

Completed



The OSI Model

The OSI Model



ISO (International Standards Organization)

A standards body that is also known as the "International Organization for Standardization."



"Switches live at Layer 2."



"Routers live at Layer 3."

Completed



The OSI Model

The OSI Model's Seven Layers

**Floor 1****Layer 2
Layer 1****Data Link
Physical**

Ethernet Switch

A Layer 2 device that can make forwarding decisions based on physical addresses.

Completed



The OSI Model

The OSI Model's Seven Layers

**Floor 1****Layer 3**

Network

Layer 2

Data Link

Layer 1

Physical

Router

A Layer 3 device that can make forwarding decisions based on logical addresses.

Completed

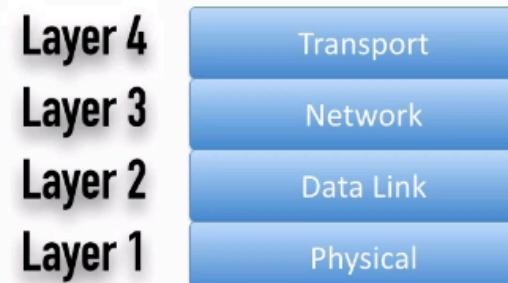


The OSI Model

The OSI Model's Seven Layers



Floor 1



TCP (Transmission Control Protocol)

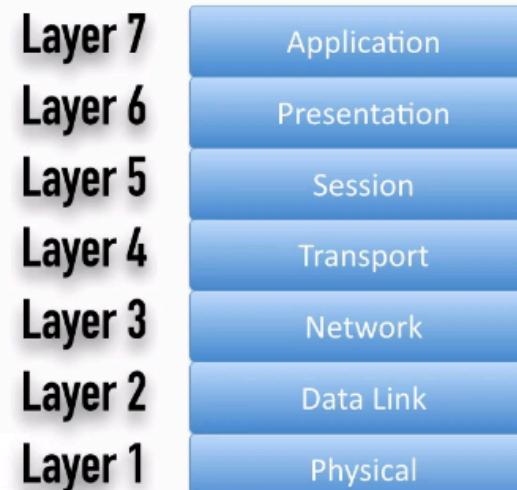
A reliable Layer 4 protocol.

Completed



The OSI Model

The OSI Model's Seven Layers

**Floor 1**

SIP (Session Initiation Protocol)

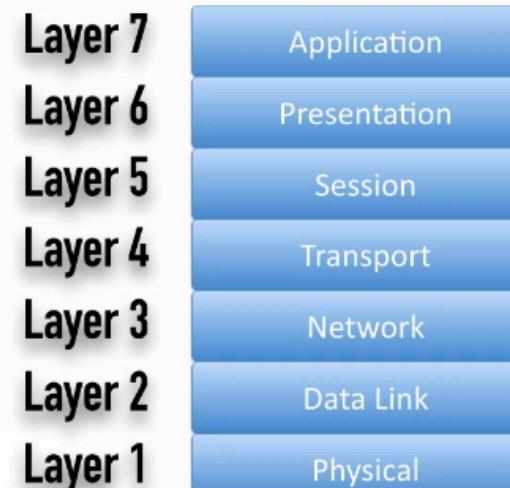
A Layer 5 protocol used in voice over IP (VoIP) networks that helps setup, maintain, and tear down a phone call.

Completed



The OSI Model

The OSI Model's Seven Layers

**Floor 1**

ASCII (American Standard Code for Information Interchange)

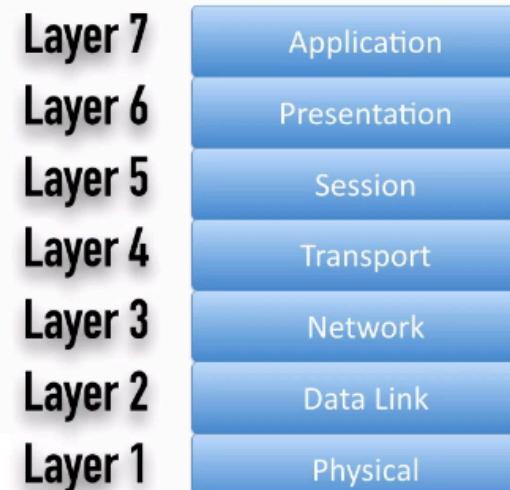


The OSI Model

The OSI Model's Seven Layers



Floor 1



EBCDIC (Extended Binary Coded Decimal Interchange Code)

Completed

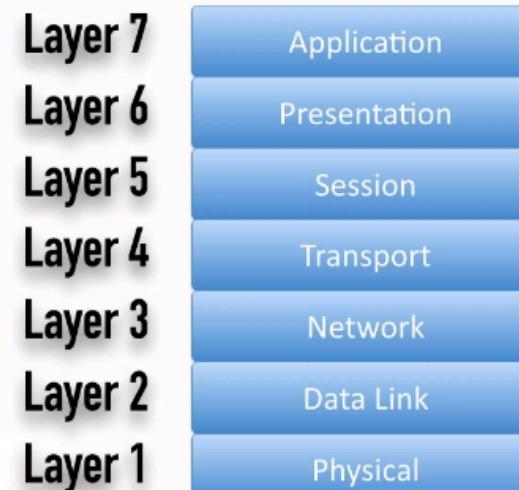


The OSI Model

The OSI Model's Seven Layers



Floor 1



All People Seem To Need Data Processing

Completed

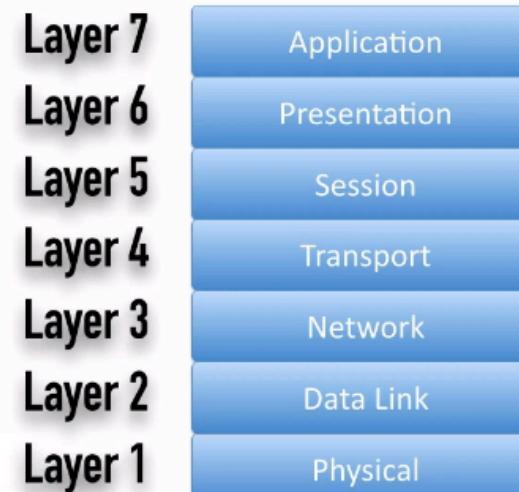


The OSI Model

The OSI Model's Seven Layers



Floor 1



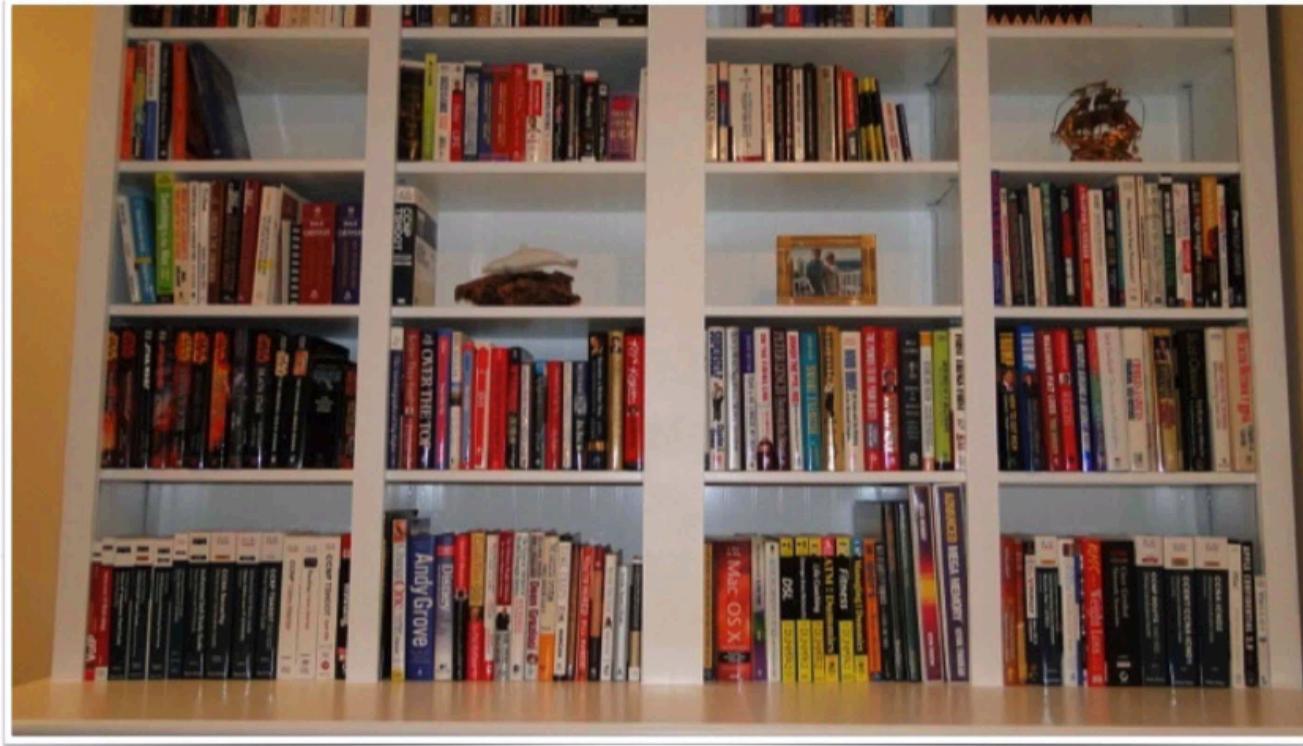
Please Do Not Throw Sausage Pizza Away

Completed



The OSI Model

The OSI Model's Seven Layers



Completed



Layer 1—The Physical Layer

Layer 1 - The Physical Layer

Playback Speed

Completed



Layer 1—The Physical Layer



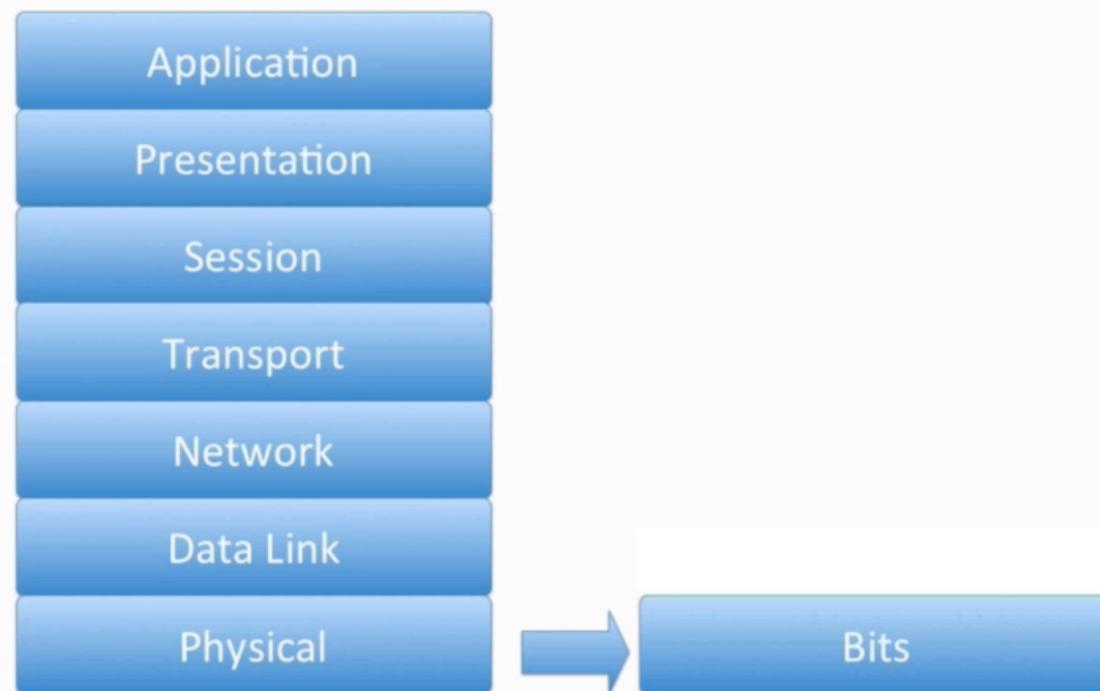
Protocol Data Units (PDUs)

The names given to data at different layers of the OSI Model.

