields - The beginning and end limits of the frame
- Naming or addressing fields
- Type field - The type of PDU contained in the frame
- Control - Flow control services
- A data field -The frame payload (Network layer packet)

Fields at the end of the frame form the trailer. These fields are used for error detection and mark the end of the frame.

Not all protocols include all of these fields. The standards for a specific Data Link protocol define the actual frame format. Examples of frame formats will be discussed at the end of this chapter.

Formatting Data for Transmission



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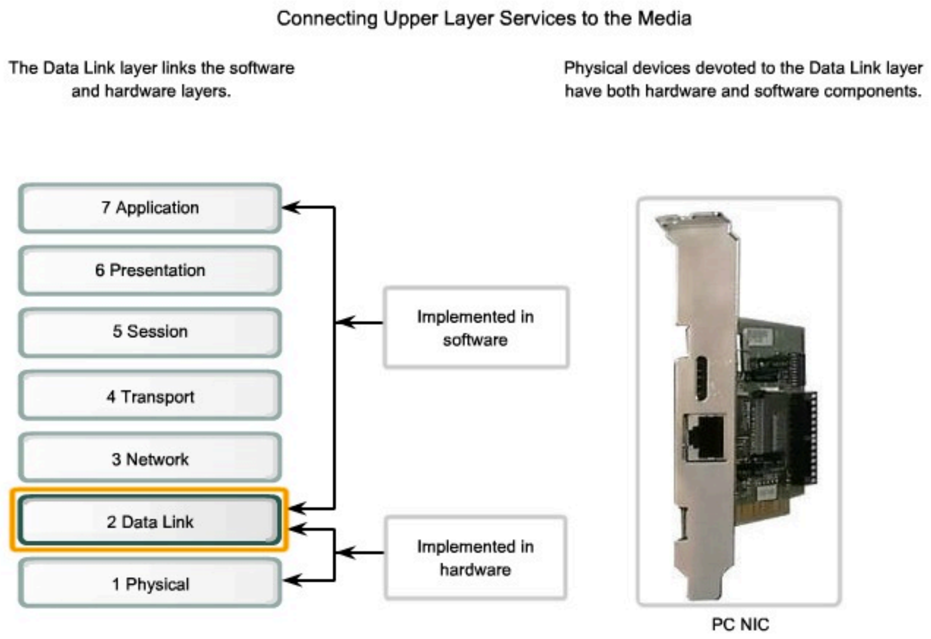
7 Data Link Layer

7.1 Data Link Layer - Accessing the Media

7.1.4 Data Link Layer - Connecting Upper Layer Services to the Media

Page 1:
The Data Link layer exists as a connecting layer between the software processes of the layers above it and the Physical layer below it. As such, it prepares the Network layer packets for transmission across some form of media, be it copper, fiber, or the atmosphere.

In many cases, the Data Link layer is embodied as a physical entity, such as an Ethernet network interface card (NIC), which inserts into the system bus of a computer and makes the connection between running software processes on the computer and physical media. The NIC is not solely a physical entity, however. Software associated with the NIC enables the NIC to perform its intermediary functions of preparing data for transmission and encoding the data as signals to be sent on the associated media.



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7 Data Link Layer

7.1 Data Link Layer - Accessing the Media

7.1.4 Data Link Layer - Connecting Upper Layer Services to the Media

Page 2:
Data Link Sublayers

To support a wide variety of network functions, the Data Link layer is often divided into two sublayers: an upper sublayer and an lower sublayer.

- The upper sublayer defines the software processes that provide services to the Network layer protocols.
- The lower sublayer defines the media access processes performed by the hardware.

Separating the Data Link layer into sublayers allows for one type of frame defined by the upper layer to access different types of media defined by the lower layer. Such is the case in many LAN technologies, including Ethernet.

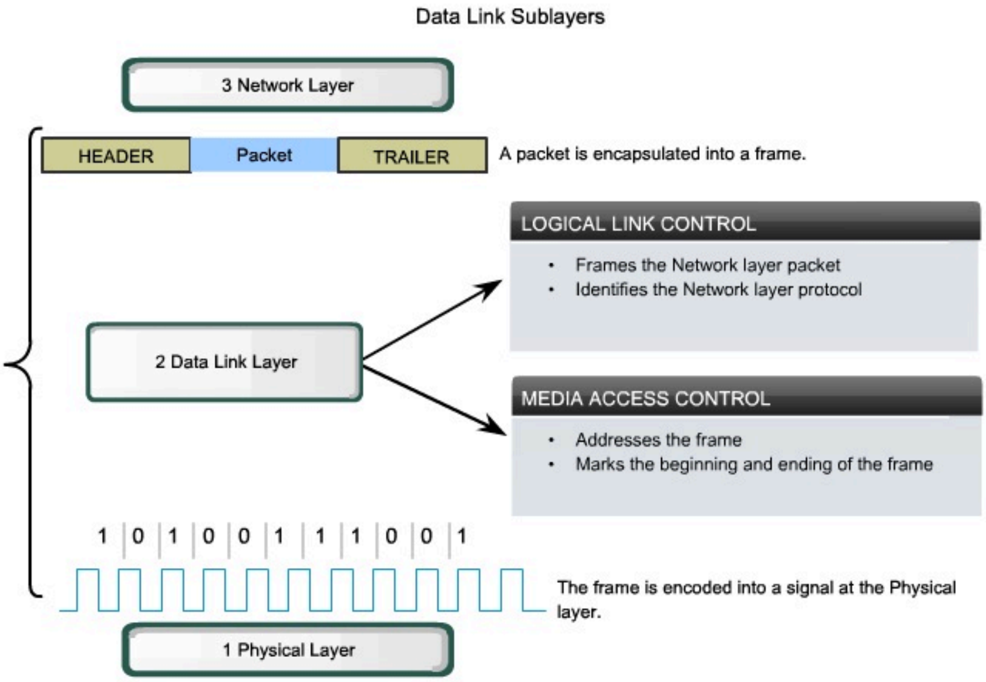
The two common LAN sublayers are:

Logical Link Control

Logical Link Control (LLC) places information in the frame that identifies which Network layer protocol is being used for the frame. This information allows multiple Layer 3 protocols, such as IP and IPX, to utilize the same network interface and media.

Media Access Control

Media Access Control (MAC) provides Data Link layer addressing and delimiting of data according to the physical signaling requirements of the medium and the type of Data Link layer protocol in use.



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7 Data Link Layer

7.1 Data Link Layer - Accessing the Media

7.1.5 Data Link Layer - Standards

Page 1:

Unlike the protocols of the upper layers of the TCP/IP suite, Data Link layer protocols are generally not defined by Request for Comments (RFCs). Although the Internet Engineering Task Force (IETF) maintains the functional protocols and services for the TCP/IP protocol suite in the upper layers, the IETF does not define the functions and operation of that model's Network access layer. The TCP/IP Network Access layer is the equivalent of the OSI Data Link and Physical layers. These two layer will be discussed in separate chapters for closer examination..

The functional protocols and services at the Data Link layer are described by engineering organizations (such as IEEE, ANSI, and ITU) and communications companies. Engineering organizations set public and open standards and protocols. Communications companies may set and use proprietary protocols to take advantage of new advances in technology or market opportunities.

Data Link layer services and specifications are defined by multiple standards based on a variety of technologies and media to which the protocols are applied. Some of these standards integrate both Layer 2 and Layer 1 services.

Engineering organizations that define open standards and protocols that apply to the Data Link layer include:

- International Organization for Standardization (ISO)
- Institute of Electrical and Electronics Engineers (IEEE)
- American National Standards Institute (ANSI)
- International Telecommunication Union (ITU)

Unlike the upper layer protocols, which are implemented mostly in software such as the host operating system or specific applications, Data Link layer processes occur both in software and hardware. The protocols at this layer are implemented within the electronics of the network adapters with which the device connects to the physical network.

For example, a device implementing the Data Link layer on a computer would be the network interface card (NIC). For a laptop, a wireless PCMCIA adapter is commonly used. Each of these adapters is the hardware that complies with the Layer 2 standards and protocols.

http://www.iso.org

http://www.ieee.org

http://www.ansi.org

http://www.itu.int

Standards for the Data Link Layer

ISO:	HDLC (High Level Data Link Control)
IEEE:	802.2 (LLC) 802.3 (Ethernet) 802.5 (Token Ring) 802.11 (Wireless LAN)
ITU:	Q.922 (Frame Relay Standard) Q.921 (ISDN Data Link Standard) HDLC (High Level Data Link Control)
ANSI:	3T9.5 ADCCP (Advanced Data Communications Control Protocol)

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7 Data Link Layer
7.2 Media Access Control Techniques
7.2.1 Placing Data on the Media

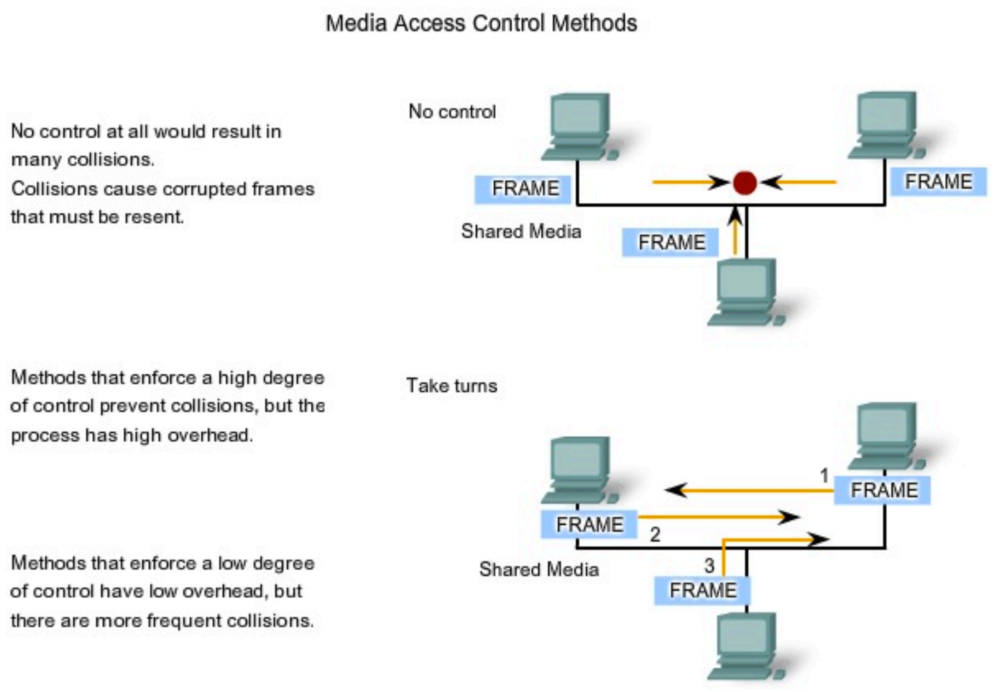
Page 1:
Regulating the placement of data frames onto the media is known as media access control. Among the different implementations of the Data Link layer protocols, there are different methods of controlling access to the media. These media access control techniques define if and how the nodes share the media.

Media access control is the equivalent of traffic rules that regulate the entrance of motor vehicles onto a roadway. The absence of any media access control would be the equivalent of vehicles ignoring all other traffic and entering the road without regard to the other vehicles.

However, not all roads and entrances are the same. Traffic can enter the road by merging, by waiting for its turn at a stop sign, or by obeying signal lights. A driver follows a different set of rules for each type of entrance.

In the same way, there are different ways to regulate the placing of frames onto the media. The protocols at the Data Link layer define the rules for access to different media. Some media access control methods use highly-controlled processes to ensure that frames are safely placed on the media. These methods are defined by sophisticated protocols, which require mechanisms that introduce overhead onto the network.

The method of media access control used depends on:
- Media sharing - If and how the nodes share the media
- Topology - How the connection between the nodes appears to the Data Link layer



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7 Data Link Layer
7.2 Media Access Control Techniques
7.2.2 Media Access Control for Shared Media

Page 1:
Some network topologies share a common medium with multiple nodes. At any one time, there may be a number of devices attempting to send and receive data using the network media. There are rules that govern how these devices share the media.

There are two basic media access control methods for shared media:
- Controlled - Each node has its own time to use the medium
- Contention-based - All nodes compete for the use of the medium

Click the tabs in the figure to see the differences in the two methods.

Controlled Access for Shared Media

When using the controlled access method, network devices take turns, in sequence, to access the medium. This method is also known as scheduled access or deterministic. If a device does not need to access the medium, the opportunity to use the medium passes to the next device in line. When one device places a frame on the media, no other device can do so until the frame has arrived at the destination and has been processed by the destination.

Although controlled access is well-ordered and provides predictable throughput, deterministic methods can be inefficient because a device has to wait for its turn before it can use the medium.

Contention-based Access for Shared Media

Also referred to as non-deterministic, contention-based methods allow any device to try to access the medium whenever it has data to send. To prevent complete chaos on the media, these methods use a Carrier Sense Multiple Access (CSMA) process to first detect if the media is carrying a signal. If a carrier signal on the media from another node is detected, it means that another device is transmitting. When the device attempting to transmit sees that the media is busy, it will wait and try again after a short time period. If no carrier signal is detected, the device transmits its data. Ethernet and wireless networks use contention-based media access control.

It is possible that the CSMA process will fail and two devices will transmit at the same time. This is called a data collision. If this occurs, the data sent by both devices will be corrupted and will need to be resent.

Contention-based media access control methods do not have the overhead of controlled access methods. A mechanism for tracking whose turn it is to access the media is not required. However, the contention-based systems do not scale well under heavy media use. As use and the number of nodes increases, the probability of successful media access without a collision decreases. Additionally, The recovery mechanisms required to correct errors due to these collisions further diminishes the throughput.

CSMA is usually implemented in conjunction with a method for resolving the media contention. The two commonly used methods are:

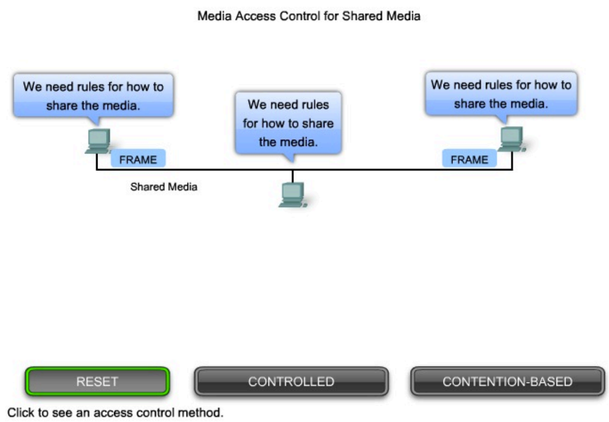
CSMA/Collision Detection

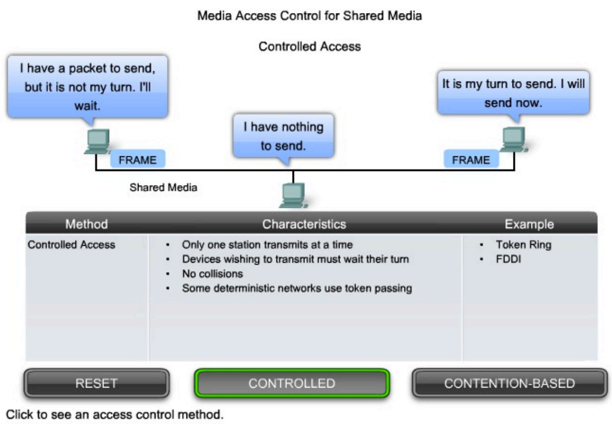
In CSMA/Collision Detection (CSMA/CD), the device monitors the media for the presence of a data signal. If a data signal is absent, indicating that the media is free, the device transmits the data. If signals are then detected that show another device was transmitting at the same time, all devices stop sending and try again later. Traditional forms of Ethernet use this method.