Completed



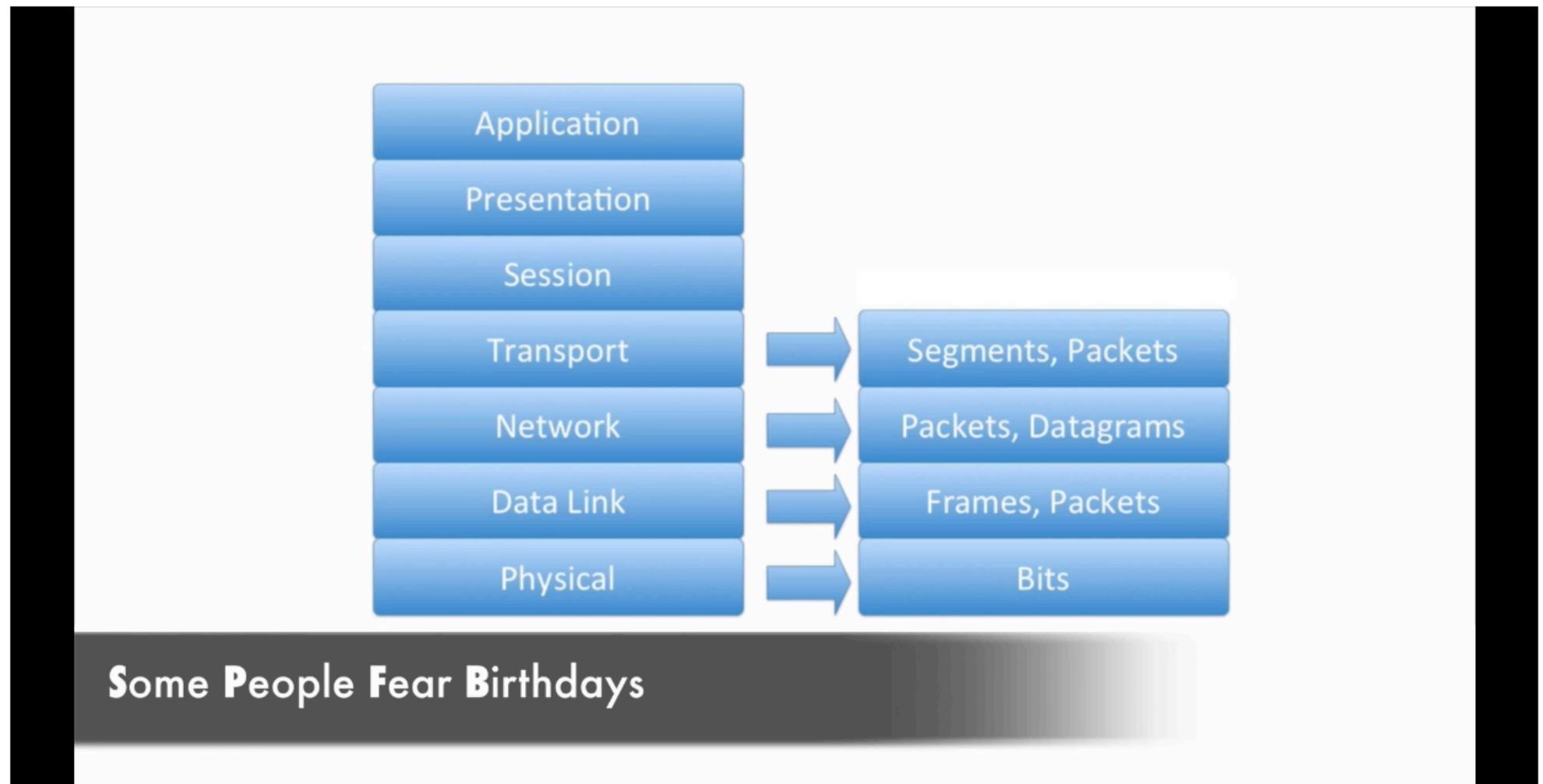
Layer 1—The Physical Layer



Completed



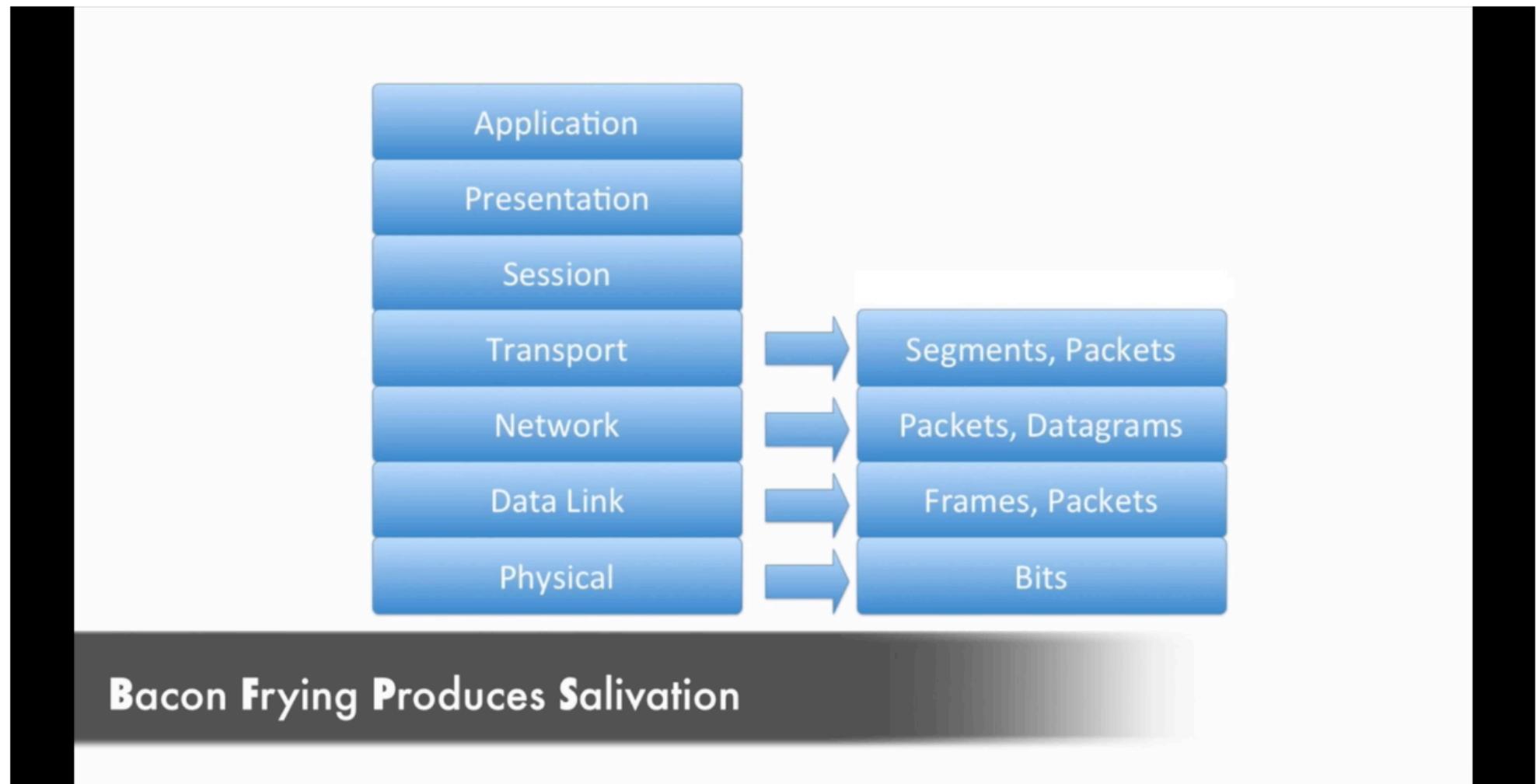
Layer 1—The Physical Layer



Completed



Layer 1—The Physical Layer



Completed



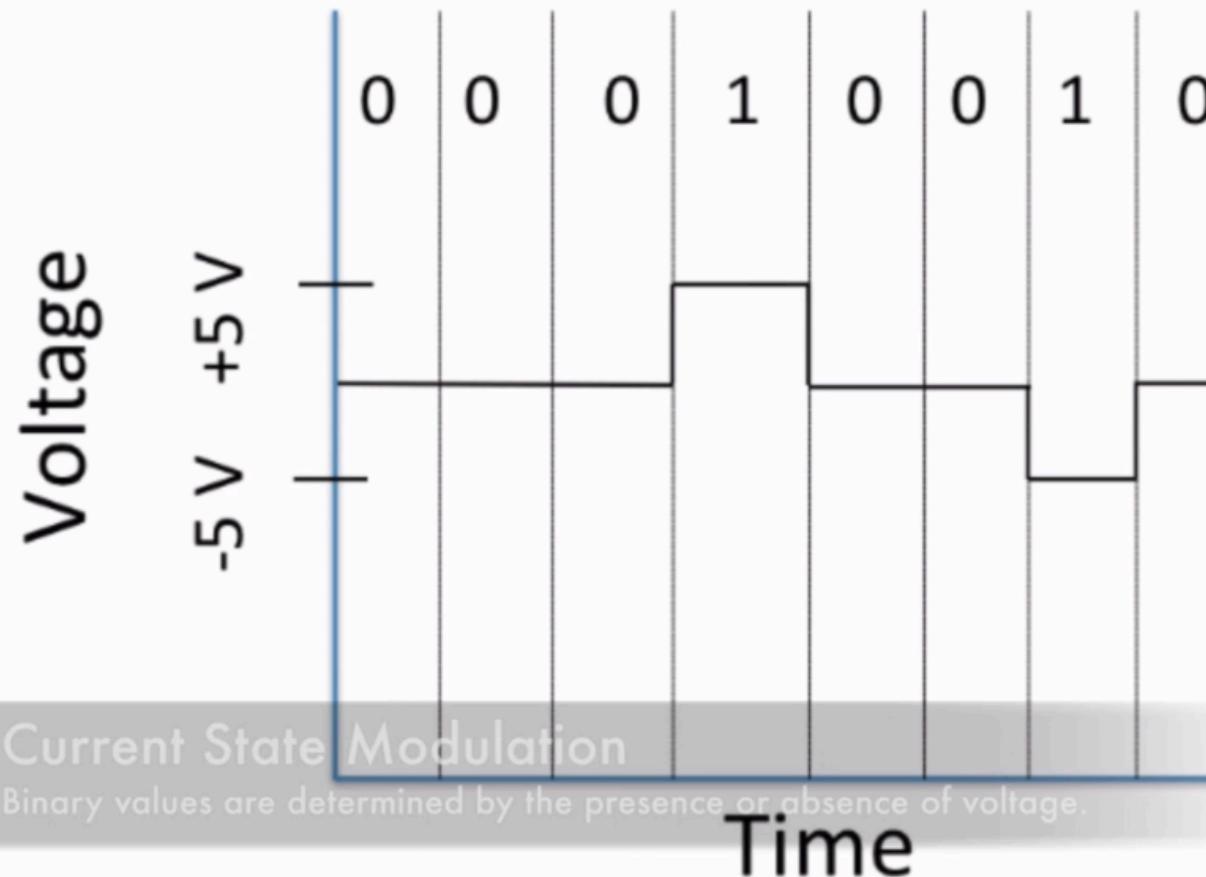
Layer 1—The Physical Layer



- How bits are represented on the medium



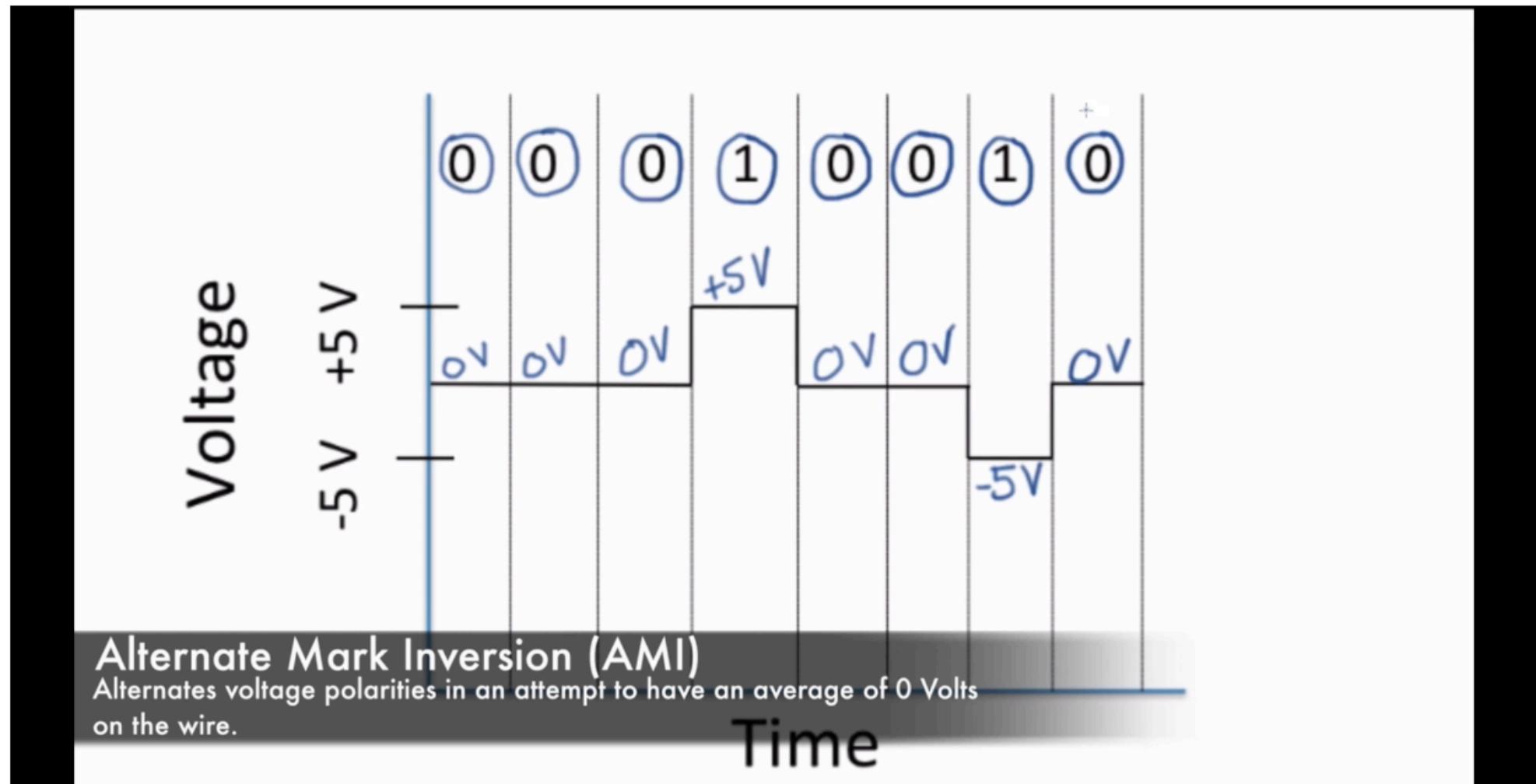
Layer 1—The Physical Layer



Completed



Layer 1—The Physical Layer



Completed



Layer 1—The Physical Layer



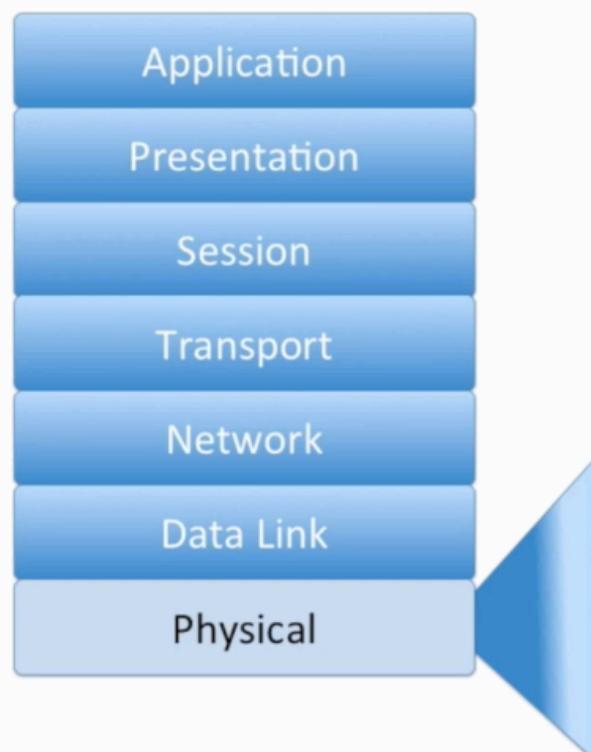
State Transition Modulation

Binary values are determined based on a change in voltage.

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks

TIA/EIA-568-B Standard

A standard that describes the wiring of an RJ-45 jack.

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology

Examples of Physical Topologies

Star, Bus, and Ring

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits

Asynchronous Synchronization

The sender sends START and STOP bits. The receiver uses an internal clock.

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits

Synchronous Communication

Both the sender and receiver use internal clocks.

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits
- Bandwidth usage

Broadband

Different communication flows use different frequency ranges.

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits
- Bandwidth usage

Baseband

A single communications flow consumes all of the frequencies on a medium.

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits
- Bandwidth usage

Time Division Multiplexing (TDM) Multiplexing strategy
Different channels are given different time slots, and they take turns.

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits
- Bandwidth usage
- Multiplexing strategy

Statistical TDM

Time slots are allocated to channels based on their current needs.

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits
- Bandwidth usage

Frequency Division Multiplexing (FDM)
Different communication channels use different frequency ranges.

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits
- Bandwidth usage

Examples of Physical Layer Responsibilities
Connectors and Wiring

Completed



Layer 1—The Physical Layer



- How bits are represented on the medium
- Wiring standards for connectors and jacks
- Physical topology
- Synchronizing bits
- Bandwidth usage

Multiplexing strategy

Example of a Physical Layer Device

Ethernet Hub

Completed



Layer 2—The Data Link Layer

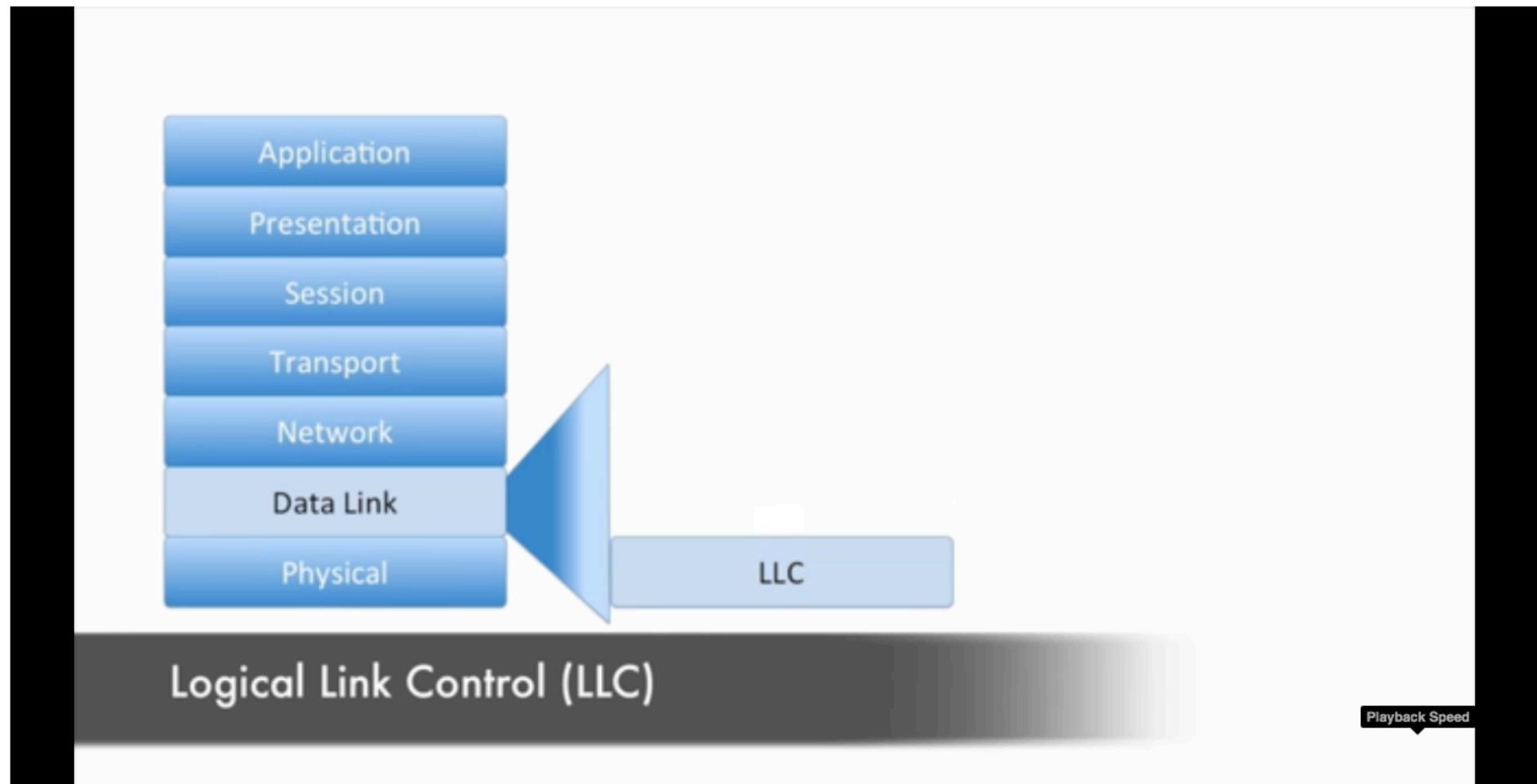
Layer 2 - The Data Link Layer

Playback Speed

Completed



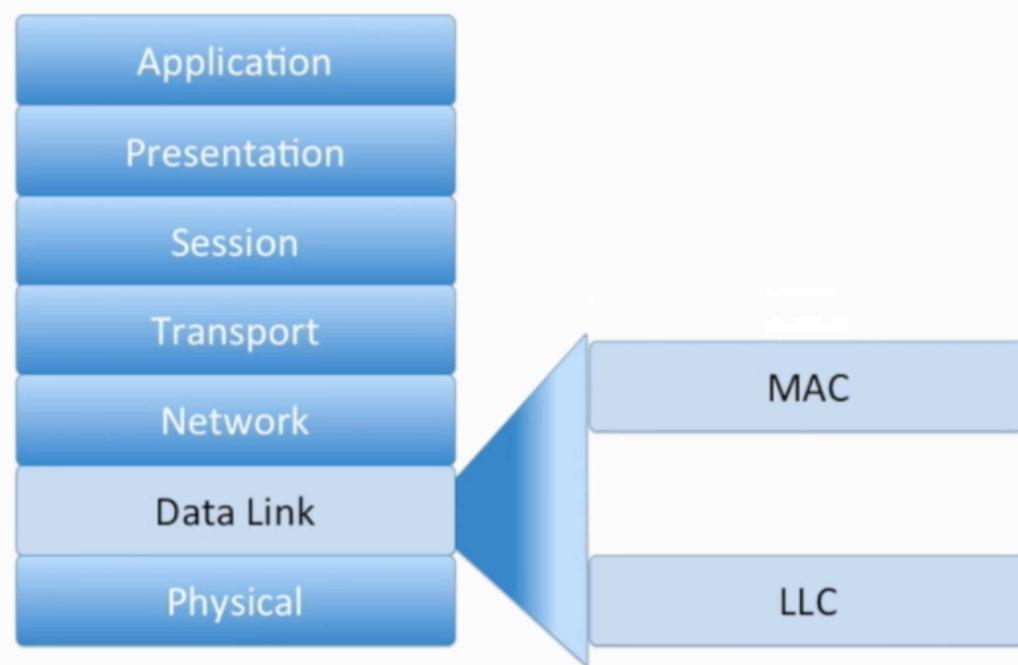
Layer 2—The Data Link Layer



Completed



Layer 2—The Data Link Layer



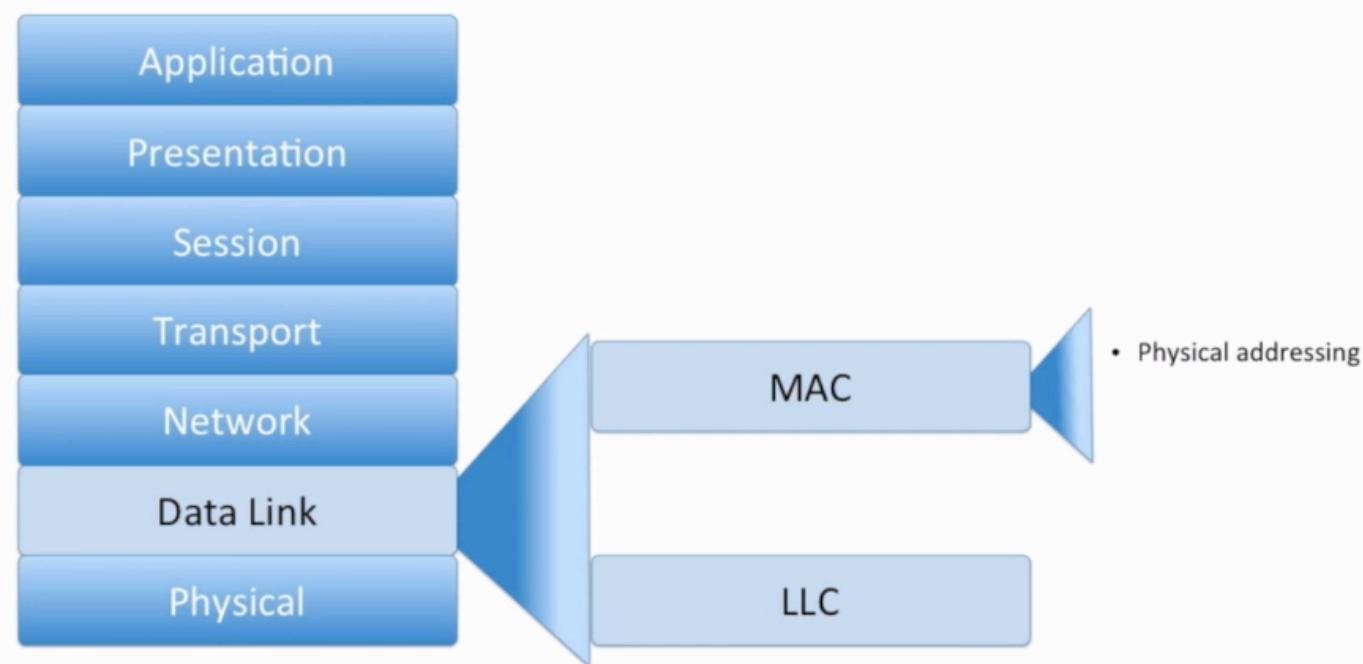
Media Access Control (MAC)