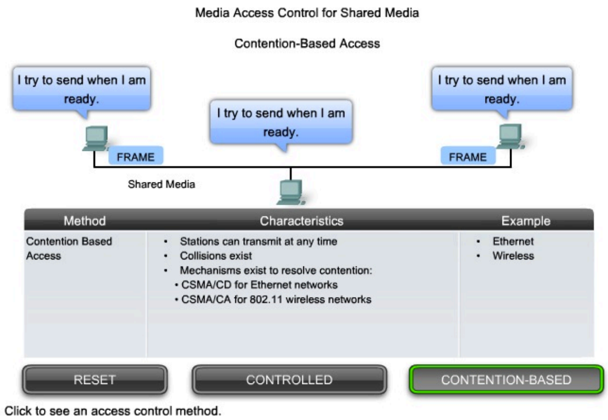
CSMA/Collision Avoidance

In CSMA/Collision Avoidance (CSMA/CA), the device examines the media for the presence of a data signal. If the media is free, the device sends a notification across the media of its intent to use it. The device then sends the data. This method is used by 802.11 wireless networking technologies.

Note: CSMA/CD will be covered in more detail in Chapter 9.







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7 Data Link Layer
7.2 Media Access Control Techniques
7.2.3 Media Access Control for Non-Shared Media

Page 1:
Media access control protocols for non-shared media require little or no control before placing frames onto the media. These protocols have simpler rules and procedures for media access control. Such is the case for point-to-point topologies.

In point-to-point topologies, the media interconnects just two nodes. In this arrangement, the nodes do not have to share the media with other hosts or determine if a frame is destined for that node. Therefore, Data Link layer protocols have little to do for controlling non-shared media access.

Full Duplex and Half Duplex

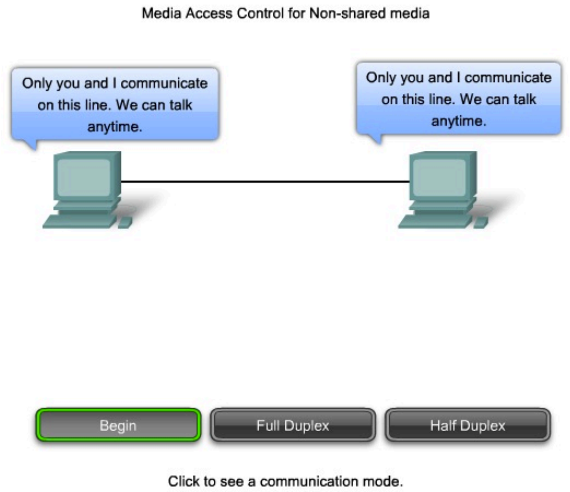
In point-to-point connections, the Data Link layer has to consider whether the communication is half-duplex or full-duplex.

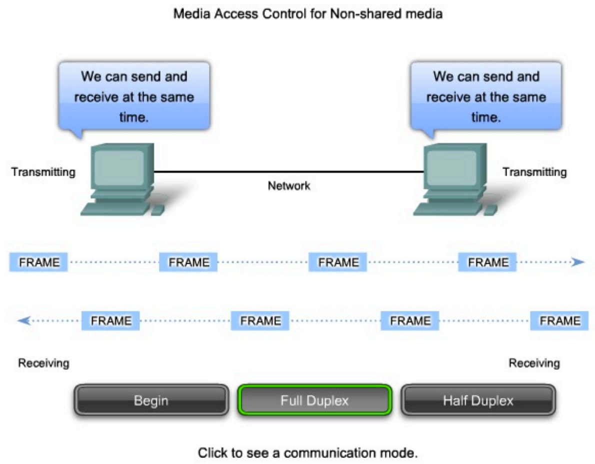
Click the tabs in the figure to see the differences in the two methods.

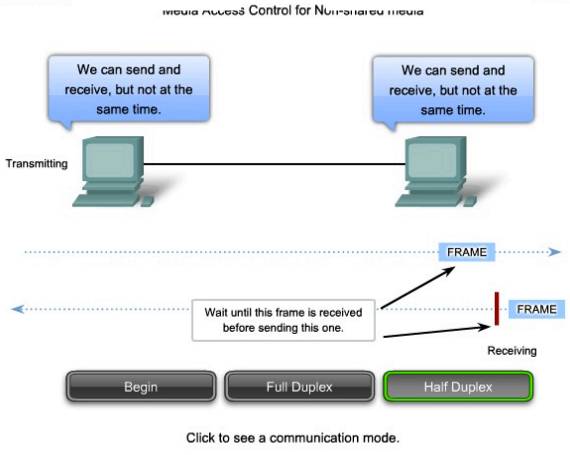
Half-duplex communication means that the devices can both transmit and receive on the media but cannot do so simultaneously. Ethernet has established arbitration rules for resolving conflicts arising from instances when more than one station attempts to transmit at the same time.

In full-duplex communication, both devices can transmit and receive on the media at the same time. The Data Link layer assumes that the media is available for transmission for both nodes at any time. Therefore, there is no media arbitration necessary in the Data Link layer.

The details of a specific media access control technique can only be examined by studying a specific protocol. Within this course, we will study traditional Ethernet, which uses CSMA/CD. Other techniques will be covered in later courses.







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7 Data Link Layer
7.2 Media Access Control Techniques
7.2.4 Logical Topology vs Physical Topology

Page 1:
The topology of a network is the arrangement or relationship of the network devices and the interconnections between them. Network topologies can be viewed at the physical level and the logical level.

The *physical topology* is an arrangement of the nodes and the physical connections between them. The representation of how the media is used to interconnect the devices is the physical topology. These will be covered in later chapters of this course.

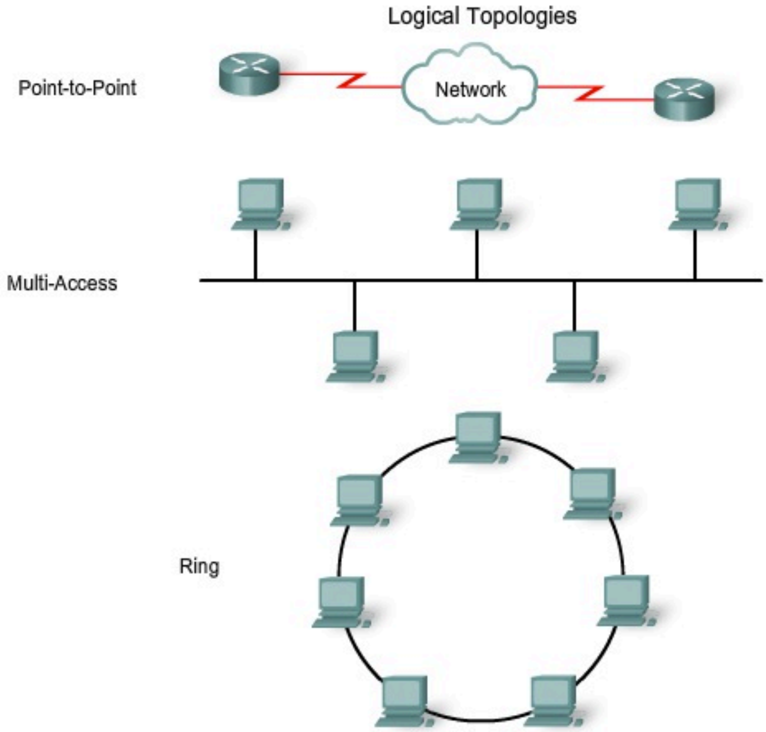
A *logical topology* is the way a network transfers frames from one node to the next. This arrangement consists of virtual connections between the nodes of a network independent of their physical layout. These logical signal paths are defined by Data Link layer protocols. The Data Link layer "sees" the logical topology of a network when controlling data access to the media. It is the logical topology that influences the type of network framing and media access control used.

The physical or cabled topology of a network will most likely not be the same as the logical topology.

Logical topology of a network is closely related to the mechanism used to manage network access. Access methods provide the procedures to manage network access so that all stations have access. When several entities share the same media, some mechanism must be in place to control access. Access methods are applied to networks to regulate this media access. Access methods will be discussed in more detail later.

Logical and physical topologies typically used in networks are:
- Point-to-Point
- Multi-Access
- Ring

The logical implementations of these topologies and their associated media access control methods are considered in the following sections.



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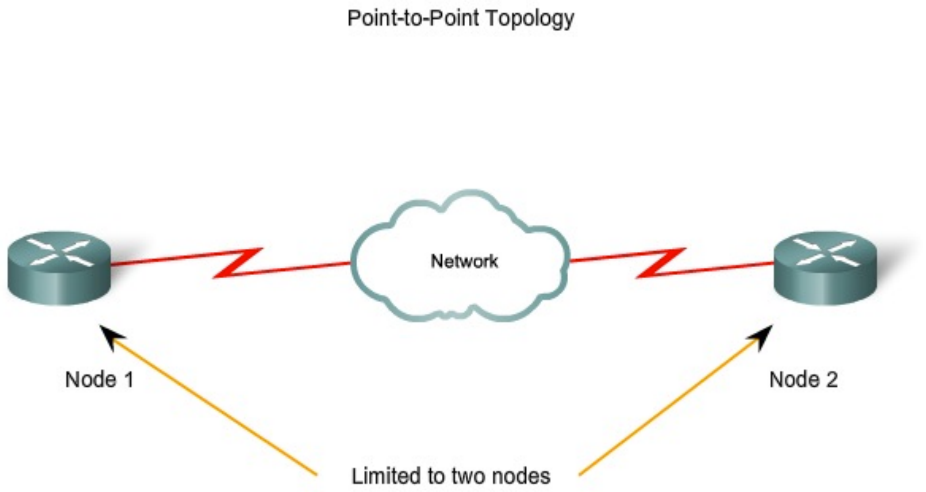
7.2 Media Access Control Techniques
7.2.5 Point-to-Point Topology

Page 1:
A point-to-point topology connects two nodes directly together, as shown in the figure. In data networks with point-to-point topologies, the media access control protocol can be very simple. All frames on the media can only travel to or from the two nodes. The frames are placed on the media by the node at one end and taken off the media by the node at the other end of the point-to-point circuit.

In point-to-point networks, if data can only flow in one direction at a time, it is operating as a half-duplex link. If data can successfully flow across the link from each node simultaneously, it is a full-duplex link.

Data Link layer protocols could provide more sophisticated media access control processes for logical point-to-point topologies, but this would only add unnecessary protocol overhead.



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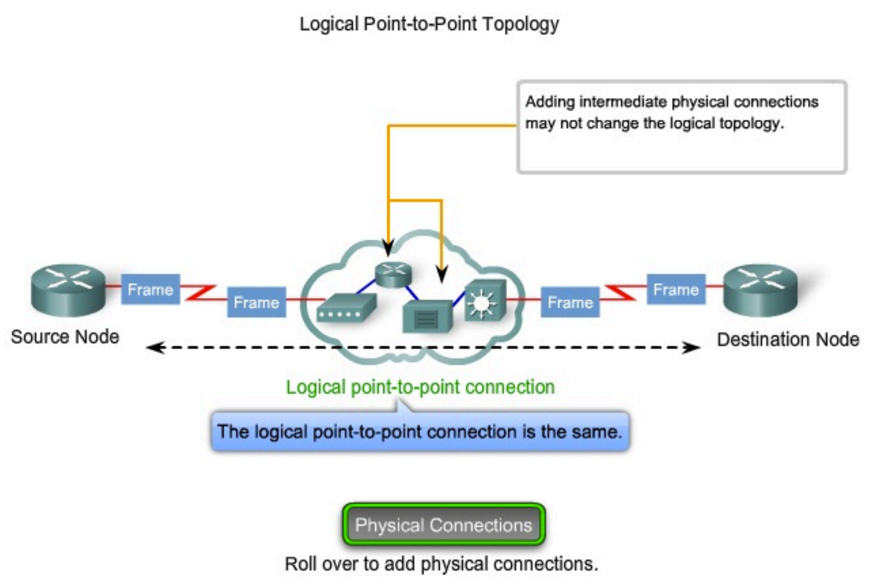
7 Data Link Layer
7.2 Media Access Control Techniques
7.2.5 Point-to-Point Topology

Page 2:
Logical Point-to-Point Networks

The end nodes communicating in a point-to-point network can be physically connected via a number of intermediate devices. However the use of physical devices in the network does not affect the logical topology. As shown in the figure, the source and destination node may be indirectly connected to each other over some geographical distance. In some cases, the logical connection between nodes forms what is called a *virtual circuit*. A virtual circuit is a logical connection created within a network between two network devices. The two nodes on either end of the virtual circuit exchange the frames with each other. This occurs even if the frames are directed through intermediary devices. Virtual circuits are important logical communication constructs used by some Layer 2 technologies.

The media access method used by the Data Link protocol is determined by the *logical* point-to-point topology, not the *physical* topology. This means that the logical point-to-point connection between two nodes may not necessarily be between two physical nodes at each end of a single physical link.



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7.2 Media Access Control Techniques
7.2.6 Multi-Access Topology

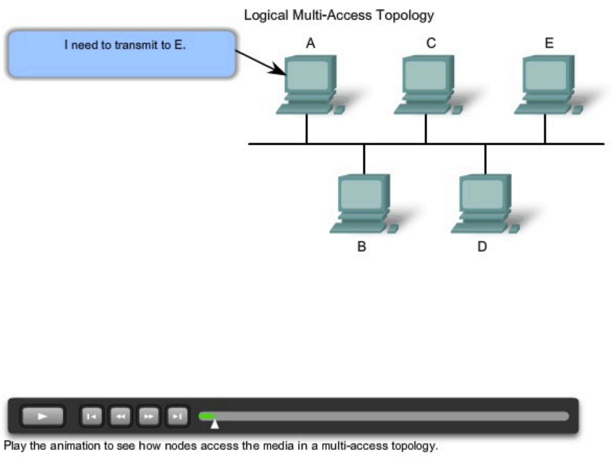
Page 1:
A logical multi-access topology enables a number of nodes to communicate by using the same shared media. Data from only one node can be placed on the medium at any one time. Every node sees all the frames that are on the medium, but only the node to which the frame is addressed processes the contents of the frame.

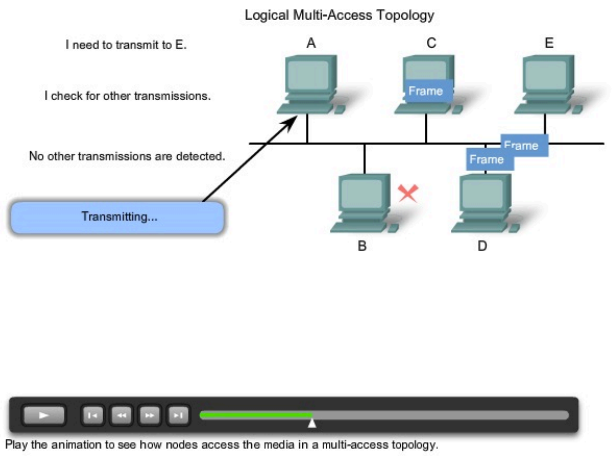
Having many nodes share access to the medium requires a Data Link media access control method to regulate the transmission of data and thereby reduce collisions between different signals.