Playback Speed

Completed



Layer 2—The Data Link Layer



MAC Address

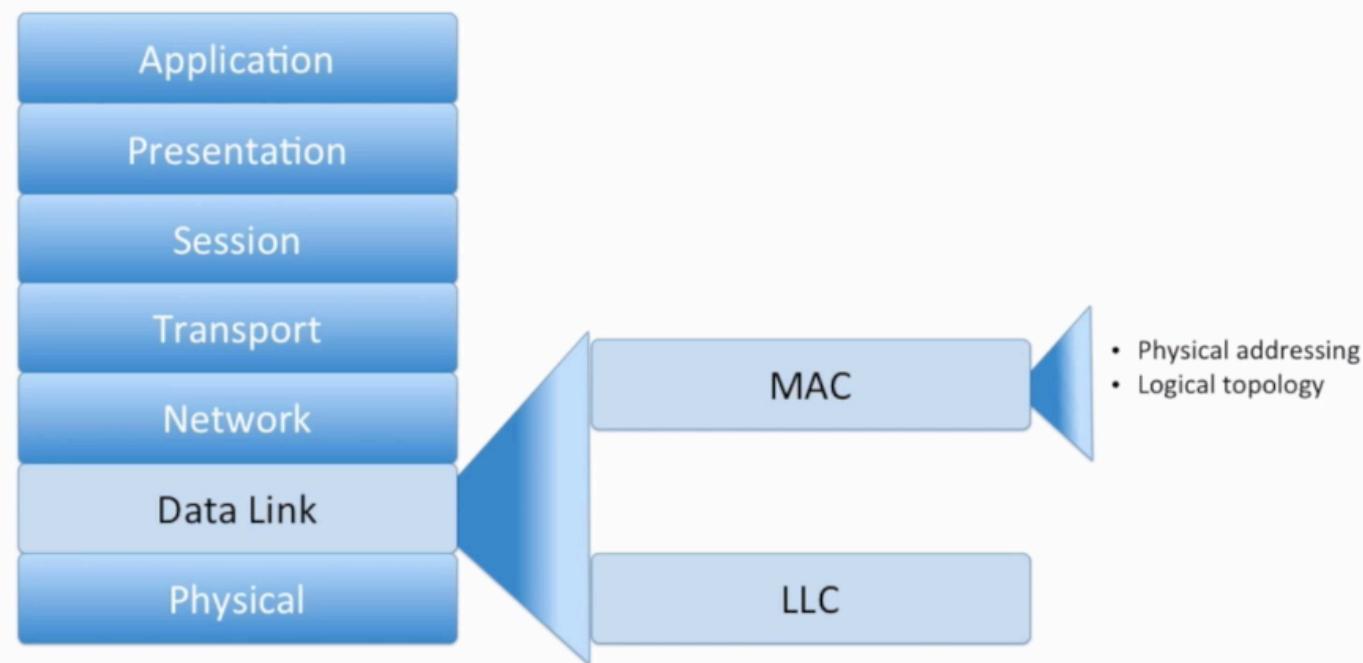
A 48-bit address burned into a network interface card (NIC).

Playback Speed

Completed



Layer 2—The Data Link Layer



Logical Topology

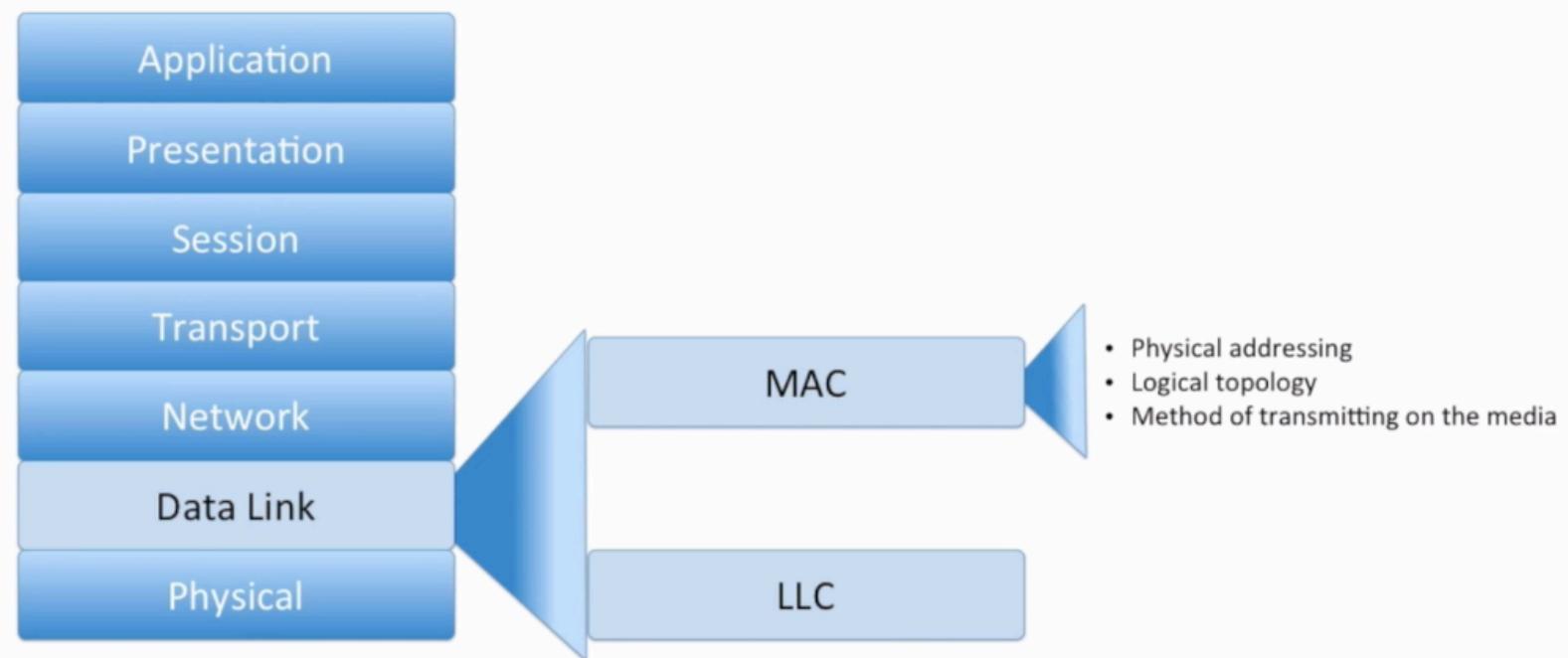
Describes how traffic logically flows between devices.

Playback Speed

Completed



Layer 2—The Data Link Layer



Token Ring

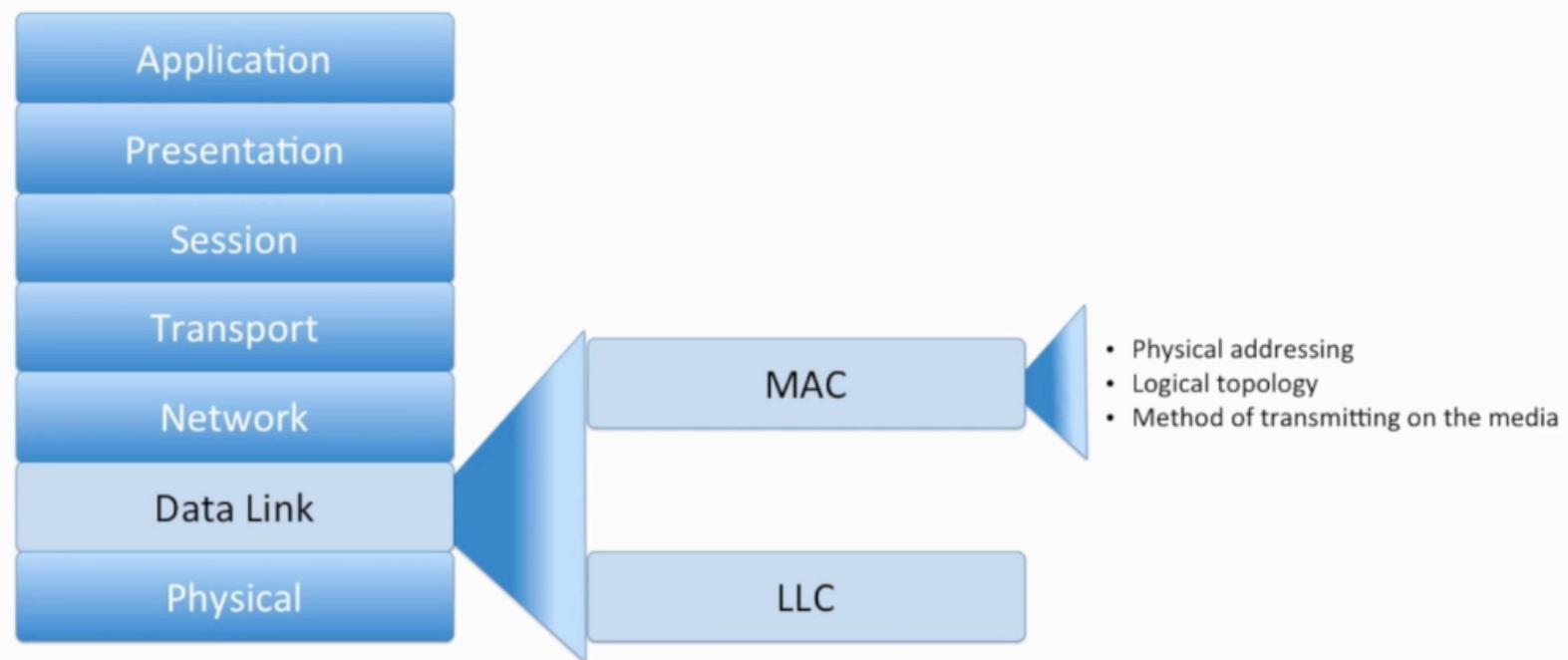
A token circulates around the ring, allowing devices in possession of the token to transmit, if the token is empty.

Playback Speed

Completed



Layer 2—The Data Link Layer



Ethernet

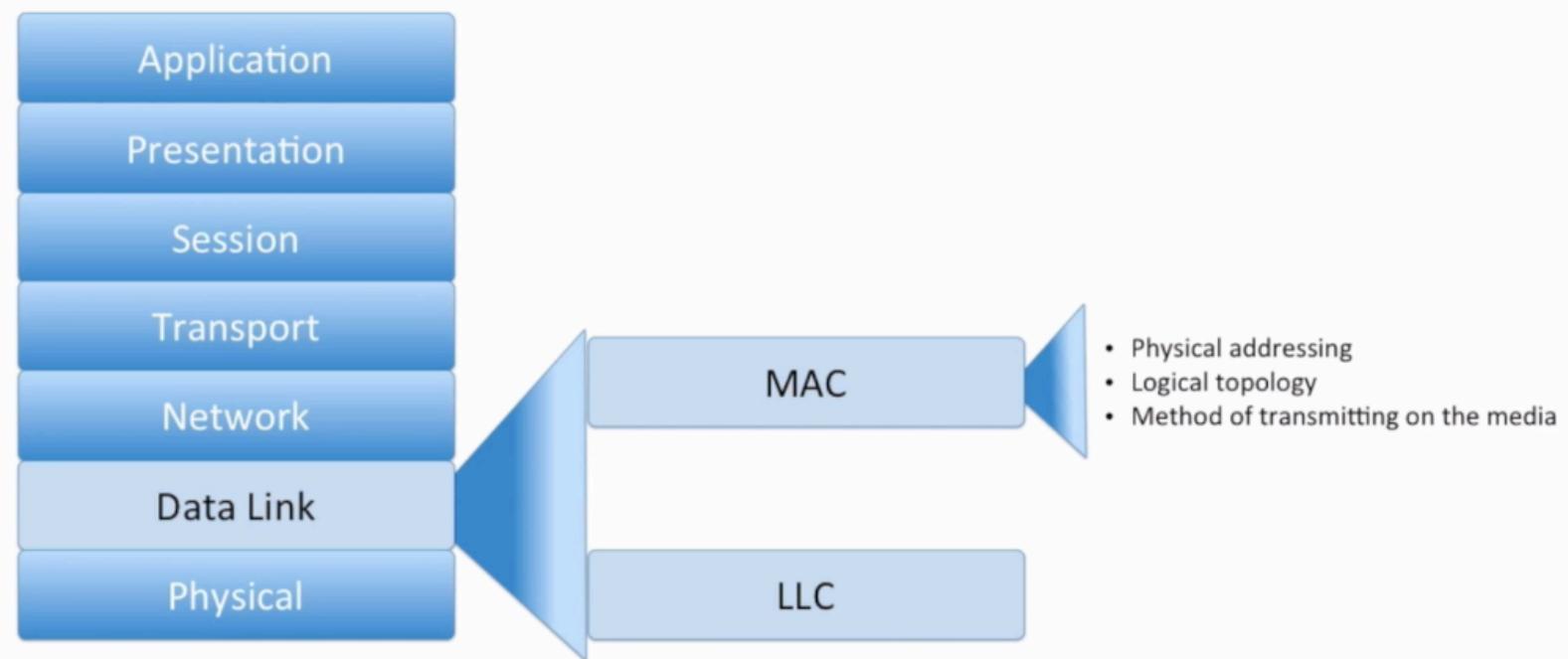
Devices on a shared segment (e.g. devices connected to a hub or a bus) check for traffic before transmitting. If a collision occurs, the devices retransmit.