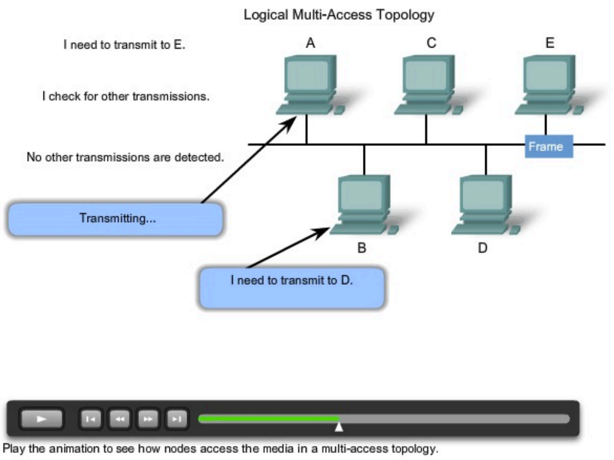
The media access control methods used by logical multi-access topologies are typically CSMA/CD or CSMA/CA. However, token passing methods can also be used.

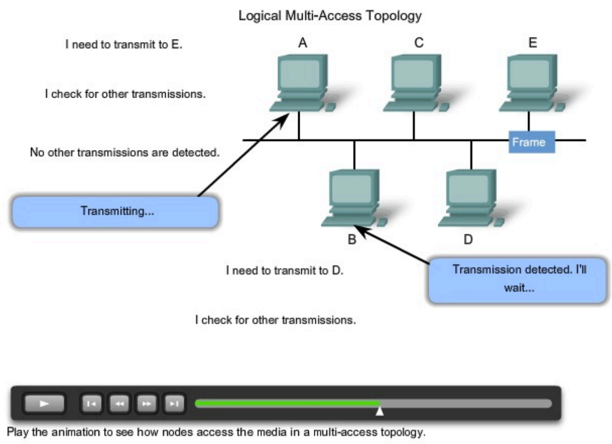
A number of media access control techniques are available for this type of logical topology. The Data Link layer protocol specifies the media access control method that will provide the appropriate balance between frame control, frame protection, and network overhead.

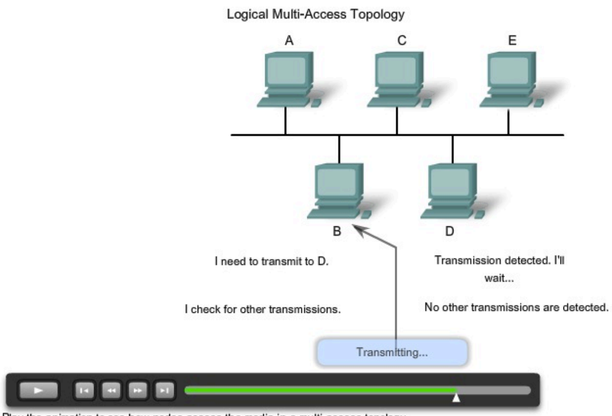
Play the animation to see how nodes access the media in a multi-access topology.



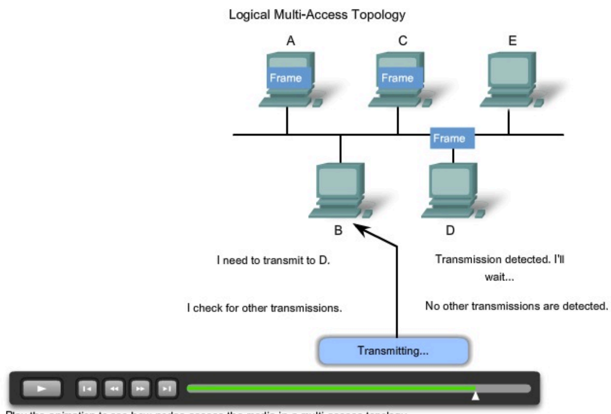




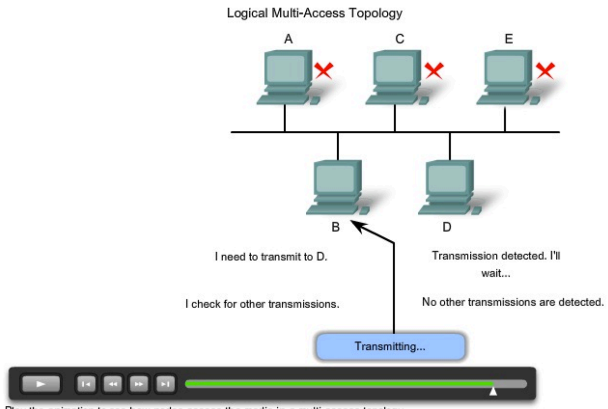




Play the animation to see how nodes access the media in a multi-access topology.



Play the animation to see how nodes access the media in a multi-access topology.



Play the animation to see how nodes access the media in a multi-access topology.

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7 Data Link Layer

7.2 Media Access Control Techniques

7.2.7 Ring Topology

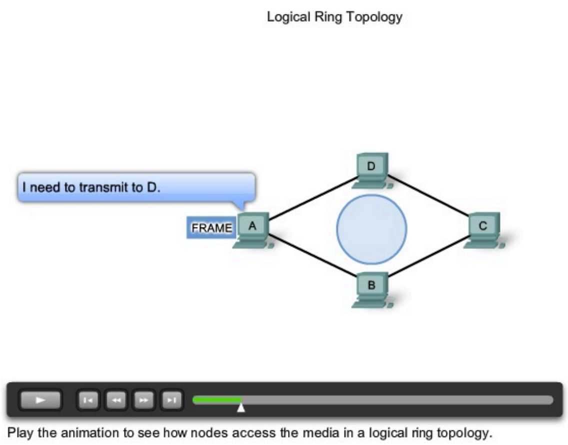
Page 1:
In a logical ring topology, each node in turn receives a frame. If the frame is not addressed to the node, the node passes the frame to the next node. This allows a ring to use a controlled media access control technique called *token passing*.

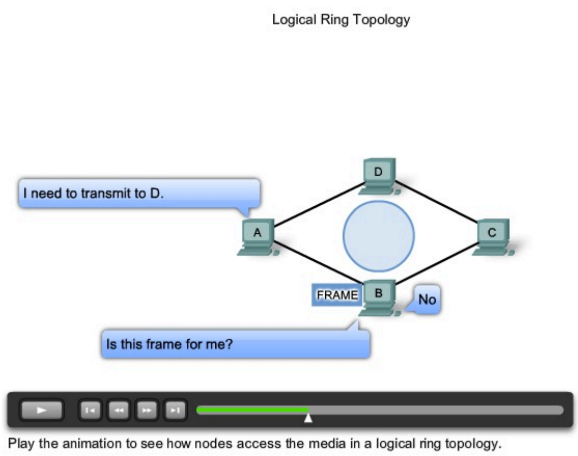
Nodes in a logical ring topology remove the frame from the ring, examine the address, and send it on if it is not addressed for that node. In a ring, all nodes around the ring- between the source and destination node examine the frame.

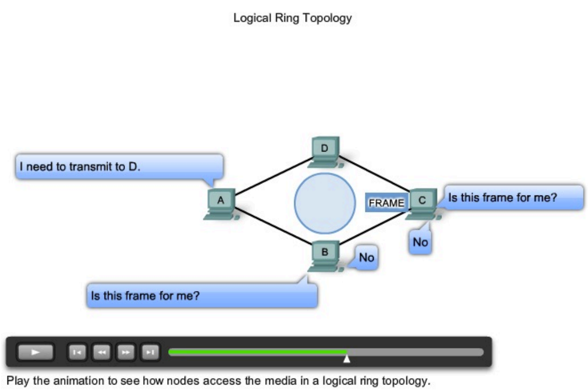
There are multiple media access control techniques that could be used with a logical ring, depending on the level of control required. For example, only one frame at a time is usually carried by the media. If there is no data being transmitted, a signal (known as a token) may be placed on the media and a node can only place a data frame on the media when it has the token.

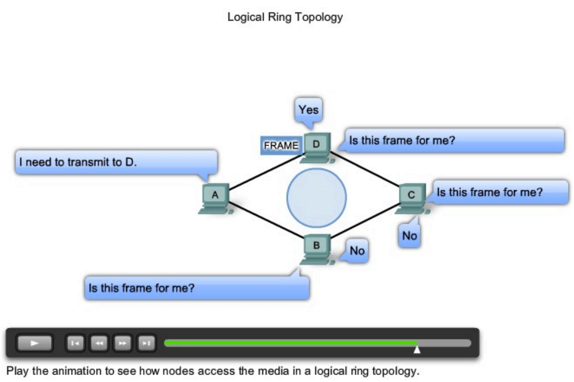
Remember that the Data Link layer "sees" a logical ring topology. The actual physical cabling topology could be another topology.

Play the animation to see how nodes access the media in a logical ring topology.









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7 Data Link Layer

7.3 Media Access Control Addressing and Framing Data

7.3.1 Data Link Layer Protocols - The Frame

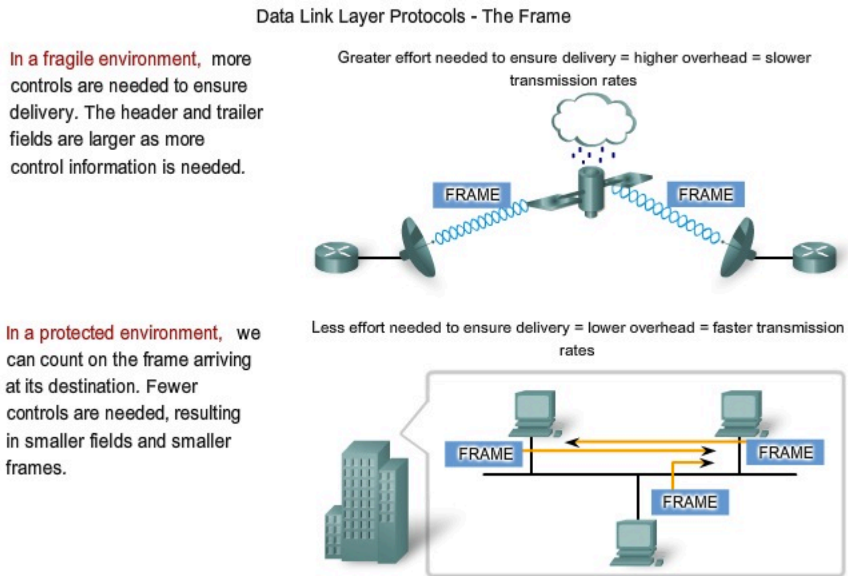
Page 1:
Remember that although there are many different Data Link layer protocols that describe Data Link layer frames, each frame type has three basic parts:

- Header
- Data
- Trailer

All Data Link layer protocols encapsulate the Layer 3 PDU within the data field of the frame. However, the structure of the frame and the fields contained in the header and trailer vary according to the protocol.

The Data Link layer protocol describes the features required for the transport of packets across different media. These features of the protocol are integrated into the encapsulation of the frame. When the frame arrives at its destination and the Data Link protocol takes the frame off the media, the framing information is read and discarded.

There is no one frame structure that meets the needs of all data transportation across all types of media. As shown in the figure, depending on the environment, the amount of control information needed in the frame varies to match the media access control requirements of the media and logical topology.



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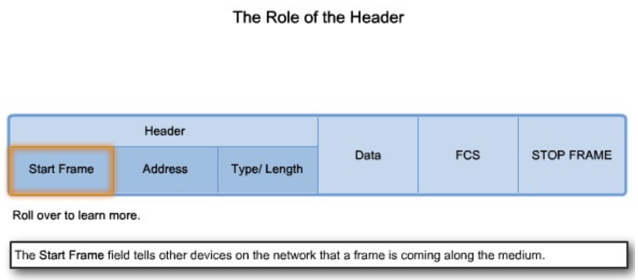
7.3 Media Access Control Addressing and Framing Data
7.3.2 Framing - Role of the Header

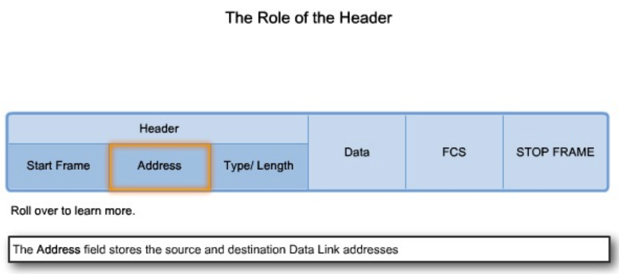
Page 1:
As shown in the figure, the frame header contains the control information specified by the Data Link layer protocol for the specific logical topology and media used.

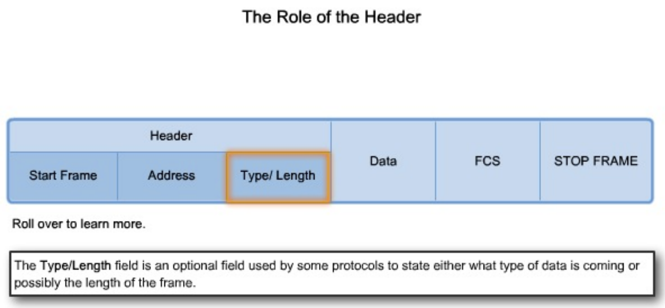
Frame control information is unique to each type of protocol. It is used by the Layer 2 protocol to provide features demanded by the communication environment.

Typical frame header fields include:
- Start Frame field - Indicates the beginning of the frame
- Source and Destination address fields - Indicates the source and destination nodes on the media
- Priority/Quality of Service field - Indicates a particular type of communication service for processing
- Type field - Indicates the upper layer service contained in the frame
- Logical connection control field - Used to establish a logical connection between nodes
- Physical link control field - Used to establish the media link
- Flow control field - Used to start and stop traffic over the media
- Congestion control field - Indicates congestion in the media

The field names above are nonspecific fields listed as examples. Different Data Link layer protocols may use different fields from those mentioned. Because the purposes and functions of Data Link layer protocols are related to the specific topologies and media, each protocol has to be examined to gain a detailed understanding of its frame structure. As protocols are discussed in this course, more information about the frame structure will be explained.







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7 Data Link Layer

7.3 Media Access Control Addressing and Framing Data

7.3.3 Addressing - Where the Frame Goes

Page 1:
The data Link layer provides addressing that is used in transporting the frame across the shared local media. Device addresses at this layer are referred to as physical addresses. Data Link layer addressing is contained within the frame header and specifies the frame destination node on the local network. The frame header may also contain the source address of the frame.

Unlike Layer 3 logical addresses that are hierarchical, physical addresses do not indicate on what network the device is located. If the device is moved to another network or subnet, it will still function with the same Layer 2 physical address.

Because the frame is only used to transport data between nodes across the local media, the Data Link layer address is only used for local delivery. Addresses at this layer have no meaning beyond the local network. Compare this to Layer 3, where addresses in the packet header are carried from source host to destination host regardless of the number of network hops along the route.