Playback Speed

Completed



Layer 2—The Data Link Layer



CSMA/CD

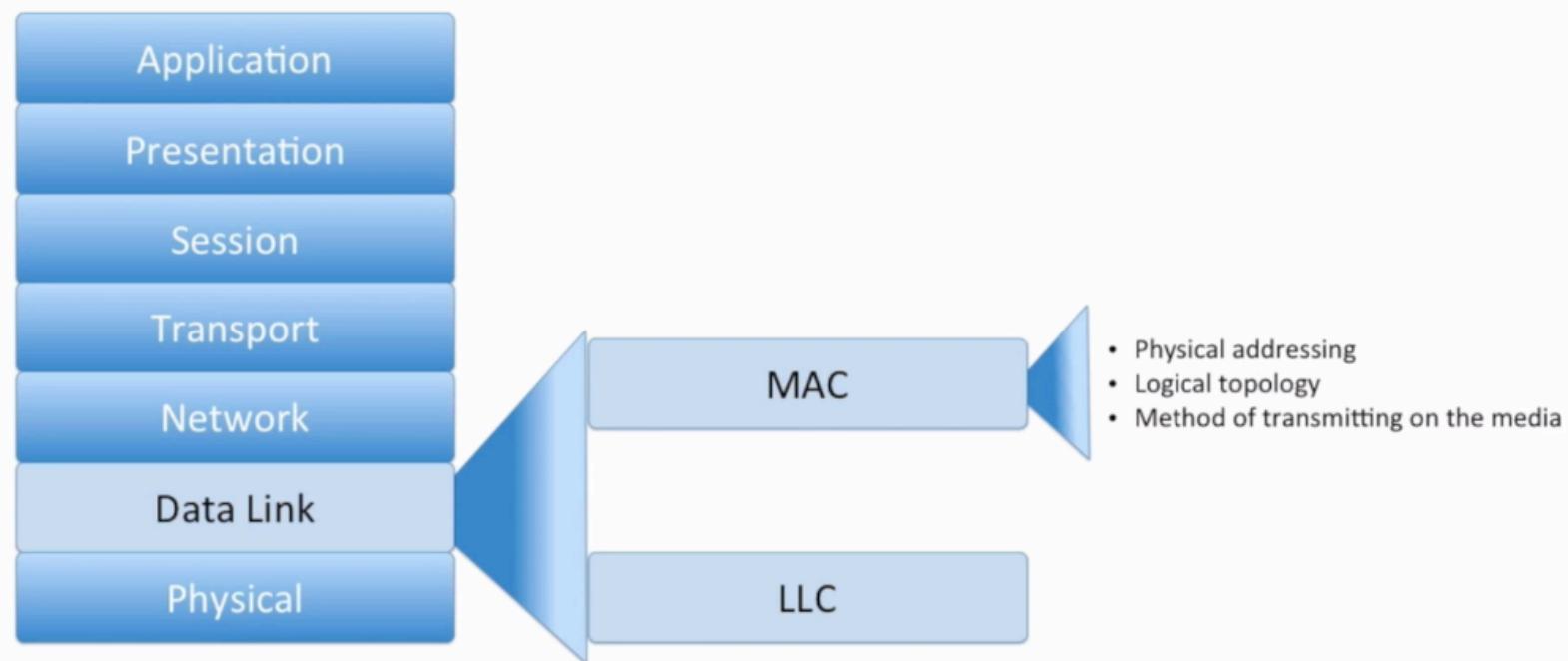
Carrier Sense, Multiple Access, with Collision Detection

Playback Speed

Completed



Layer 2—The Data Link Layer



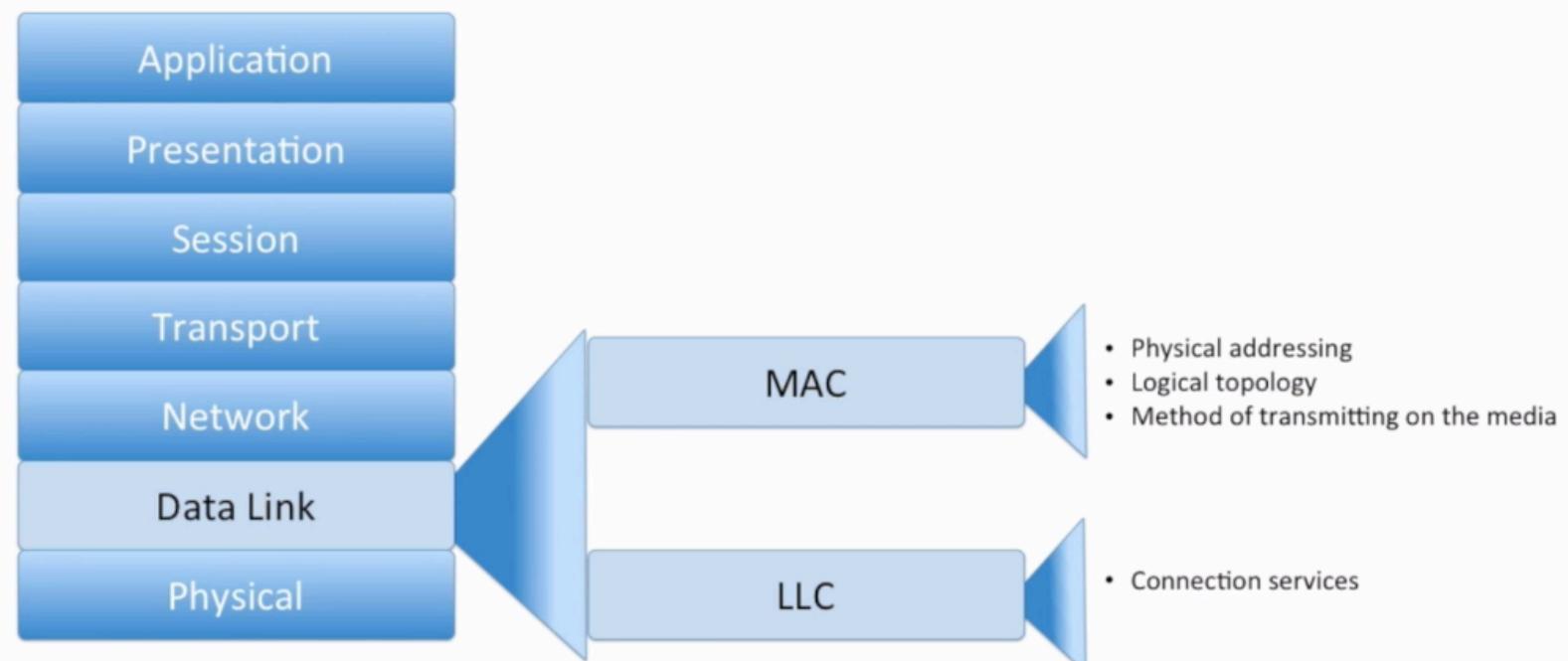
Random Backoff Timer

A random delay is selected by stations that experienced a collision. The stations retransmit their frames after their unique (and random) delays.

Completed



Layer 2—The Data Link Layer



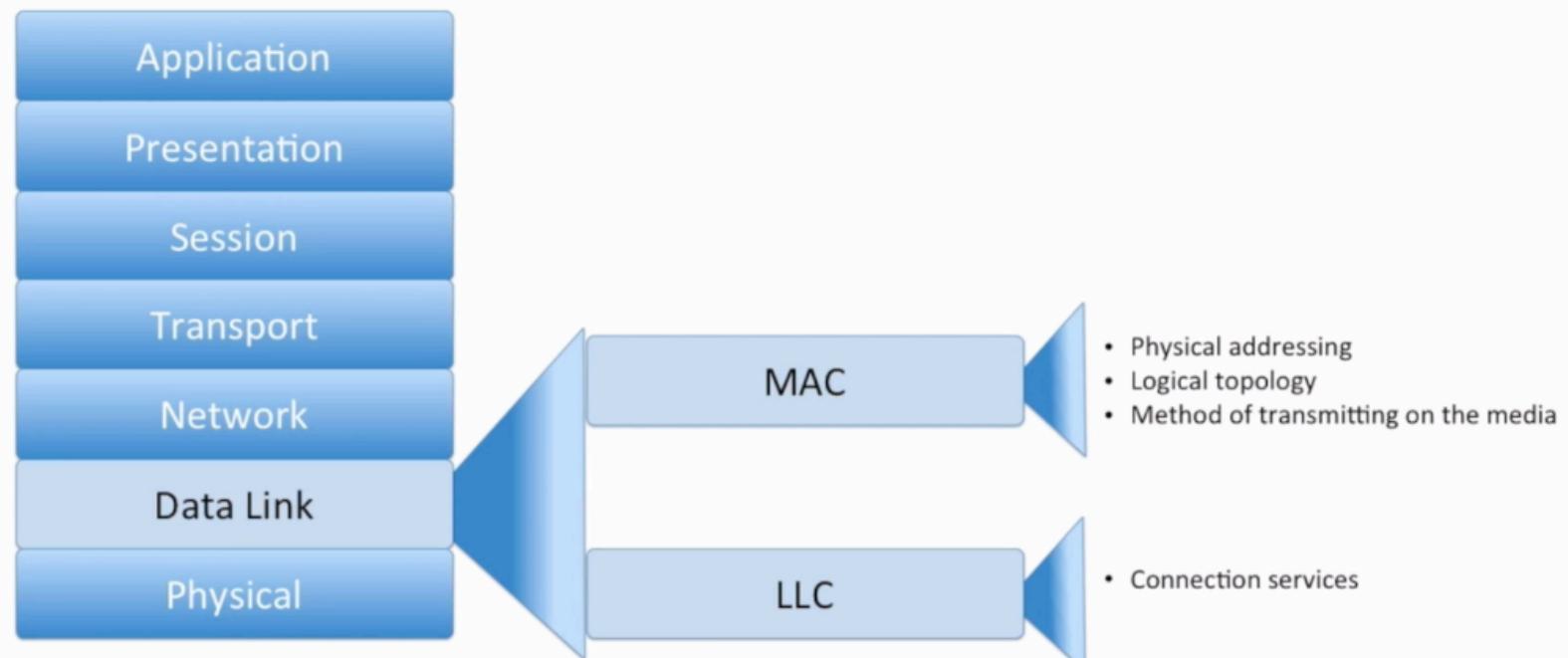
Flow Control

Allows a receiver to tell the sender to slow down its transmission rate.

Completed



Layer 2—The Data Link Layer



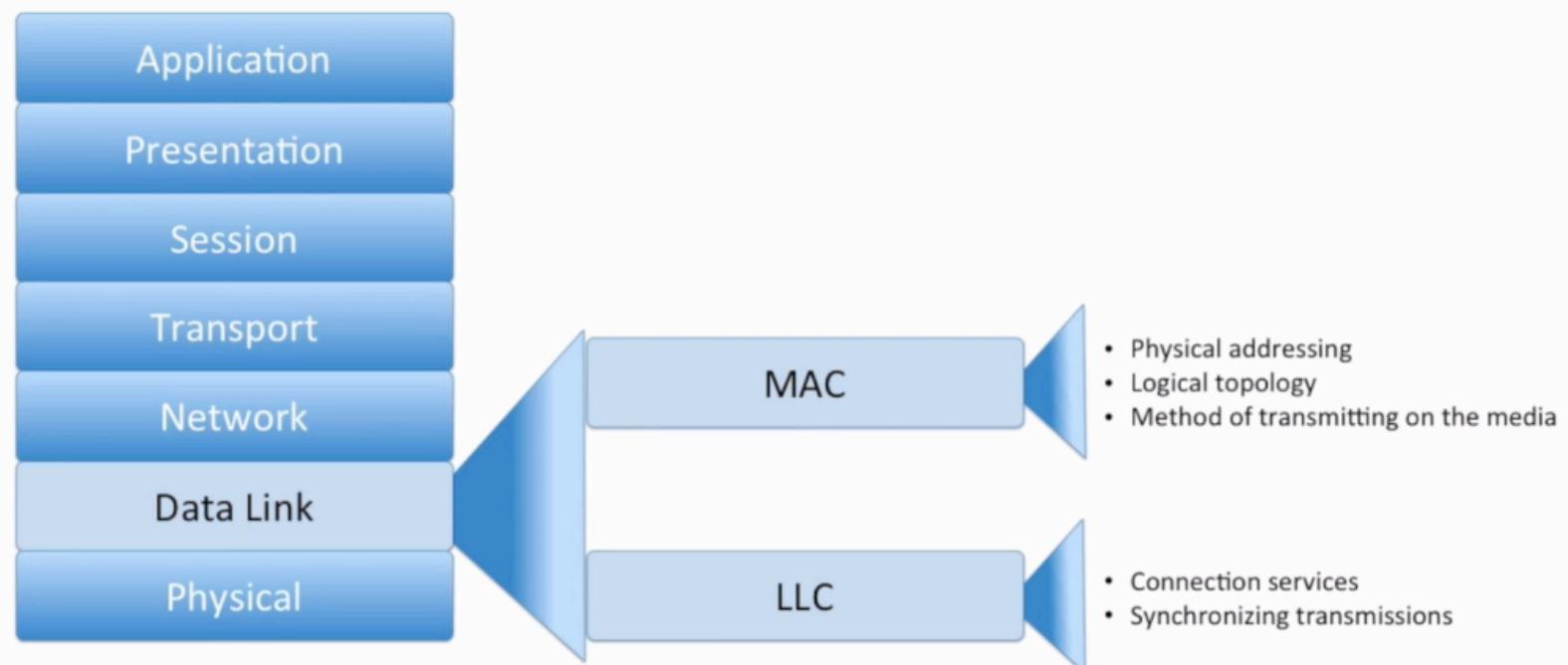
Error Control

Allows a receiver to detect an error in a received frame, and request the sender to retransmit.

Completed



Layer 2—The Data Link Layer



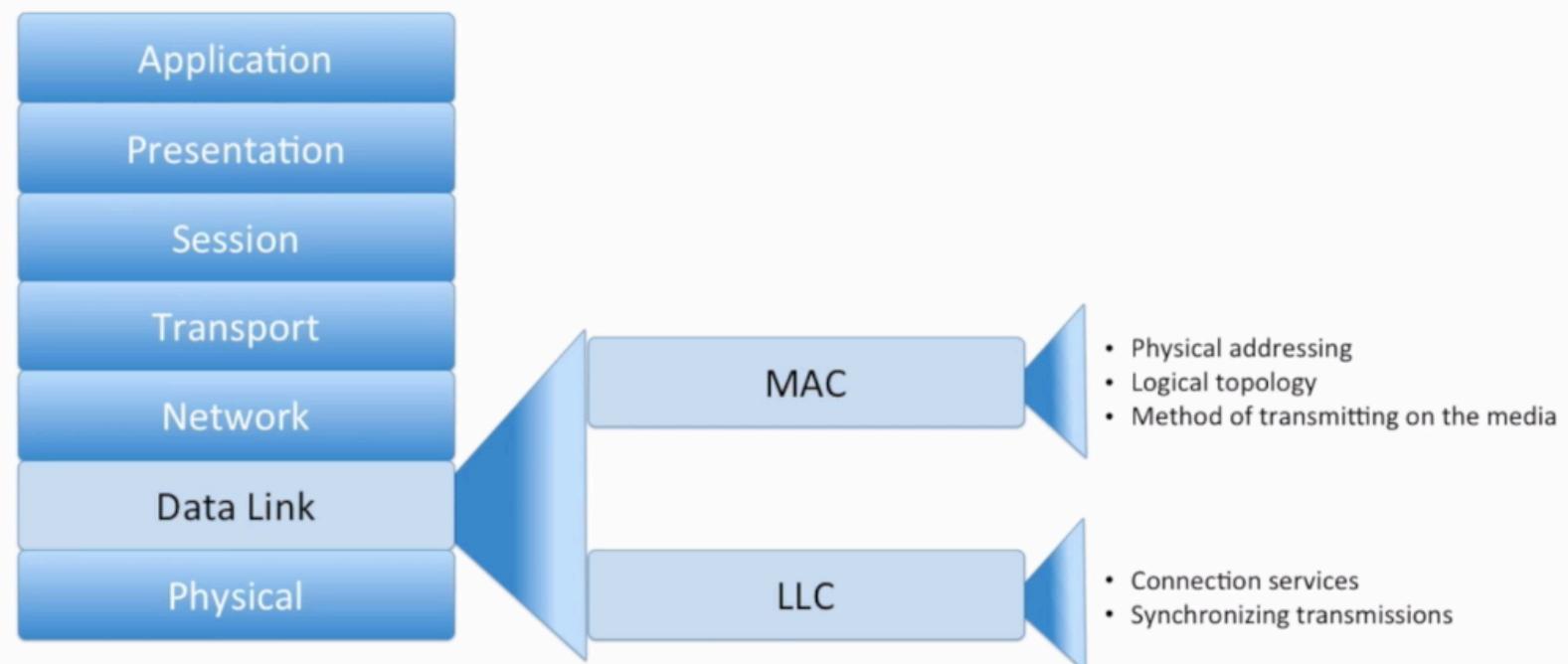
3 Basic Approaches to Synchronizing Transmissions

Isochronous, Asynchronous, and Synchronous

Completed



Layer 2—The Data Link Layer



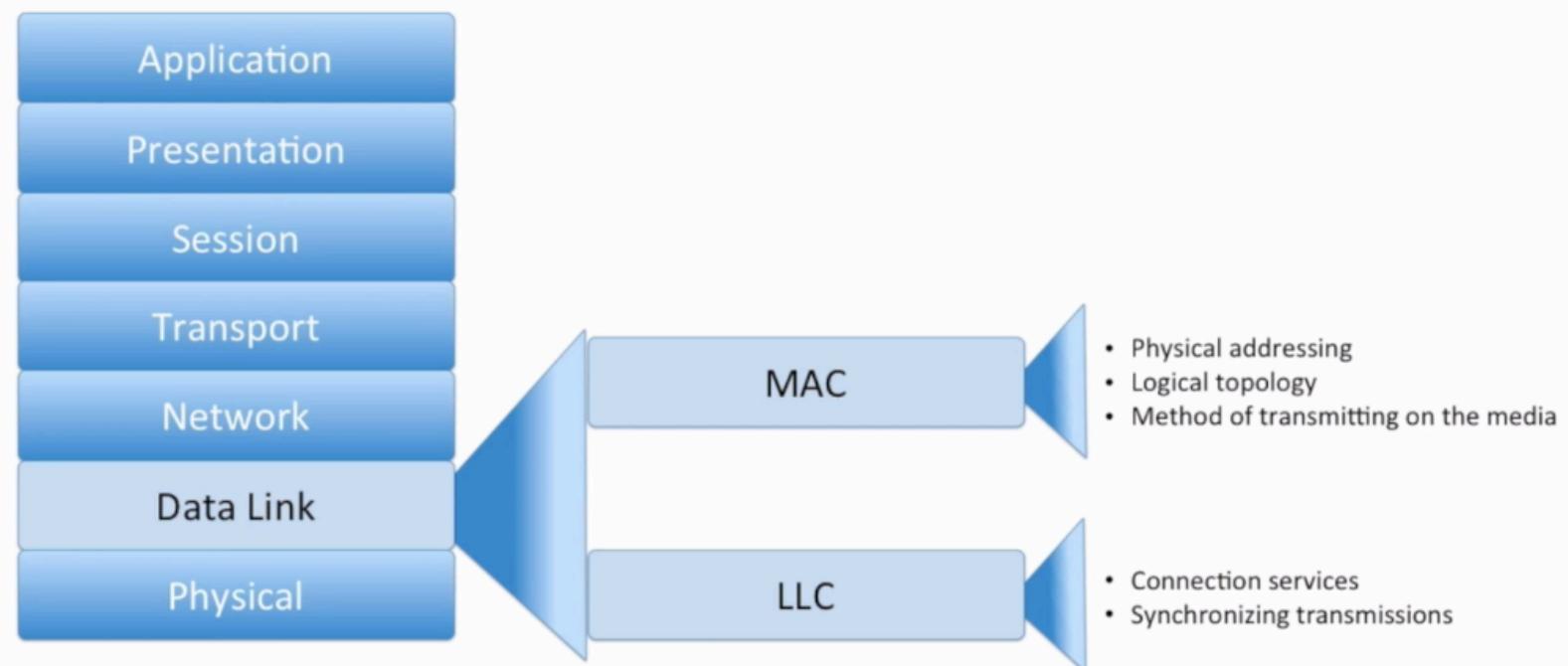
Isochronous

Devices receive external clocking. The clocking determines time slots.
Data can be transmitted in empty time slots. It has very low overhead.

Completed



Layer 2—The Data Link Layer



Asynchronous

Devices reference their internal clocks. The beginning and ending of a frame are identified with START and STOP bits. Parity bits can check for errors.

Completed



Layer 2—The Data Link Layer

**Parity
Bit**



Data Bits

Completed



Layer 2—The Data Link Layer

**Parity
Bit**



Completed



Layer 2—The Data Link Layer

**Parity
Bit**

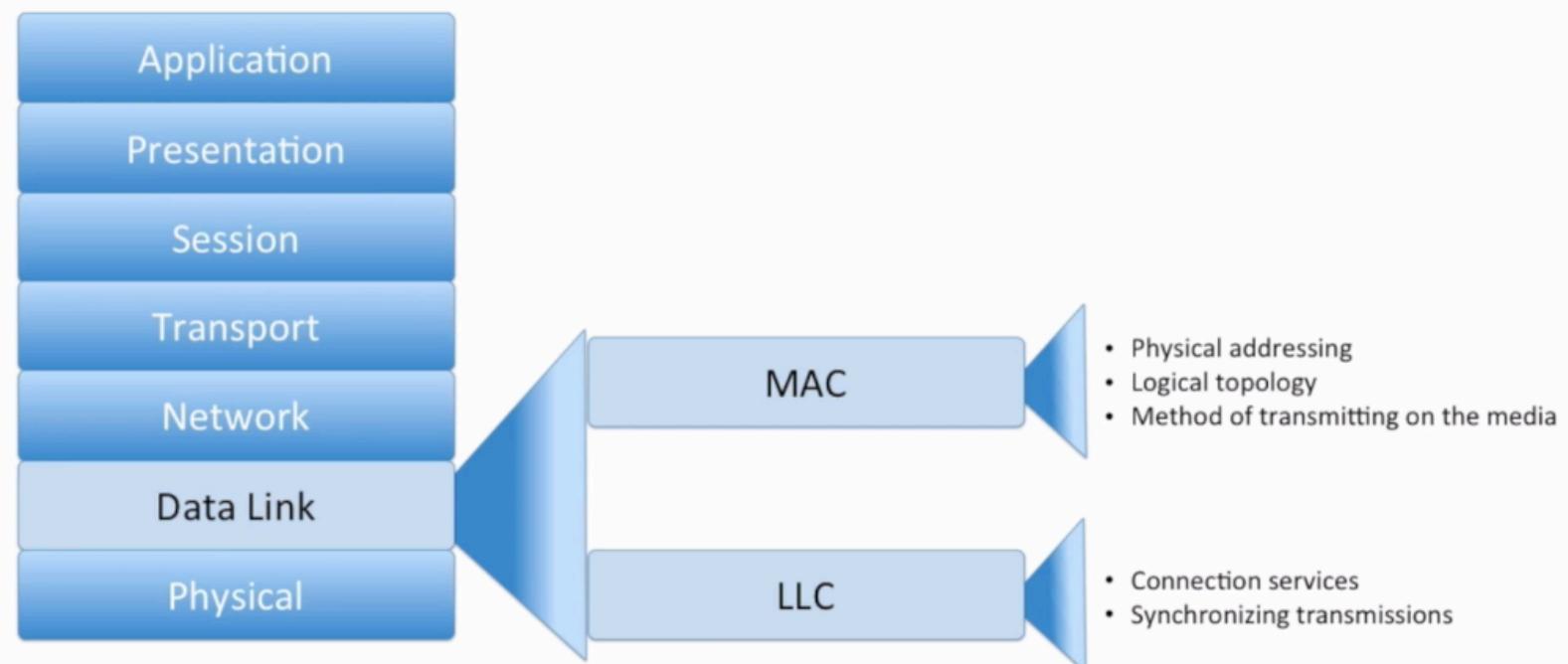


Data Bits

Completed



Layer 2—The Data Link Layer



Synchronous

A sender and receiver share clocking over a separate communications channel. A Cyclic Redundancy Check (CRC) can check for errors.

Completed



Layer 2—The Data Link Layer

The diagram illustrates a Content Addressable Memory (CAM) table and a network switch. On the left, a table is shown with columns labeled "Port" and "MAC". To the right, a blue rectangular box represents a switch. Three lines labeled 1, 2, and 3 connect the switch to three different devices: a computer monitor (labeled AAAA), a server rack (labeled BBBB), and a laptop (labeled CCCC). Arrows on the switch indicate bidirectional communication. A man in a blue Cisco polo shirt stands in front of the diagram, gesturing towards it.

Content Addressable Memory (CAM) Table

A table that shows which MAC addresses reside off of specific switch ports.

Completed



Layer 2—The Data Link Layer

Port | MAC

1	AAAAA
2	DDDD
2	EEEE
3	CCCC

The whiteboard also shows a network diagram with a computer connected to a switch (labeled 1). The switch has three ports labeled 1, 2, and 3. Port 1 is connected to a computer. Port 2 is connected to a bridge or another switch. Port 3 is connected to a laptop. Handwritten MAC addresses are also written next to the network components: 'AAAAA' next to the computer, 'DDDD' and 'EEEE' next to the bridge, and 'CCCC' next to the laptop.

Data Link Layer Characteristics
It has two sublayers (the MAC and LLC sublayers).

Completed



Layer 2—The Data Link Layer

Port	MAC
1	AAAA
2	BBBB
2	EEEE
3	CCCC

The whiteboard also shows a network diagram with three hosts connected to a switch. The switch has three ports labeled 1, 2, and 3, corresponding to the MAC addresses in the table.

MAC Sublayer Responsibilities
Physical Addressing, Logical Topologies, and Transmission Methods

Completed



Layer 2—The Data Link Layer

Port | MAC

1	AAAAA
2	DDDD
2	EEEE
3	CCCC

The whiteboard also shows a network diagram with a computer connected to a switch (port 1). The switch has three ports labeled 1, 2, and 3. Port 2 is connected to another switch, which in turn connects to a laptop. Port 3 is connected directly to the laptop. MAC addresses AAAA, DDDD, EEEE, and CCCC are written near their respective connections.