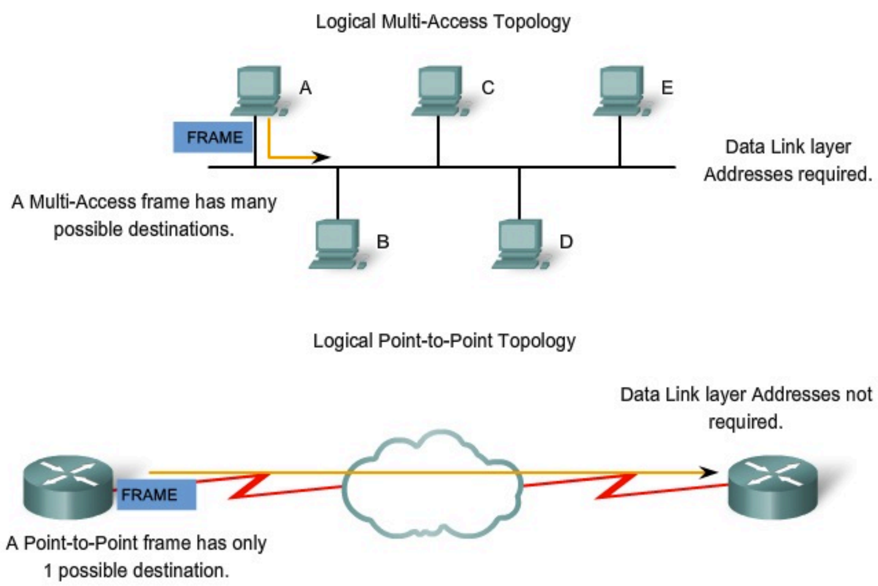
If the packet in the frame must pass onto another network segment, the intermediate device - a router - will decapsulate the original frame, create a new frame for the packet, and send it onto the new segment. The new frame will use source and destination addressing as necessary to transport the packet across the new media.

Addressing Requirements

The need for Data Link layer addressing at this layer depends on the logical topology.

Point-to-point topologies, with just two interconnected nodes, do not require addressing. Once on the medium, the frame has only one place it can go.

Because ring and multi-access topologies can connect many nodes on a common medium, addressing is required for these typologies. When a frame reaches each node in the topology, the node examines the destination address in the header to determine if it is the destination of the frame.



CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.3 Media Access Control Addressing and Framing Data
7.3.4 Framing - Role of the Trailer

Page 1:
Data Link layer protocols add a trailer to the end of each frame. The trailer is used to determine if the frame arrived without error. This process is called *error detection*. Note that this is different from *error correction*. Error detection is accomplished by placing a logical or mathematical summary of the bits that comprise the frame in the trailer.

Frame Check Sequence

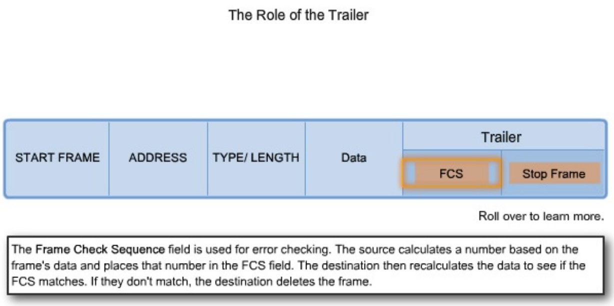
The Frame Check Sequence (FCS) field is used to determine if errors occurred in the transmission and reception of the frame. Error detection is added at the Data Link layer because this is where data is transferred across the media. The media is a potentially unsafe environment for data. The signals on the media could be subject to interference, distortion, or loss that would substantially change the bit values that those signals represent. The error detection mechanism provided by the use of the FCS field discovers most errors caused on the media.

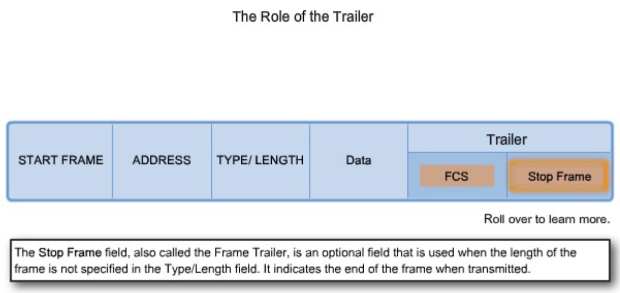
To ensure that the content of the received frame at the destination matches that of the frame that left the source node, a transmitting node creates a logical summary of the contents of the frame. This is known as the cyclic redundancy check (CRC) value. This value is placed in the Frame Check Sequence (FCS) field of the frame to represent the contents of the frame.

When the frame arrives at the destination node, the receiving node calculates its own logical summary, or CRC, of the frame. The receiving node compares the two CRC values. If the two values are the same, the frame is considered to have arrived as transmitted. If the CRC value in the FCS differs from the CRC calculated at the receiving node, the frame is discarded.

There is always the small possibility that a frame with a good CRC result is actually corrupt. Errors in bits may cancel each other out when the CRC is calculated. Upper layer protocols would then be required to detect and correct this data loss.

The protocol used in the Data Link layer, will determine if error correction will take place. The FCS is used to detect the error, but not every protocol will support correcting the error.





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7 Data Link Layer

7.3 Media Access Control Addressing and Framing Data

7.3.5 Data Link Layer Protocols - The Frame

Page 1:
In a TCP/IP network, all OSI Layer 2 protocols work with the Internet Protocol at OSI Layer 3. However, the actual Layer 2 protocol used depends on the logical topology of the network and the implementation of the Physical layer. Given the wide range of physical media used across the range of topologies in networking, there are a correspondingly high number of Layer 2 protocols in use.

Protocols that will be covered in CCNA courses include:

- Ethernet
- Point-to-Point Protocol (PPP)
- High-Level Data Link Control (HDLC)
- Frame Relay
- Asynchronous Transfer Mode (ATM)

Each protocol performs media access control for specified Layer 2 logical topologies. This means that a number of different network devices can act as nodes that operate at the Data Link layer when implementing these protocols. These devices include the network adapter or network interface cards (NICs) on computers as well as the interfaces on routers and Layer 2 switches.

The Layer 2 protocol used for a particular network topology is determined by the technology used to implement that topology. The technology is, in turn, determined by the size of the network - in terms of the number of hosts and the geographic scope - and the services to be provided over the network.

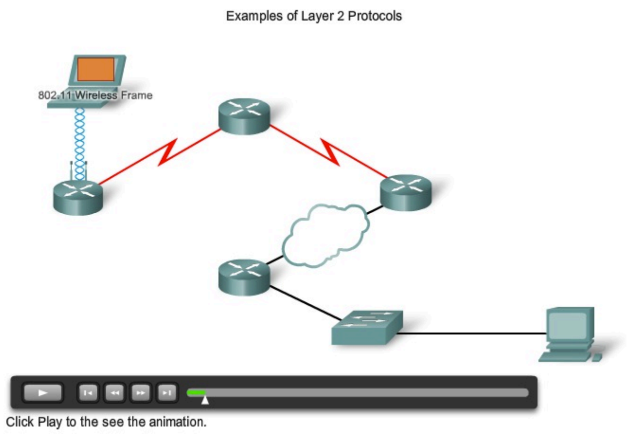
LAN Technology

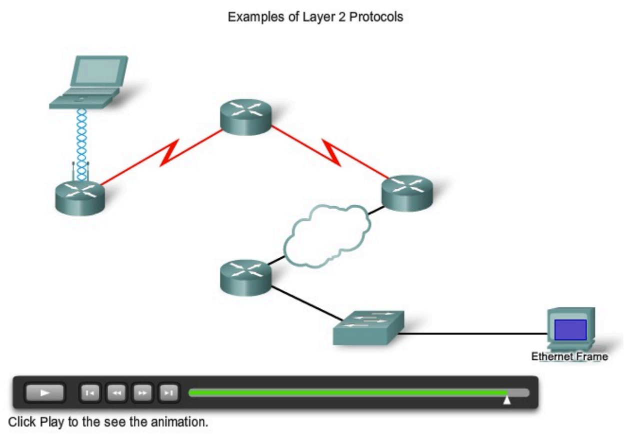
A Local Area Network typically uses a high bandwidth technology that is capable of supporting large numbers of hosts. A LAN's relatively small geographic area (a single building or a multi-building campus) and its high density of users make this technology cost effective.

WAN Technology

However, using a high bandwidth technology is usually not cost-effective for Wide Area Networks that cover large geographic areas (cities or multiple cities, for example). The cost of the long distance physical links and the technology used to carry the signals over those distances typically results in lower bandwidth capacity.

Difference in bandwidth normally results in the use of different protocols for LANs and WANs.





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7 Data Link Layer

7.3 Media Access Control Addressing and Framing Data

7.3.5 Data Link Layer Protocols - The Frame

Page 2:
Ethernet Protocol for LANs

Ethernet is a family of networking technologies that are defined in the IEEE 802.2 and 802.3 standards. Ethernet standards define both the Layer 2 protocols and the Layer 1 technologies. Ethernet is the most widely used LAN technology and supports data bandwidths of 10, 100, 1000, or 10,000 Mbps.

The basic frame format and the IEEE sublayers of OSI Layers 1 and 2 remain consistent across all forms of Ethernet. However, the methods for detecting and placing data on the media vary with different implementations.

Ethernet provides unacknowledged connectionless service over a shared media using CSMA/CD as the media access methods. Shared media requires that the Ethernet frame header use a Data Link layer address to identify the source and destination nodes. As with most LAN protocols, this address is referred to as the MAC address of the node. An Ethernet MAC address is 48 bits and is generally represented in hexadecimal format.

The Ethernet frame has many fields, as shown in the figure. At the Data Link layer, the frame structure is nearly identical for all speeds of Ethernet. However, at the Physical layer, different versions of Ethernet place the bits onto the media differently.

Ethernet II is the Ethernet frame format used in TCP/IP networks.

Ethernet is such an important part of data networking, we have devoted a chapter to it. We also use it in examples throughout this series of courses.

Ethernet Protocol

A Common Data Link Layer Protocol for LANs

Frame

Field name	Preamble	Destination	Source	Type	Data	Frame Check Sequence
Size	8 bytes	6 bytes	6 bytes	2 bytes	46 - 1500 bytes	4 bytes

Preamble - used for synchronization; also contains a delimiter to mark the end of the timing information.
Destination Address- 48 bit MAC address for the destination node.
Source Address- 48 bit MAC address for the source node.
Type - value to indicate which upper layer protocol will receive the data after the Ethernet process is complete.
Data or payload - this is the PDU, typically an IPv4 packet, that is to be transported over the media.
Frame Check Sequence(FCS) - A value used to check for damaged frames.

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Page 3:
Point-to-Point Protocol for WANs

Point-to-Point Protocol (PPP) is a protocol used to deliver frames between two nodes. Unlike many Data Link layer protocols that are defined by electrical engineering organizations, the PPP standard is defined by RFCs. PPP was developed as a WAN protocol and remains the protocol of choice to implement many serial WANs. PPP can be used on various physical media, including twisted pair, fiber optic lines, and satellite transmission, as well as for virtual connections.

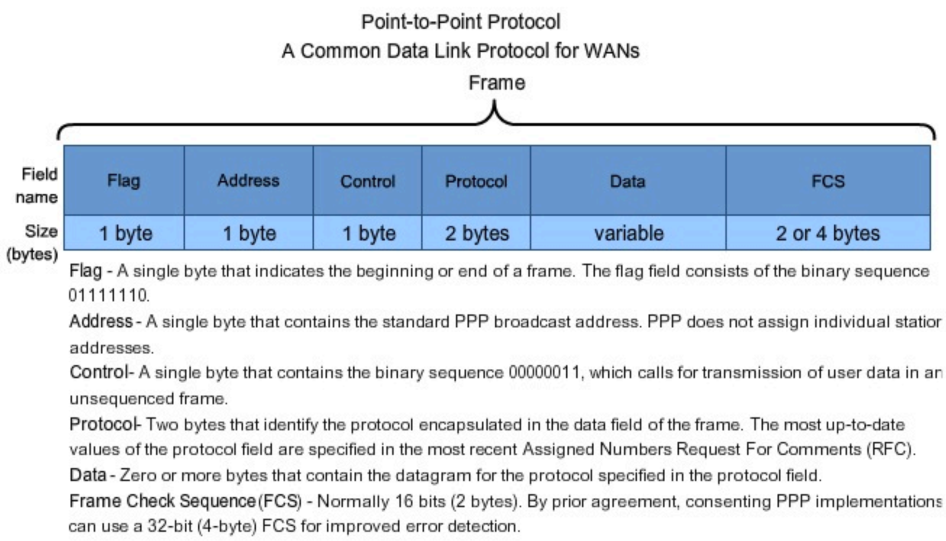
PPP uses a layered architecture. To accommodate the different types of media, PPP establishes logical connections, called sessions, between two nodes. The PPP session hides the underlying physical media from the upper PPP protocol. These sessions also provide PPP with a method for encapsulating multiple protocols over a point-to-point link. Each protocol encapsulated over the link establishes its own PPP session.

PPP also allows the two nodes to negotiate options within the PPP session. This includes authentication, compression, and multilink (the use of multiple physical connections).

See the figure for the basic fields in a PPP frame.

PPP protocol: http://www.ietf.org/rfc/rfc1661.txt?number=1661

PPP Vendor Extensions: http://www.ietf.org/rfc/rfc2153.txt?number=2153



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Page 4:
Wireless Protocol for LANs

802.11 is an extension of the IEEE 802 standards. It uses the same 802.2 LLC and 48-bit addressing scheme as other 802 LANs, However there are many differences at the MAC sublayer and Physical layer. In a wireless environment, the environment requires special considerations. There is no definable physical connectivity; therefore, external factors may interfere with data transfer and it is difficult to control access. To meet these challenges, wireless standards have additional controls.

The Standard IEEE 802.11, commonly referred to as *Wi-Fi*, is a contention-based system using a Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) media access process. CSMA/CA specifies a random backoff procedure for all nodes that are waiting to transmit. The most likely opportunity for medium contention is just after the medium becomes available. Making the nodes back off for a random period greatly reduces the likelihood of a collision.

802.11 networks also use Data Link acknowledgements to confirm that a frame is received successfully. If the sending station does not detect the acknowledgement frame, either because the original data frame or the acknowledgment was not received intact, the frame is retransmitted. This explicit acknowledgement overcomes interference and other radio-related problems.

Other services supported by 802.11 are authentication, association (connectivity to a wireless device), and privacy (encryption).

An 802.11 frame is shown in the figure. It contains these fields:

Protocol Version field - Version of 802.11 frame in use

Type and Subtype fields - Identifies one of three functions and sub functions of the frame: control, data, and management

To DS field - Set to 1 in data frames destined for the distribution system (devices in the wireless structure)

From DS field - Set to 1 in data frames exiting the distribution system

More Fragments field - Set to 1 for frames that have another fragment

Retry field - Set to 1 if the frame is a retransmission of an earlier frame

Power Management field - Set to 1 to indicate that a node will be in power-save mode

More Data field - Set to 1 to indicate to a node in power-save mode that more frames are buffered for that node

Wired Equivalent Privacy (WEP) field - Set to 1 if the frame contains WEP encrypted information for security

Order field - Set to 1 in a data type frame that uses Strictly Ordered service class (does not need reordering)

Duration/ID field - Depending on the type of frame, represents either the time, in microseconds, required to transmit the frame or an association identity (AID) for the station that transmitted the frame

Destination Address (DA) field - MAC address of the final destination node in the network

Source Address (SA) field - MAC address of the node the initiated the frame

Receiver Address (RA) field - MAC address that identifies the wireless device that is the immediate recipient of the frame

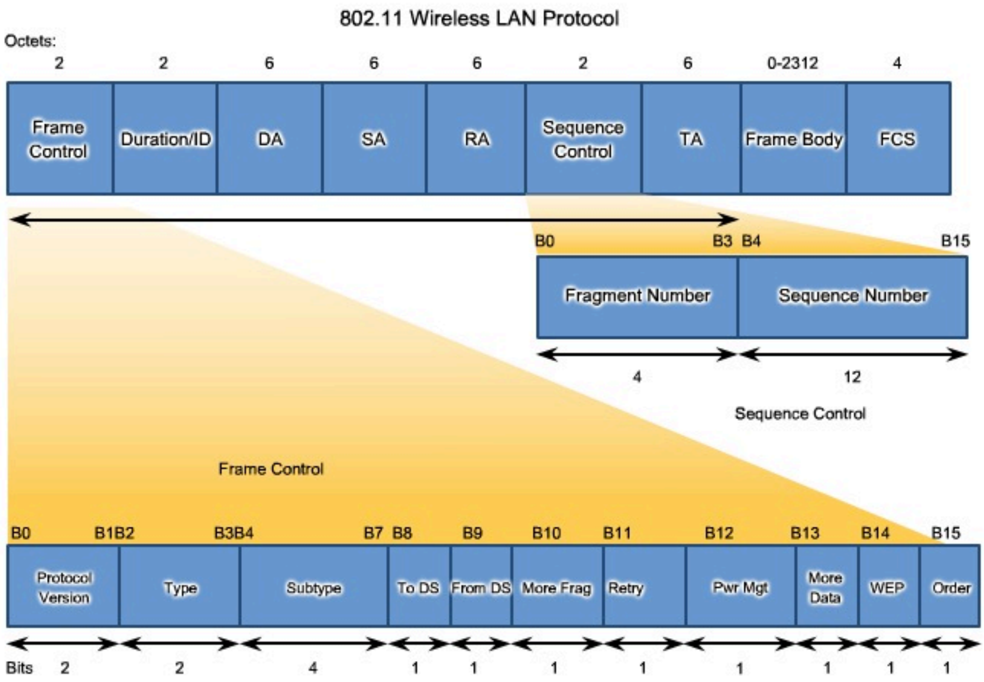
Transmitter Address (TA) field - MAC address that identifies the wireless device that transmitted the frame

Sequence Number field - Indicates the sequence number assigned to the frame; retransmitted frames are identified by duplicate sequence numbers

Fragment Number field - Indicates the number for each fragment of a frame

Frame Body field - Contains the information being transported; for data frames, typically an IP packet

FCS field - Contains a 32-bit cyclic redundancy check (CRC) of the frame



CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.4 Putting it All Together
7.4.1 Follow Data Through an Internetwork

Page 1:
The figure on the next page presents a simple data transfer between two hosts across an internetwork. We highlight the function of each layer during the communication. For this example we will depict an HTTP request between a client and a server.

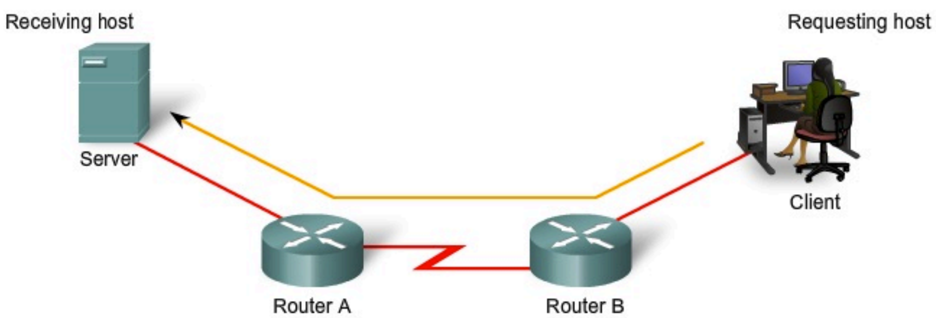
To focus on the data transfer process, we are omitting many elements that may occur in a real transaction. In each step we are only bringing attention to the major elements. Many parts of the headers are ignored, for example.

We are assuming that all routing tables are converged and ARP tables are complete. Additionally, we are assuming that a TCP session is already established between the client and server. We will also assume that the DNS lookup for the WWW server is already cached at the client.

In the WAN connection between the two routers, we are assuming that PPP has already established a physical circuit and has established a PPP session.

On the next page, you can step through this communication. We encourage you to read each explanation carefully and study the operation of the layers for each device.

A simple data transfer between two hosts across an internetwork.



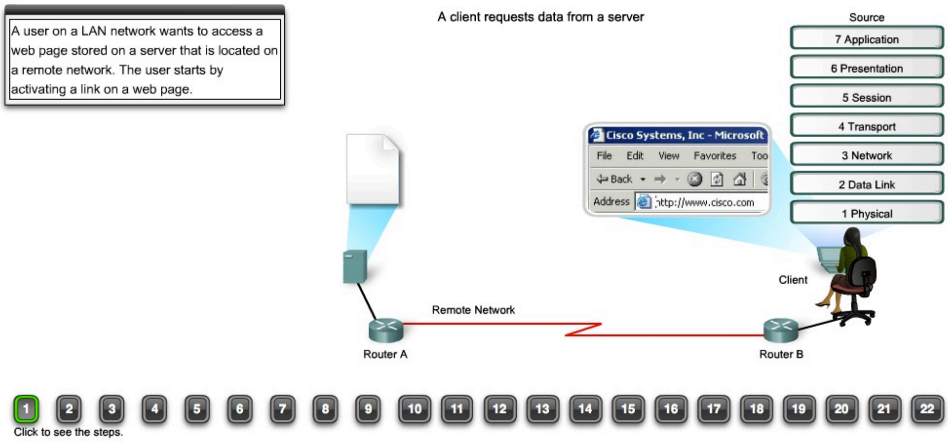
CCNA Exploration - Network Fundamentals

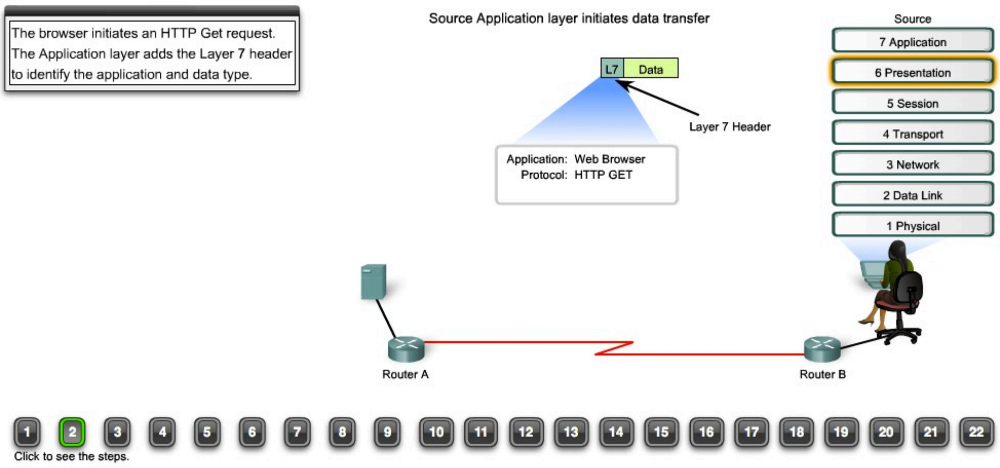
7 Data Link Layer

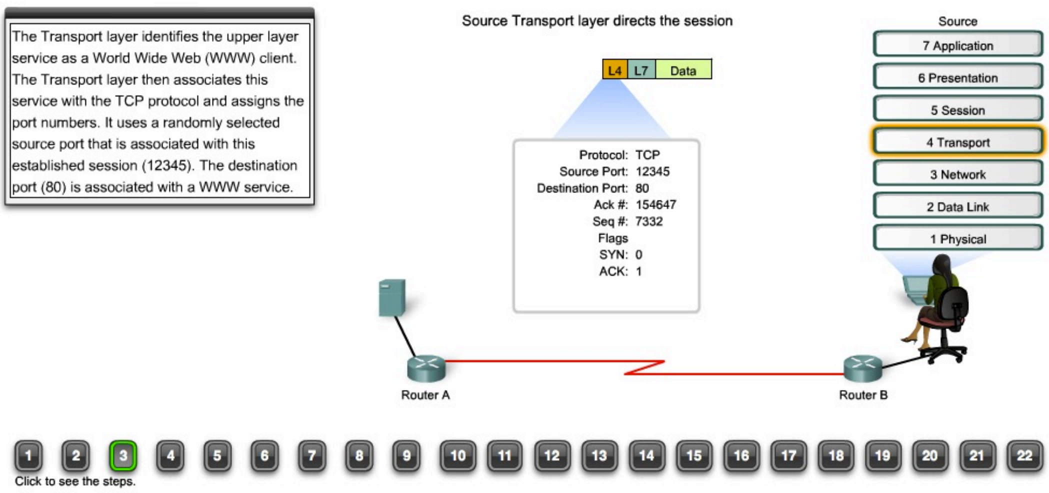
7.4 Putting it All Together

7.4.1 Follow Data Through an Internetwork

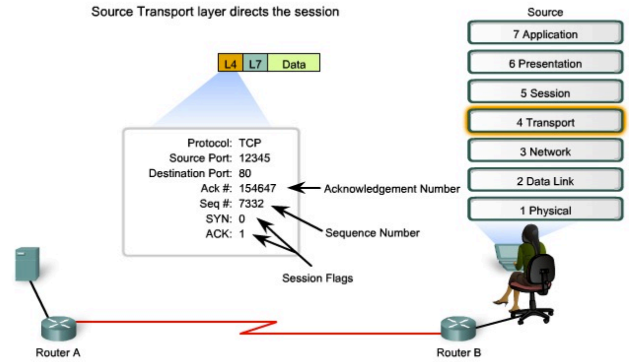
Page 2:





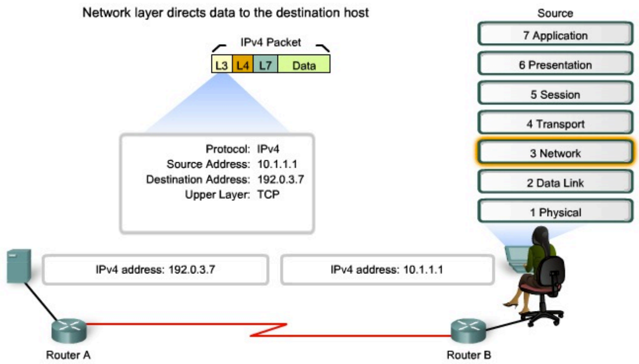


TCP also sends an acknowledgement number that tells the WWW server the sequence number of the next TCP segment it expects to receive. The sequence number will indicate where this segment is placed in the series of related segments. Flags are also set as appropriate to establish a session.



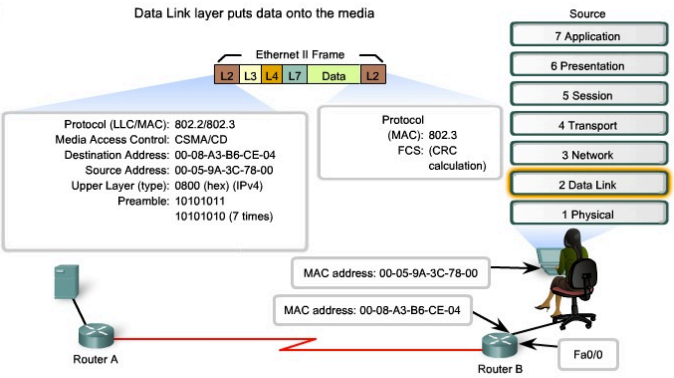
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.

At the Network layer, an IP packet is constructed to identify the source and destination hosts. For the destination address, the client host uses the IP address associated with the WWW server host name that is cached in the host table. It uses its own IPv4 address as the source address. The Network layer also identifies the upper layer protocol encapsulated in this packet as a TCP segment.



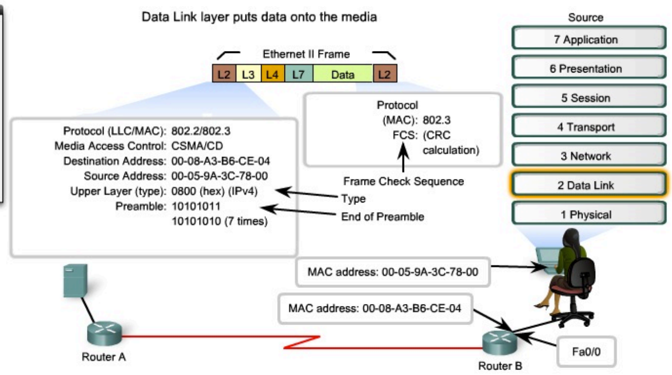
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.

The Data Link layer refers to the Address Resolution Protocol (ARP) cache to determine the MAC address that is associated with the interface of RouterB, which is specified as the default gateway. It then uses this address to build an Ethernet II frame to transport the IPv4 packet across the local media. The MAC address of the laptop is used as the source MAC address, and the MAC address of the Fa0/0 interface of RouterB is used as the destination MAC address in the frame.



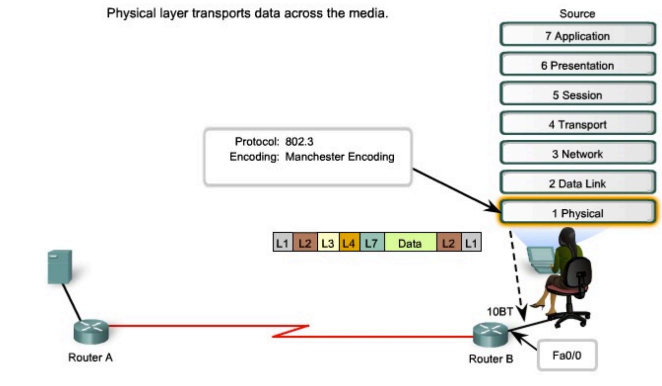
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.

The frame also indicates the upper layer protocol of IPv4 with a value of 0800 (hex) in the Type field. The frame begins with the Preamble and ends with a cyclic redundancy check (CRC) in the Frame Check Sequence at the end of the frame for the error detection. The Data Link layer then uses CSMA/CD to control the placing of the frame onto the media.



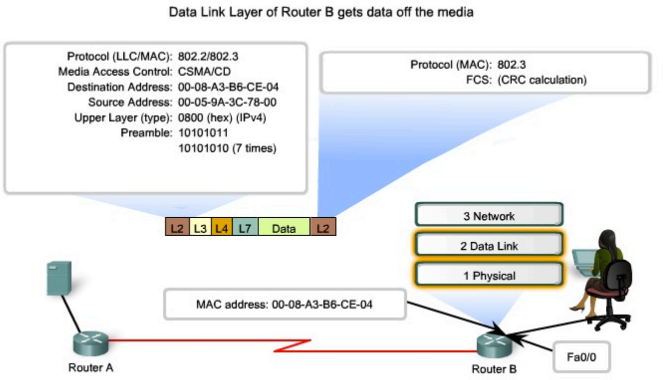
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.

The Physical layer begins encoding the frame onto the media, bit by bit. The segment between RouterB and the source host is a 10Base-T segment; therefore, the bits are encoded using Manchester Differential encoding. The Router B interface circuitry buffers the bits as they are received.