LLC Sublayer Responsibilities
Connection Services (Flow Control & Error Checking) and Transmission Synchronization

Completed



Layer 2—The Data Link Layer

A man in a blue Cisco polo shirt is holding a Cisco Cat3750 Ethernet switch. He is pointing at a whiteboard behind him. The whiteboard displays a network diagram and a table showing MAC addresses assigned to ports.

Port	MAC
1	AAAAA
2	DDDD
2	EEEE
3	CCCC

The network diagram shows a computer connected to port 1 of a blue switch. Port 2 is connected to a white switch, which is further connected to a laptop. Port 3 is connected to another laptop. The whiteboard also has some handwritten text: "AAA" and "CCCC" near the bottom right.

Ethernet Switch
A Layer 2 device that makes frame forwarding decisions based on MAC addresses.

Completed



Layer 3—The Network Layer

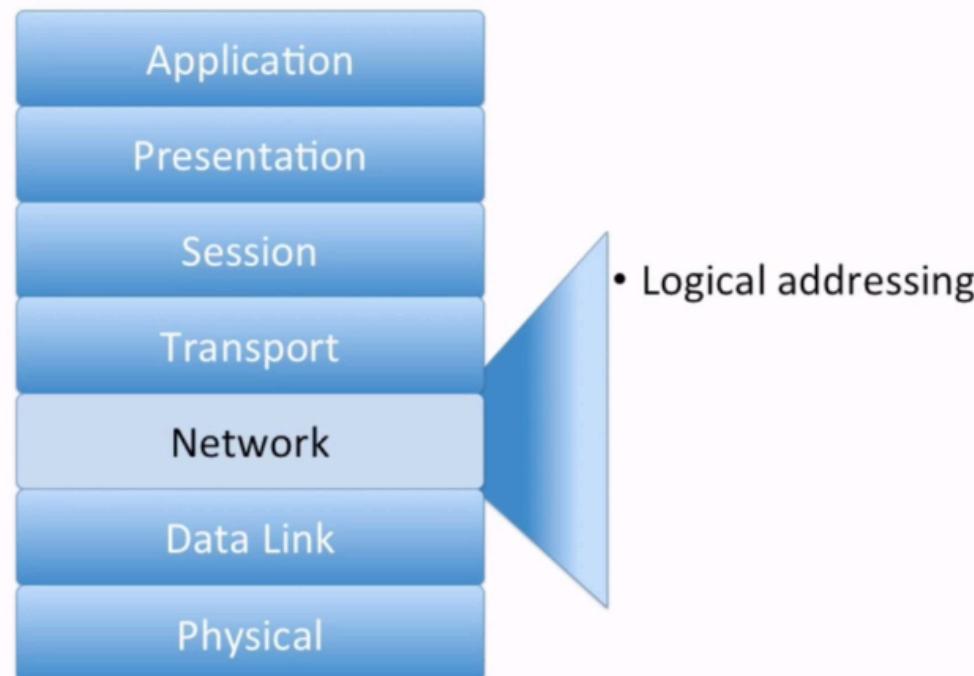
Layer 3 - The Network Layer

Playback Speed

Completed



Layer 3—The Network Layer



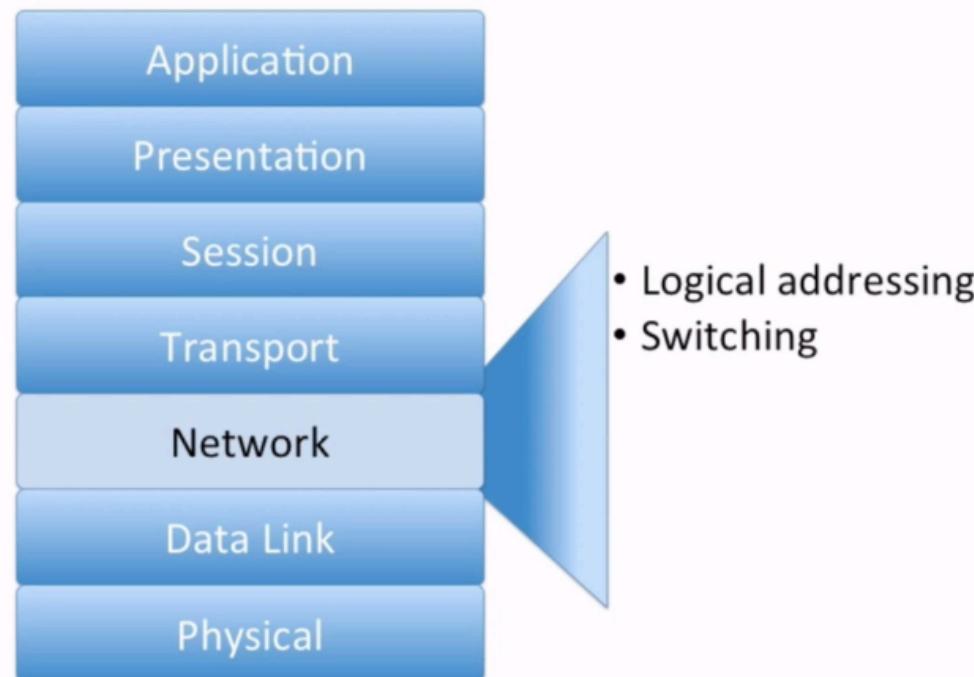
Examples of Logical Addresses

IPv4, IPv6, IPX, and AppleTalk

Completed



Layer 3—The Network Layer



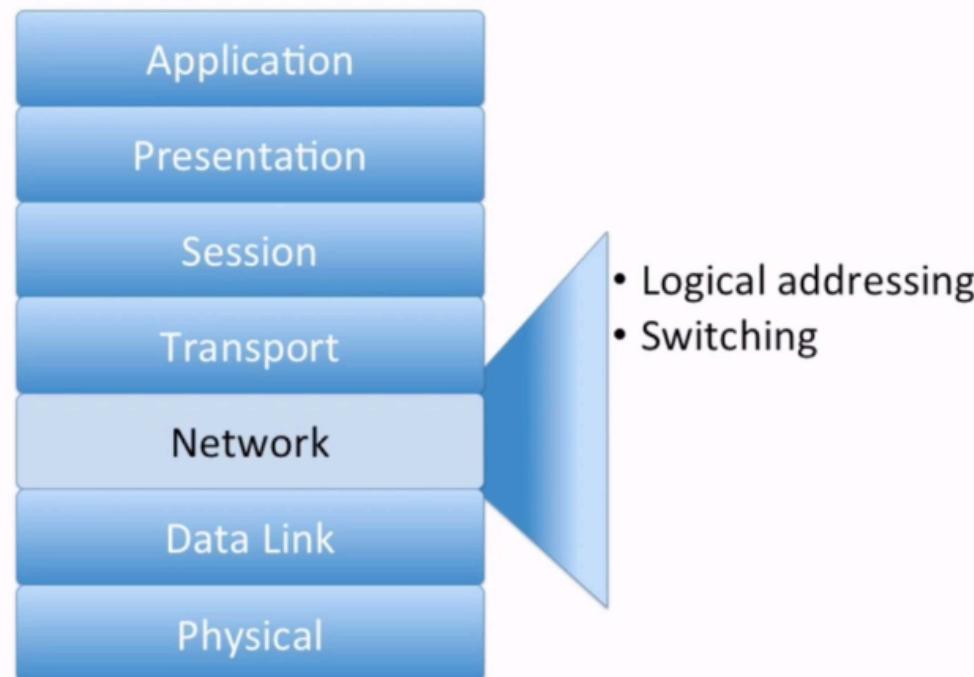
Packet Switching

A data stream is divided into packets. A packet contains a header with a source and destination address.

Completed



Layer 3—The Network Layer



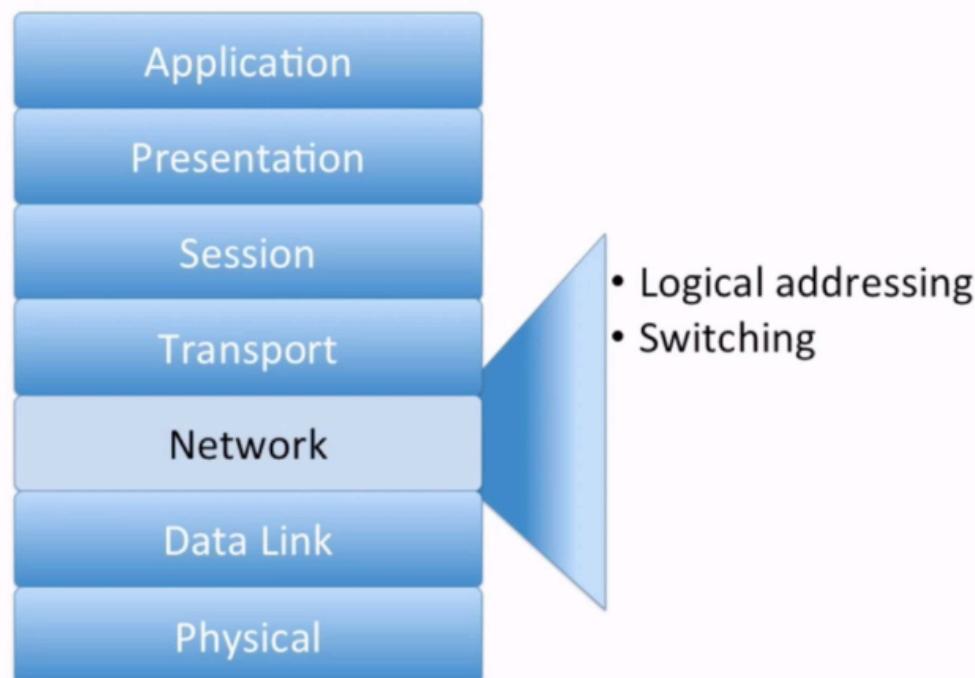
Router

Makes packet forwarding decisions based on logical addresses.

Completed



Layer 3—The Network Layer



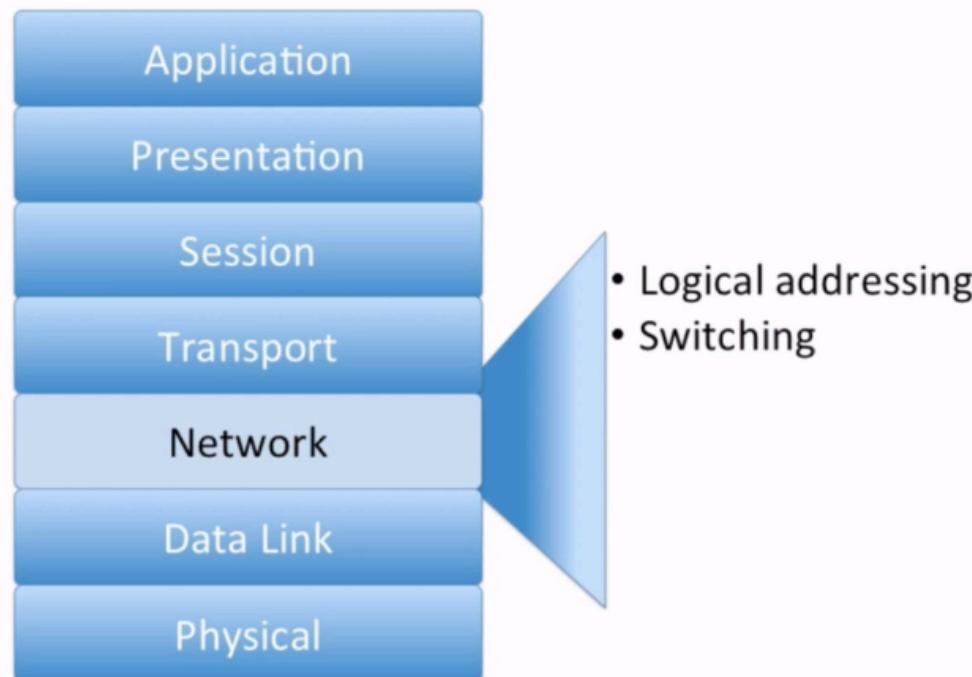
Circuit Switching

A temporary connection, called a *circuit*, is brought up on an as-needed basis, similar to placing a phone call.

Completed



Layer 3—The Network Layer



Message Switching

A data stream is broken into messages, which are not necessarily delivered immediately. Rather, they use a store-and-forward approach, similar to e-mail.