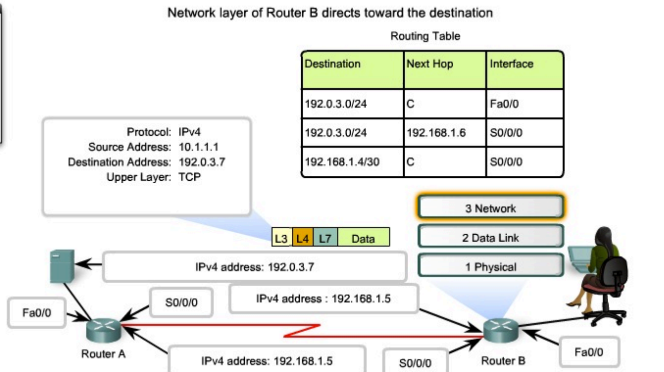
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.

RouterB examines the bits in the preamble, looking for the two consecutive 1 bits that indicate the synching process is completed and the beginning of the frame. RouterB then begins buffering the bits as part of the reconstructed frame. When the entire frame is received, RouterB generates a CRC of the frame. It then compares this to the FCS at the end of the frame to determine that the frame was received intact. When the frame is confirmed as a good frame, the destination MAC address in the frame is compared to the MAC address of the interface (Fa0/0). Because it matches, the headers are removed and the packet is pushed up to the Network layer.



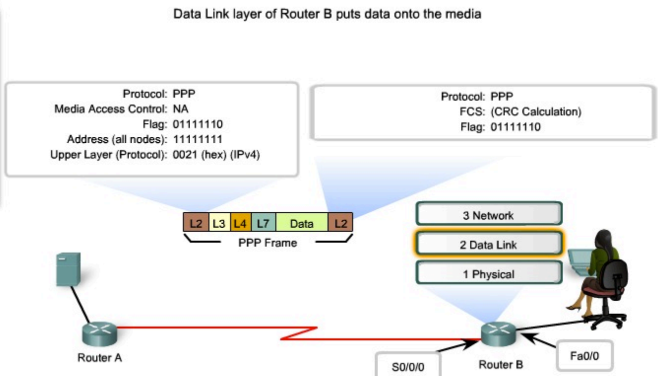
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.

At the Network layer, the destination IPv4 address of the packet is compared against the routes in the routing table. A match is found that is associated with a next hop out interface S0/0/0. The packet inside RouterB is then passed to the circuitry for the S0/0/0 interface.



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.

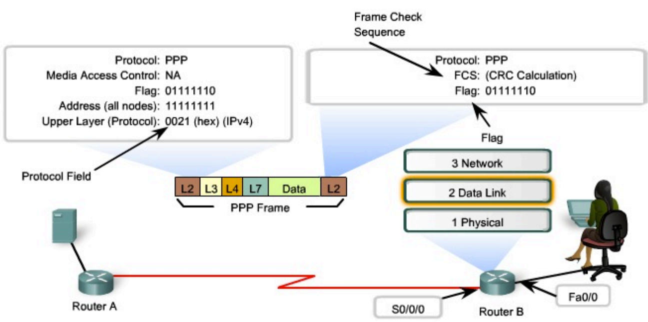
RouterB creates a PPP frame to transport the packet across the WAN. In the PPP header, a flag of 01111110 binary is added to indicate the start of the frame. Following that, an address field of 11111111 is added, which is equivalent to a broadcast (it means "send to all stations"). Because PPP is point-to-point and is used as direct link between two nodes, this field has no real meaning.



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.

Also included is a Protocol field with a value of 0021(hex) to indicate that an IPv4 packet is encapsulated. The frame trailer ends with a cyclic redundancy check in the Frame Check Sequence for the error detection. A Flag value of 01111110 binary indicates the end of a PPP frame.

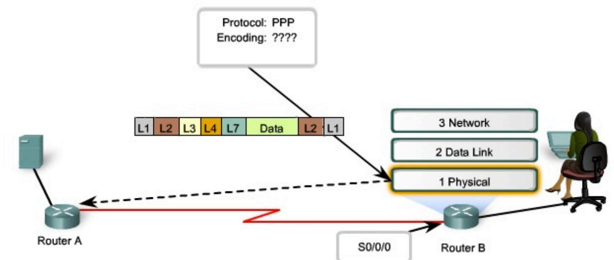
Data Link layer of Router B puts data onto the media



Click to see the steps.

With the circuit and PPP session already established between the routers, the Physical layer begins encoding the frame onto the WAN media, bit by bit. The receiving router (RouterA) buffers the bits as they are received. The type of bit representation and encoding is dependent on the type of WAN technology being used.

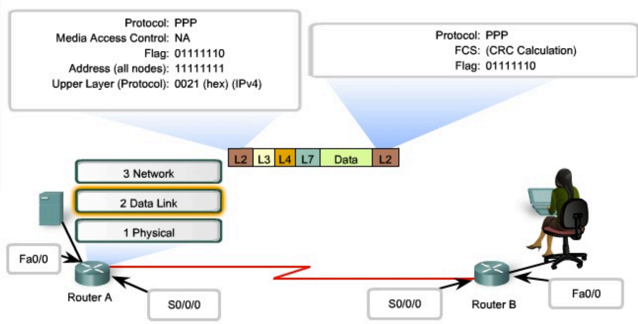
Physical layer transports across the media



Click to see the steps.

RouterA examines the bits in the flag to identify the beginning of the frame. RouterA then begins buffering the bits as part of the reconstructed frame. When the entire frame is received, as indicated by the flag in the trailer, the RouterA generates a CRC of the frame. It then compares this to the FCS at the end of the frame to determine that the frame was received intact. When the frame is confirmed as a good frame, the headers are removed and the packet is pushed up to the Network layer of RouterA.

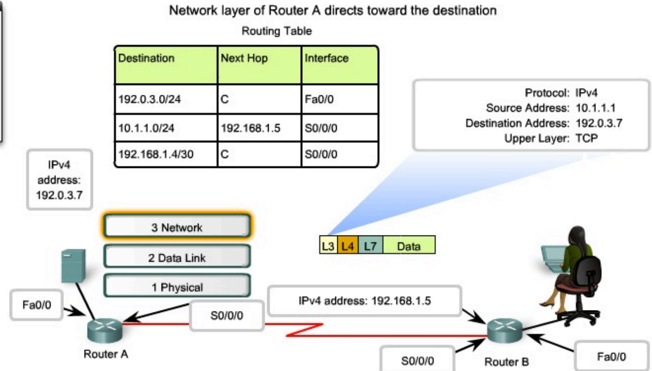
Data Link layer of Router A gets data off the media



Click to see the steps.

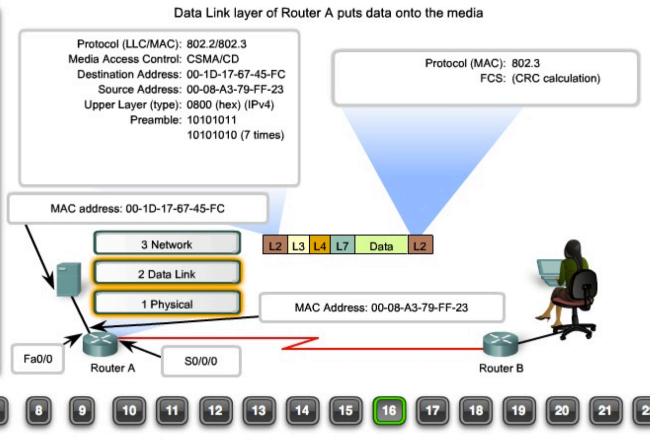
At the Network layer, the destination IPv4 address of the packet is compared against the routes in the routing table. A match is found that is directly connected to interface Fa0/0. The packet inside RouterA is then passed to the circuitry for the Fa0/0 interface.

Network layer of Router A directs toward the destination

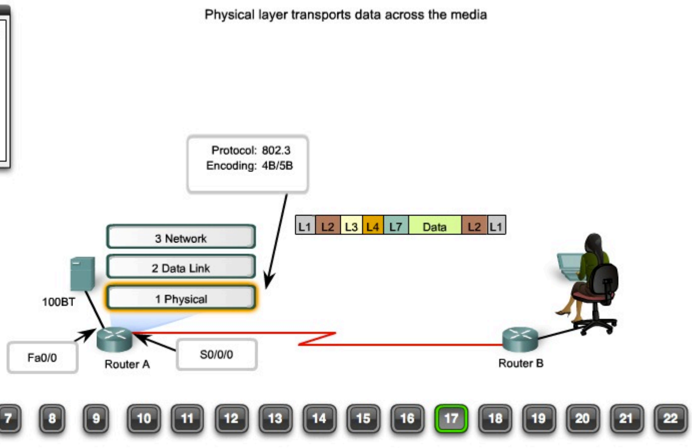


Click to see the steps.

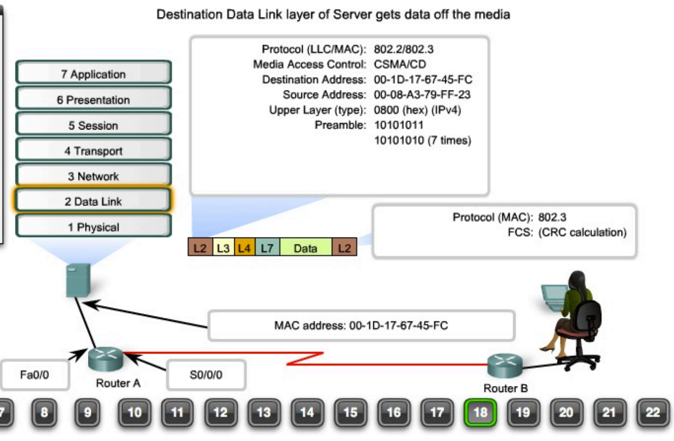
The Data Link layer refers to the ARP cache of RouterA to determine the MAC address that is associated with the interface of Web Server. It then uses this MAC address to build an Ethernet II frame to transport the IPv4 packet across the local media to the server. The MAC address of the Fa0/0 interface of RouterA is used as the source MAC address, and the MAC address of the server is used as the destination MAC address in the frame. The frame also indicates the upper layer protocol of IPv4 with a value of 0800 (hex) in the Type field. The frame begins with the Preamble and ends with a cyclic redundancy check in the Frame Check Sequence at the end of the frame for the



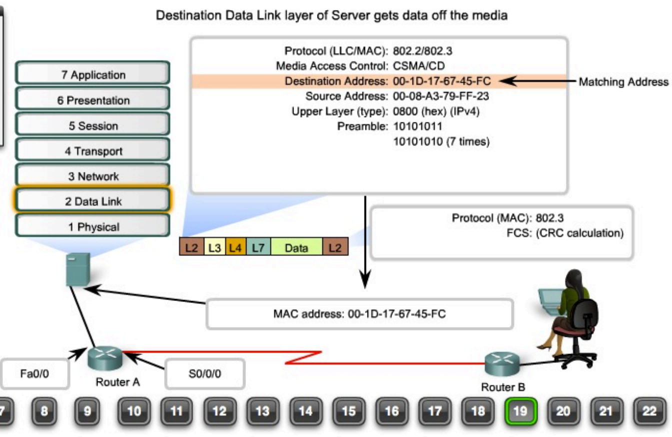
The Physical layer begins encoding the frame onto the media, bit by bit. The segment between RouterA and the server is a 100Base-T segment; therefore, the bits are encoded using 4B/5B encoding. The NIC circuitry within the server buffers the bits as they are recived.

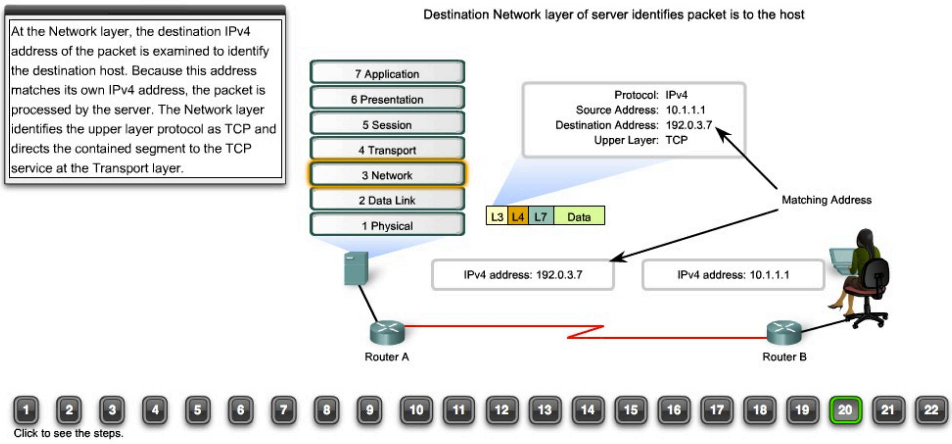


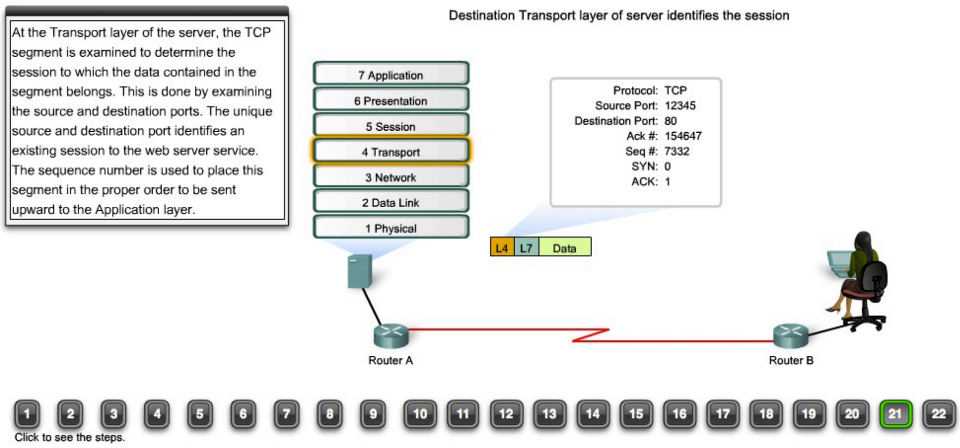
The NIC circuitry in the server examines the bits in the Preamble, looking for the two consecutive 1 bits that indicate the synching process is completed and the beginning of the frame. The server then begins buffering the bits as part of the reconstructed frame. When it has received the entire frame, the Data Link Layer generates a CRC of the frame. It then compares this to the FCS at the end of the frame to determine that the frame was received intact.

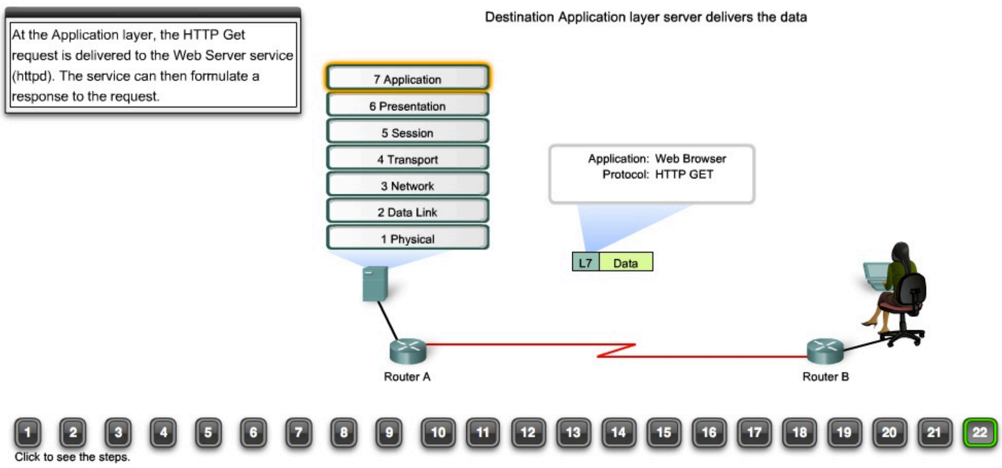


When the frame is confirmed as a good frame, the destination MAC address in the frame is compared to the MAC address of the NIC in the server. Because it matches, the headers are removed and the packet is pushed up to the Network layer.



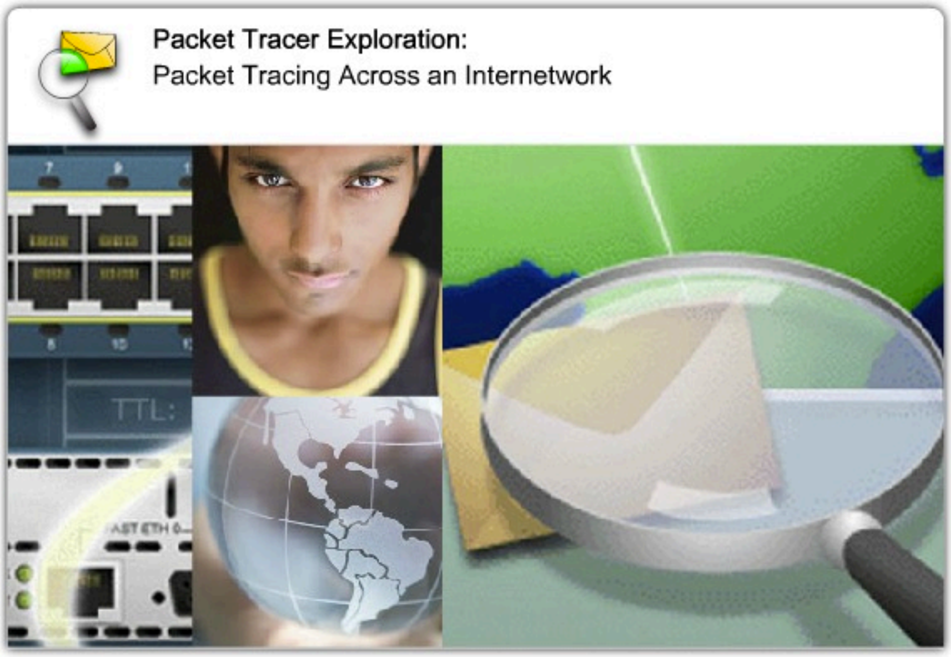

At the Network layer, the destination IPv4 address of the packet is examined to identify the destination host. Because this address matches its own IPv4 address, the packet is processed by the server. The Network layer identifies the upper layer protocol as TCP and directs the contained segment to the TCP service at the Transport layer.
Destination Network layer of server identifies packet is to the host
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical
Protocol: IPv4
Source Address: 10.1.1.1
Destination Address: 192.0.3.7
Upper Layer: TCP
Matching Address
L3
L4
L7
Data
IPv4 address: 192.0.3.7
IPv4 address: 10.1.1.1
Router A
Router B
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.


At the Transport layer of the server, the TCP segment is examined to determine the session to which the data contained in the segment belongs. This is done by examining the source and destination ports. The unique source and destination port identifies an existing session to the web server service. The sequence number is used to place this segment in the proper order to be sent upward to the Application layer.
Destination Transport layer of server identifies the session
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical
Protocol: TCP
Source Port: 12345
Destination Port: 80
Ack #: 154647
Seq #: 7332
SYN: 0
ACK: 1
L4
L7
Data
Router A
Router B
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.


At the Application layer, the HTTP Get request is delivered to the Web Server service (httpd). The service can then formulate a response to the request.
Destination Application layer server delivers the data
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical
Application: Web Browser
Protocol: HTTP GET
L7
Data
Router A
Router B
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Click to see the steps.

CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.4 Putting it All Together
7.4.1 Follow Data Through an Internetwork

Page 3:
In this activity, you can examine in further detail the step-by-step animation on the previous page.

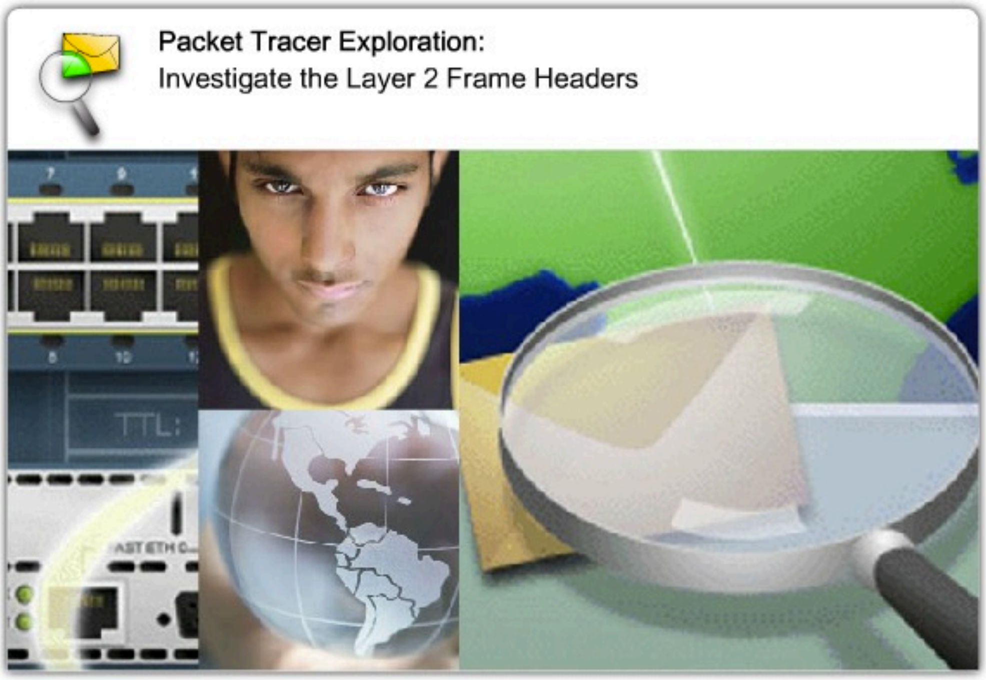


File: 7.4.1 – pka.pka

CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.5 Labs and Activities
7.5.1 Investigating Layer 2 Frame Headers

Page 1:
In this activity, you can explore some of the most common Layer 2 encapsulations.

Click the Packet Tracer icon to launch the Packet Tracer activity.



File: 7.5.1 – pka.pka

CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.5 Labs and Activities
7.5.2 Lab - Frame Examination

Page 1:
In this lab, you will use Wireshark to capture and analyze Ethernet II frame header fields.

Click the Lab icon to for more information.

File: 7.5.2 - lab - Frame Examination.pdf

CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.6 Chapter Summary
7.6.1 Summary and Review

Page 1:
The OSI Data Link layer prepares Network layer packets for placement onto the physical media that transports data.

The wide range of data communications media requires a correspondingly wide range of Data Link protocols to control data access to these media.

Media access can be orderly and controlled or it can be contention-based. The logical topology and physical medium help determine the media access method.

The Data Link layer prepares the data for placement on the media by encapsulating the Layer 3 packet into a frame.

A frame has header and trailer fields that include Data Link source and destination addresses, QoS, type of protocol, and Frame Check Sequence values.

In this chapter, you learned to:

- Explain the role of Data Link layer protocols in data transmission.
- Describe how the Data Link layer prepares data for transmission on network media.
- Describe the different types of media access control methods.
- Identify several common logical network topologies and describe how the logical topology determines the media access control method for that network.
- Explain the purpose of encapsulating packets into frames to facilitate media access.
- Describe the Layer 2 frame structure and identify generic fields.
- Explain the role of key frame header and trailer fields, including addressing, QoS, type of protocol, and Frame Check Sequence.

CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.6 Chapter Summary
7.6.1 Summary and Review

Page 2:

Use this activity to check your understanding of the main points in this chapter.

- A series of questions will be presented. This is not a quiz and your answers are not recorded.
- Click **Answer** to see the answer.
- Click **Next Question** to go to the next question in the series.

Click Here to Begin

1. How does the Data Link layer prepare packets for transmission?

Answer

The Data Link layer prepares a packet for transport across the local media by encapsulating it with a header and a trailer to create a frame.

Next Question

2. Describe four general Data Link layer media access methods. Suggest data communications environments in which these access methods may be appropriately implemented.

Answer

Media access control methods for shared media:

- Controlled—Each node has its own time to use the medium - a ring topology
- Contention-based—All nodes compete for the use of the medium - a bus topology

Media access control in point-to-point connections:

- Half-duplex-a node can only transmit or receive at one time - long distance low bandwidth link
- Full-duplex- a node can both transmit and receive at the same time- long distance high bandwidth link

Next Question

3. Compare and contrast the logical point-to-point and logical multi-access topologies.

Answer

A logical point-to-point topology connects two nodes directly together. In data networks with point-to-point topologies, the media access control protocol can be very simple. All frames on the media can only travel to or from the two nodes. The frames are placed on the media by the node at one end and taken off the media by the node at the other end. In point-to-point networks, if data can only flow in one direction at a time, it is operating as a half-duplex link. If data can successfully flow across the link from each node simultaneously, it is a full-duplex service.

A logical multi-access topology enables a number of nodes to communicate by using the same shared media. Data from only one node can be placed on the medium at any one time. Every node sees all the frames that are on the medium, but only the node to which the frame is addressed

3. Compare and contrast the logical point-to-point and logical multi-access topologies.

Answer

end and taken off the media by the node at the other end. In point-to-point networks, if data can only flow in one direction at a time, it is operating as a half-duplex link. If data can successfully flow across the link from each node simultaneously, it is a full-duplex service.

A logical multi-access topology enables a number of nodes to communicate by using the same shared media. Data from only one node can be placed on the medium at any one time. Every node sees all the frames that are on the medium, but only the node to which the frame is addressed processes the contents of the frame. Having many nodes share access to the medium requires a Data Link media access control method to regulate the transmission of data and thereby reduce collisions between different signals.

Next Question

4. Describe the features of a logical ring topology.

Answer

In a logical ring topology, each node in turn receives a frame. If the frame is not addressed to a node, the node passes the frame to the next node. This allows a ring to use a controlled media access control technique called token passing.

The media usually carries only one frame at a time. If there is no data being transmitted, a signal (known as a token) may be placed on the media and a node can only place a data frame on the media when it has the token.

Next Question

5. Name five Layer 2 protocols.

Answer

- Point-to-Point Protocol (PPP)
- Ethernet
- High-Level Data Link Control (HDLC)
- Frame Relay
- Asynchronous Transfer Mode (ATM)

Next Question

6. How do Data Link layer addresses differ from Network layer addresses?

Answer

Unlike Layer 3 logical addresses that are hierarchical, physical addresses do not indicate on what network the device is located. If the device is moved to another network or subnet, it will still function with the same Layer 2 physical address.

Because the frame is only used to transport data between nodes across the local media, the Data Link layer address is only used for local delivery. Addresses at this layer have no meaning beyond the local network. Compare this to Layer 3, where addresses in the packet header are carried from source host to destination host regardless of the number of network hops along the route.

Next Question

7. What are the possible header field types in Data Link frames?

Answer

Typical frame header fields include:

- Start Frame field—Indicates the beginning of the frame
- Source and Destination address fields—Indicates the source and destination nodes on the media
- Priority/Quality of Service field—Indicates a particular type of communication service for processing
- Type field—Indicates the upper layer service contained in the frame
- Logical connection control field—Used to establish a logical connection between nodes
- Physical link control field—Used to establish the media link
- Flow control field—Used to start and stop traffic over the media
- Congestion control field—Indicates congestion in the media

Next Question

8. Give the purpose of the Frame Check Sequence field in a Data Link frame trailer.

Answer

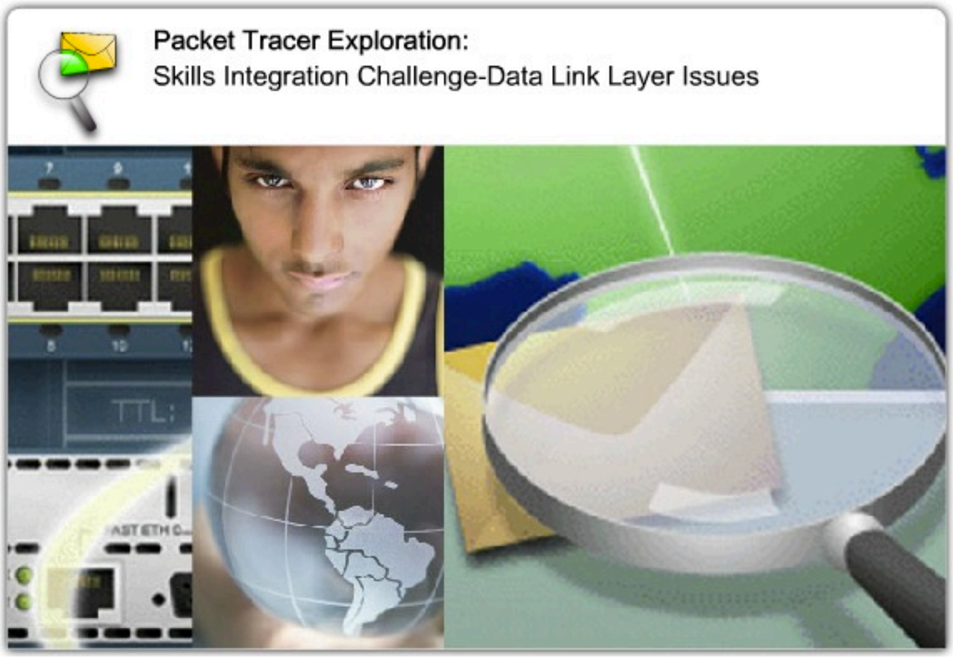
The media is a potentially unsafe environment for data. The signals on the media could be subject to interference, distortion, or loss that would substantially change the bit values that those signals represent. To ensure that the content of the received frame at the destination matches that of the frame that left the source node, a transmitting node creates a logical summary of the contents of the frame. This is known as the Frame Check Sequence (FCS) and is placed in the trailer to represent the contents of the frame. When the frame arrives at the destination node, the receiving node calculates its own logical summary, or FCS, of the frame. The receiving node compares the two FCS values. If the two values are the same, the frame is considered to have arrived as transmitted. If the FCS values differ, the frame is discarded. There is always the small possibility that a frame with a good FCS result is actually corrupt. Errors in bits may cancel each other out when the FCS is calculated. Upper layer protocols would then be required to detect and correct this data loss.

This concludes this chapter's Problems and Discussion questions.

CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.6 Chapter Summary
7.6.1 Summary and Review

Page 3:
In this activity, you will continue to build a more complex model of the Exploration lab network.

Click the Packet Tracer icon to launch the Packet Tracer activity.



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CCNA Exploration - Network Fundamentals
7 Data Link Layer
7.6 Chapter Summary
7.6.1 Summary and Review

Page 4:
To Learn More
Reflection Questions

How did the widespread adoption of the OSI model change the development of network technologies? How does today's data communications environment differ from that of twenty years ago because of the adoption of the model?

Discuss and compare Carrier Sense Multi-Access Data Link media access protocol features and operation with those of deterministic media access protocols.

Discuss and consider the issues that the developers of a new physical data communications medium have to resolve to ensure interoperability with the existing upper layer TCP/IP protocols.

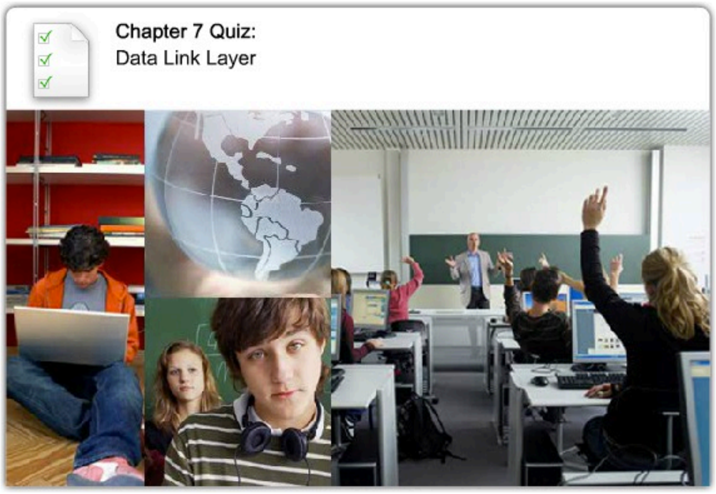
CCNA Exploration - Network Fundamentals

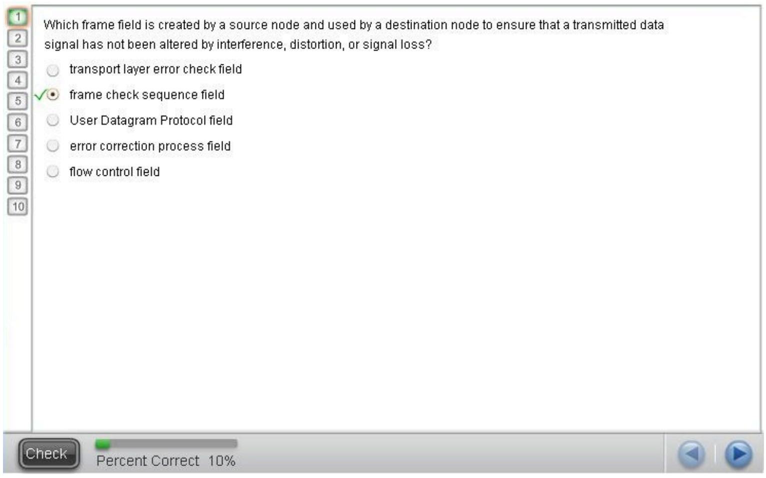
7 Data Link Layer

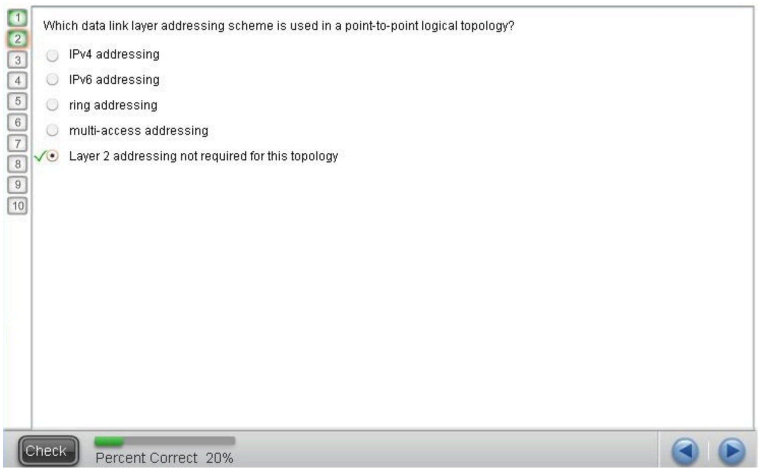
7.7 Chapter Quiz

7.7.1 Chapter Quiz

Page 1:







What do network hosts use data link layer addresses for?

- remote delivery
- local and remote delivery
- local delivery
- remote delivery using routers

Check
Percent Correct 30%

Which three basic parts are common to all frame types supported by the data link layer? (Choose three.)

- header
- type field
- MTU size
- data
- trailer
- CRC value

Check
Percent Correct 40%

What are two characteristics of the controlled media access method? (Choose two.)

- It is known as a deterministic access method.
- There are no collisions when this type of method is in use.
- Any station can transmit at any time.
- Bandwidth is more efficiently utilized than in a contention-based access method.
- Stations must determine if the media is carrying a signal before they can transmit.

Check
Percent Correct 50%

Which of the following are sublayers of the Data Link layer?

- ACL, LMC
- MAC, LAC
- MAC, LLC
- OSI, LLC

Check
Percent Correct 60%

1 2 3 4 5 6 7 8 9 10

Which of the following are data link layer encapsulation details? (Choose two.)

- [x] A header and trailer are added.
- [ ] Data is converted into packets.
- [x] Packets are packaged into frames.
- [ ] Frames are divided into segments.
- [ ] Packets are changed into bits for Internet travel.

Check Percent Correct 70%

1 2 3 4 5 6 7 8 9 10

What is achieved by the encapsulation process at the data link layer?

- (•) Packets are put into frames.
- ( ) Data is packaged into a packet.
- ( ) Packets are divided into segments.
- ( ) Data is converted for Internet transmission.

Check Percent Correct 80%

1 2 3 4 5 6 7 8 9 10

Drag the characteristics on the left to the associated media access control methods on the right. (Not all options are used.)

deterministic

Ethernet

physical ring topology

no collisions

non-deterministic

Only one station can transmit at a time.

Stations can transmit at any time.

token passing

more efficient use of bandwidth

controlled access

contention-based access

Check Percent Correct 80%

1 2 3 4 5 6 7 8 9 10

Drag the characteristics on the left to the associated media access control methods on the right. (Not all options are used.)

physical ring topology

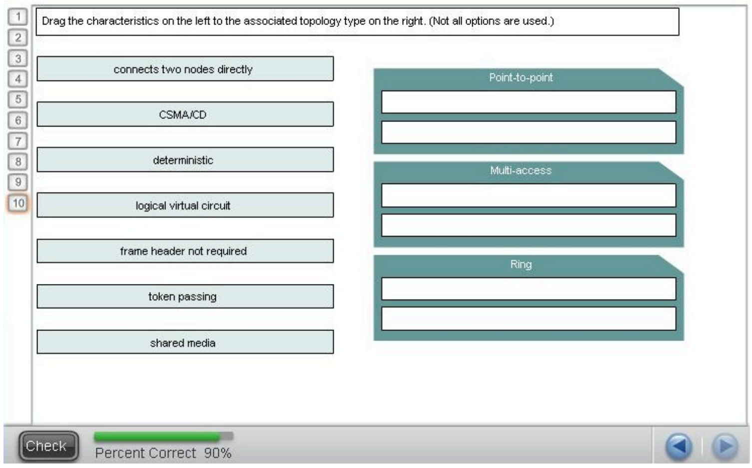
controlled access

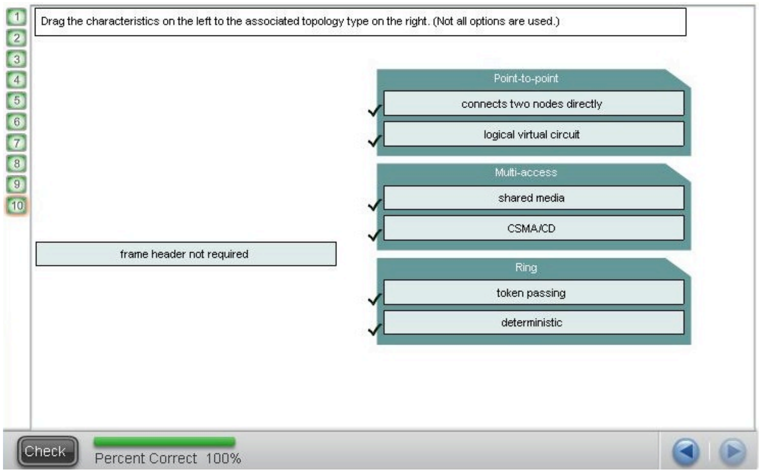
- ✓ deterministic
- ✓ token passing
- ✓ Only one station can transmit at a time.
- ✓ no collisions

contention-based access

- ✓ non-deterministic
- ✓ Ethernet
- ✓ Stations can transmit at any time.
- ✓ more efficient use of bandwidth

Check Percent Correct 90%


Drag the characteristics on the left to the associated topology type on the right. (Not all options are used.)
connects two nodes directly
CSMA/CD
deterministic
logical virtual circuit
frame header not required
token passing
shared media
Point-to-point
Multi-access
Ring
Check
Percent Correct 90%

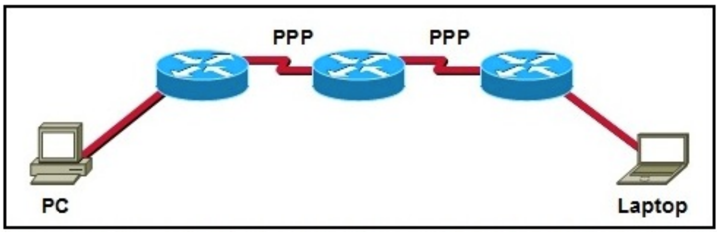

Drag the characteristics on the left to the associated topology type on the right. (Not all options are used.)
Point-to-point
connects two nodes directly
logical virtual circuit
Multi-access
shared media
CSMA/CD
Ring
token passing
deterministic
frame header not required
Check
Percent Correct 100%

CCNA Exploration - Network Fundamentals
MODULE 7 (version 4.0)

1. **Which options are properties of contention-based media access for a shared media? (Choose three.)**
   non-deterministic
   less overhead
   one station transmits at a time
   collisions exist
   devices must wait their turn
   token passing

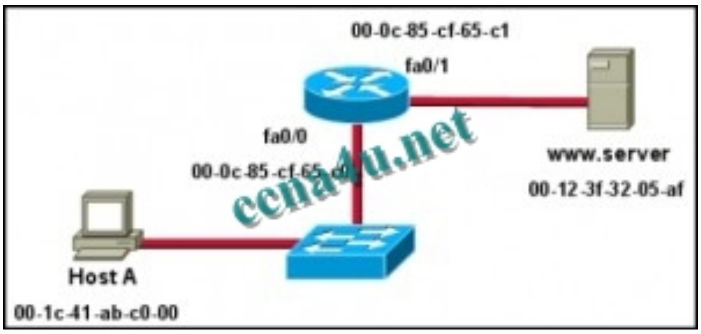
2. **What is a primary purpose of encapsulating packets into frames?**
   provide routes across the internetwork
   format the data for presentation to the user
   facilitate the entry and exit of data on media
   identify the services to which transported data is associated

3. **Refer to the exhibit. How many unique CRC calculations will take place as traffic routes from the PC to the laptop?**
   1
   2
   4
   8
   16



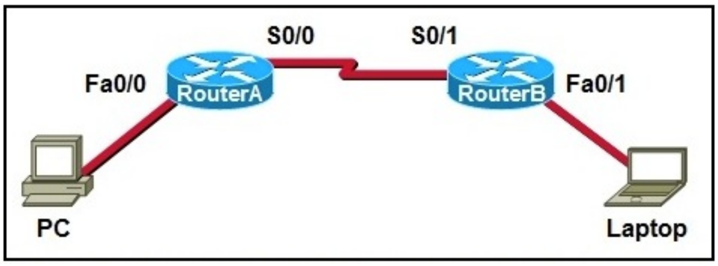
4. **What is true concerning physical and logical topologies?**
   The logical topology is always the same as the physical topology.
   Physical topologies are concerned with how a network transfers frames.
   Physical signal paths are defined by Data Link layer protocols.
   Logical topologies consist of virtual connections between nodes.

5. **Refer to the exhibit. Assuming that the network in the exhibit is converged meaning the routing tables and ARP tables are complete, which MAC address will Host A place in the destination address field of Ethernet frames destined for http://www.server?**
   00-1c-41-ab-c0-00
   00-0c-85-cf-65-c0
   00-0c-85-cf-65-c1
   00-12-3f-32-05-af



6. **What are three characteristics of valid Ethernet Layer 2 addresses? (Choose three.)**
They are 48 binary bits in length.
They are considered physical addresses.
They are generally represented in hexadecimal format.
They consist of four eight-bit octets of binary numbers.
They are used to determine the data path through the network.
They must be changed when an Ethernet device is added or moved within the network.

7. **Refer to the exhibit. A frame is being sent from the PC to the laptop. Which source MAC and IP addresses will be included in the frame as it leaves RouterB? (Choose two.)**
source MAC – PC
source MAC – S0/0 on RouterA
source MAC – Fa0/1 on RouterB
source IP – PC
source IP – S0/0 on RouterA
source IP – Fa0/1 of RouterB



8. **What determines the method of media access control? (Choose two.)**
network layer addressing
media sharing
application processes
logical topology
intermediary device function

9. **What is the purpose of the preamble in an Ethernet frame?**
is used as a pad for data
is used to identify the source address
is used to identify the destination address
is used for timing synchronization

10. **What statements are true regarding addresses found at each layer of the OSI model? (Choose two.)**
Layer 2 may identify devices by a physical address burned into the network card
Layer 2 identifies the applications that are communicating
Layer 3 represents a hierarchical addressing scheme
Layer 4 directs communication to the proper destination network
Layer 4 addresses are used by intermediary devices to forward data

11. **Which statements describe the logical token-passing topology? (Choose two.)**
Network usage is on a first come, first serve basis.
Computers are allowed to transmit data only when they possess a token.
Data from a host is received by all other hosts.
Electronic tokens are passed sequentially to each other.
Token passing networks have problems with high collision rates.

12. **Which sublayer of the data link layer prepares a signal to be transmitted at the physical layer?**
LLC
MAC
HDLC
NIC

13. **What is true regarding media access control? (Choose three.)**
Ethernet utilizes CSMA/CD
defined as placement of data frames on the media

contention-based access is also known as deterministic
802.11 utilizes CSMA/CD
Data Link layer protocols define the rules for access to different media
controlled access contains data collisions

14. **What is a characteristic of a logical point-to-point topology?**
The nodes are physically connected.
The physical arrangement of the nodes is restricted.
The media access control protocol can be very simple.
The data link layer protocol used over the link requires a large frame header.

15. **What two facts are true when a device is moved from one network or subnet to another? (Choose two.)**
The Layer 2 address must be reassigned.
The default gateway address should not be changed.
The device will still operate at the same Layer 2 address.
Applications and services will need additional port numbers assigned.
The Layer 3 address must be reassigned to allow communications to the new network.

16. **What is a function of the data link layer?**
provides the formatting of data
provides end-to-end delivery of data between hosts
provides delivery of data between two applications
provides for the exchange data over a common local media

17. **Which three factors should be considered when implementing a Layer 2 protocol in a network? (Choose three.)**
the Layer 3 protocol selected
the geographic scope of the network
the PDU defined by the transport layer
the physical layer implementation
the number of hosts to be interconnected

18. **What is the primary purpose of the trailer in a data link layer frame?**
define the logical topology
provide media access control
support frame error detection
carry routing information for the frame

19. **A network administrator has been asked to provide a graphic representation of exactly where the company network wiring and equipment are located in the building. What is this type of drawing?**
logical topology
physical topology
cable path
wiring grid
access topology

20. **Refer to the exhibit. Which statement describes the media access control methods that are used by the networks in the exhibit?**
All three networks use CSMA/CA
None of the networks require media access control.
Network 1 uses CSMA/CD and Network 3 uses CSMA/CA.
Network 1 uses CSMA/CA and Network 2 uses CSMA/CD.
Network 2 uses CSMA/CA and Network 3 uses CSMA/CD.