Completed



Layer 3—The Network Layer



- Logical addressing
- Switching
- Route discovery and selection

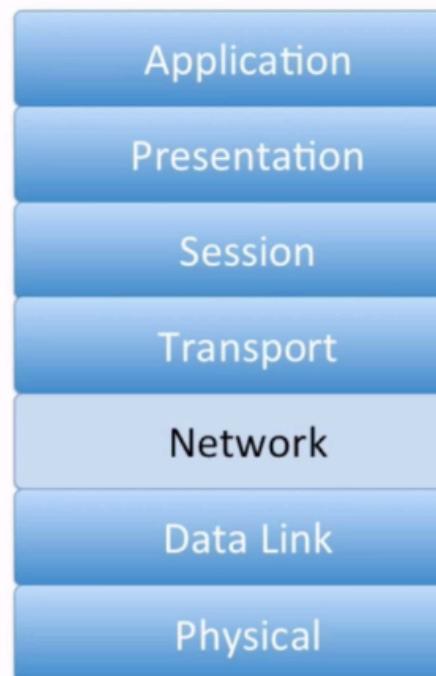
How a Network is Learned by a Router

Directly Connected, Statically Configured, Dynamically Learned

Completed



Layer 3—The Network Layer



- Logical addressing
- Switching
- Route discovery and selection

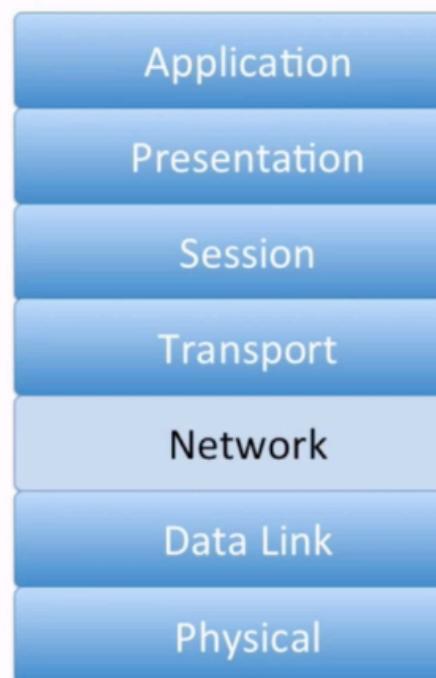
Examples of Routing Protocols

EIGRP, OSPF, RIP, IS-IS, and BGP

Completed



Layer 3—The Network Layer



- Logical addressing
- Switching
- Route discovery and selection
- Connection services

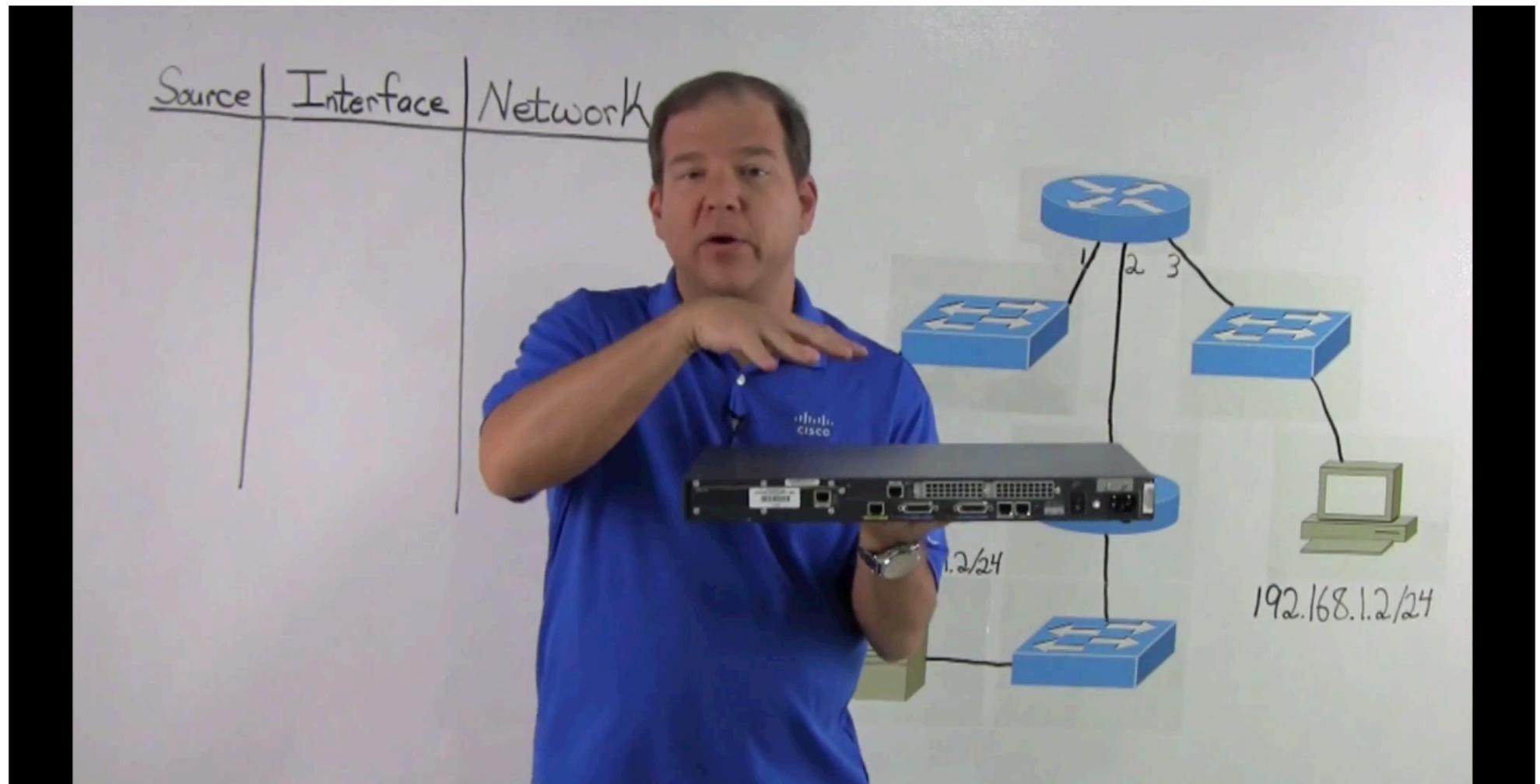
Examples of Connection Services

Flow Control and Packet Reordering

Completed



Layer 3—The Network Layer



Completed



Layer 3—The Network Layer

Interface	Network
1	10.1.1.0/24
3	192.168.1.0/24
2	172.16.1.0/24
4	0.0.0.0

Router
Makes packet forwarding decisions based on logical addresses.

The diagram illustrates a network topology. A central blue circular node, representing a router, is connected to four interfaces, each represented by a blue rectangular box with a grid of arrows indicating bidirectional communication. Interface 1 connects to a local network with address 10.1.1.0/24. Interface 3 connects to a local network with address 192.168.1.0/24. Interface 2 connects to a local network with address 172.16.1.0/24. Interface 4 connects to the Internet, which is represented by a cloud-like shape labeled "Internet".

Completed



Layer 4—The Transport Layer

Layer 4 - The Transport Layer

Completed



Layer 4—The Transport Layer



- Protocols
- Windowing
- Buffering

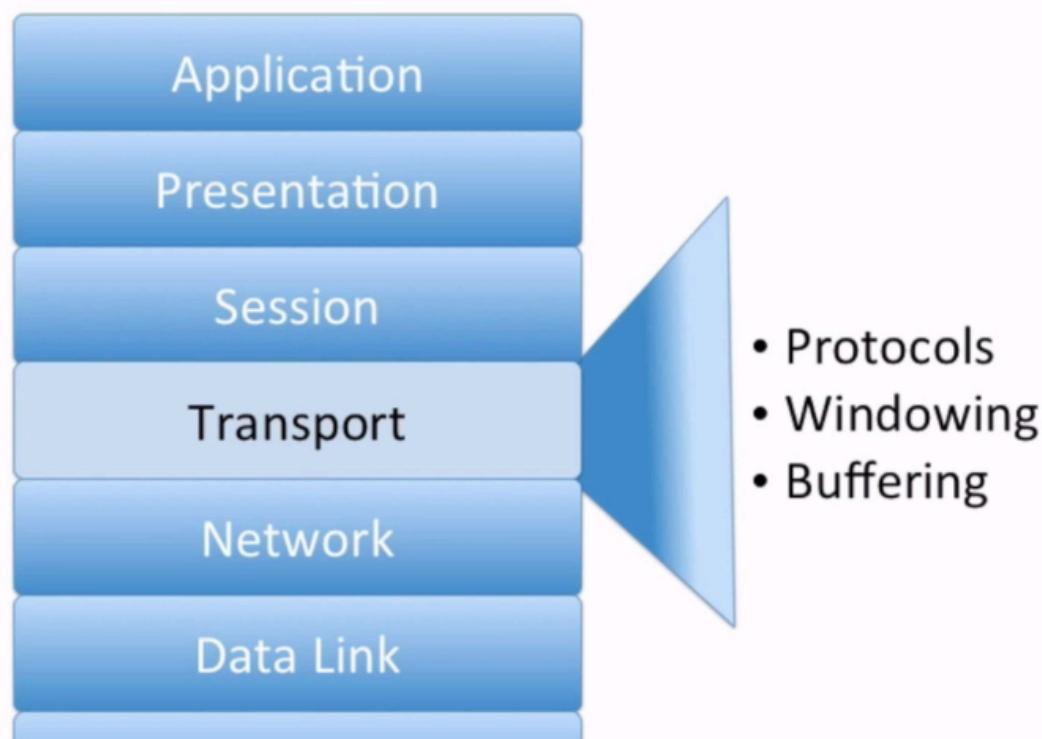
User Datagram Protocol (UDP)

A Layer 4 protocol used for unreliable (i.e. unacknowledged) communication.

Completed



Layer 4—The Transport Layer



Real-time Transport Protocol (RTP)

A Layer 4 protocol that is encapsulated in another Layer 4 protocol (UDP) and transmits voice in a Voice over IP (VoIP) network.

Completed



Layer 4—The Transport Layer



- Protocols
- Windowing
- Buffering

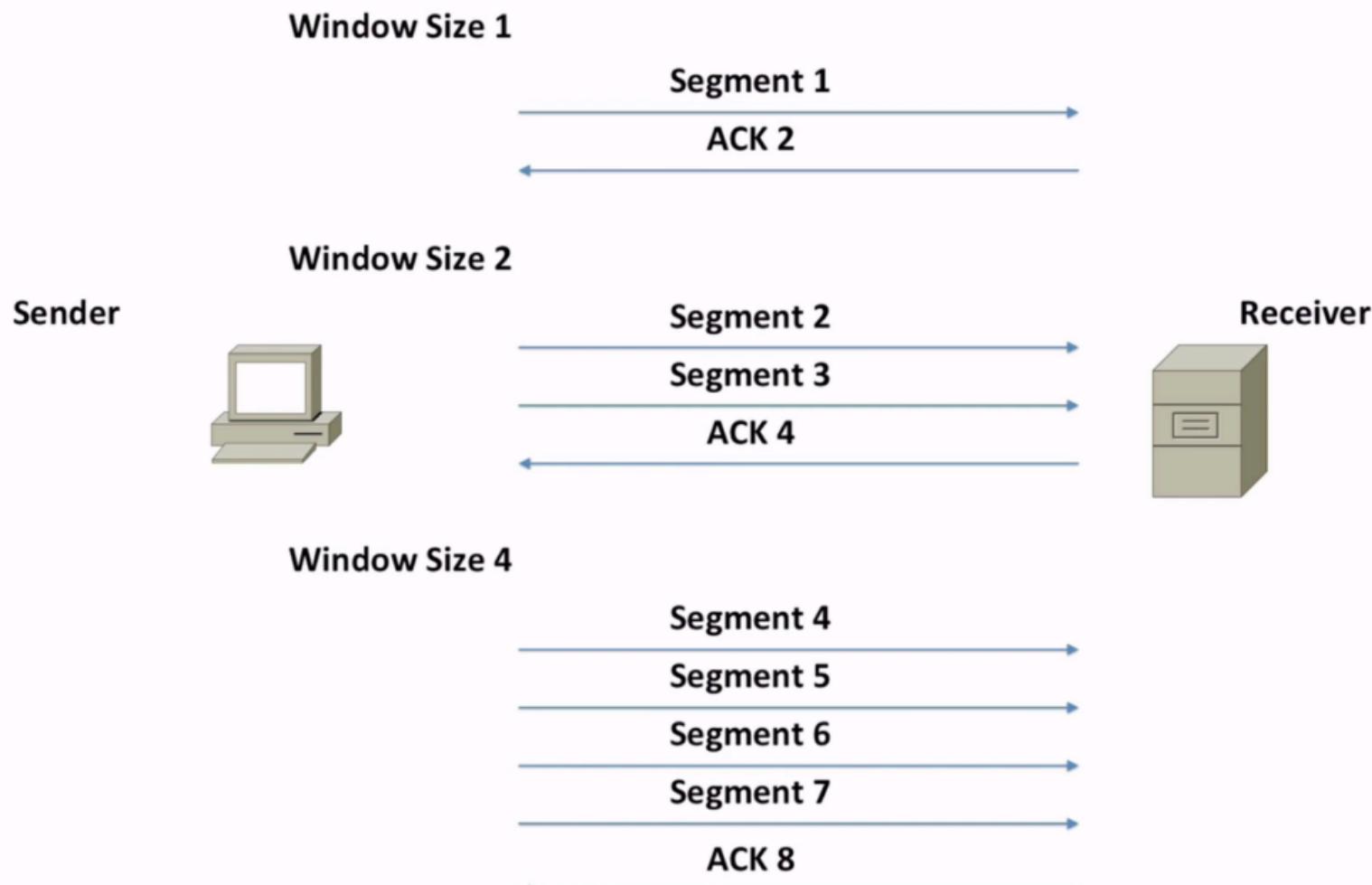
Sliding Window

Allows the TCP window size (i.e. the number of segments that can be sent before an acknowledgement is received) to grow, based on network reliability.

Completed



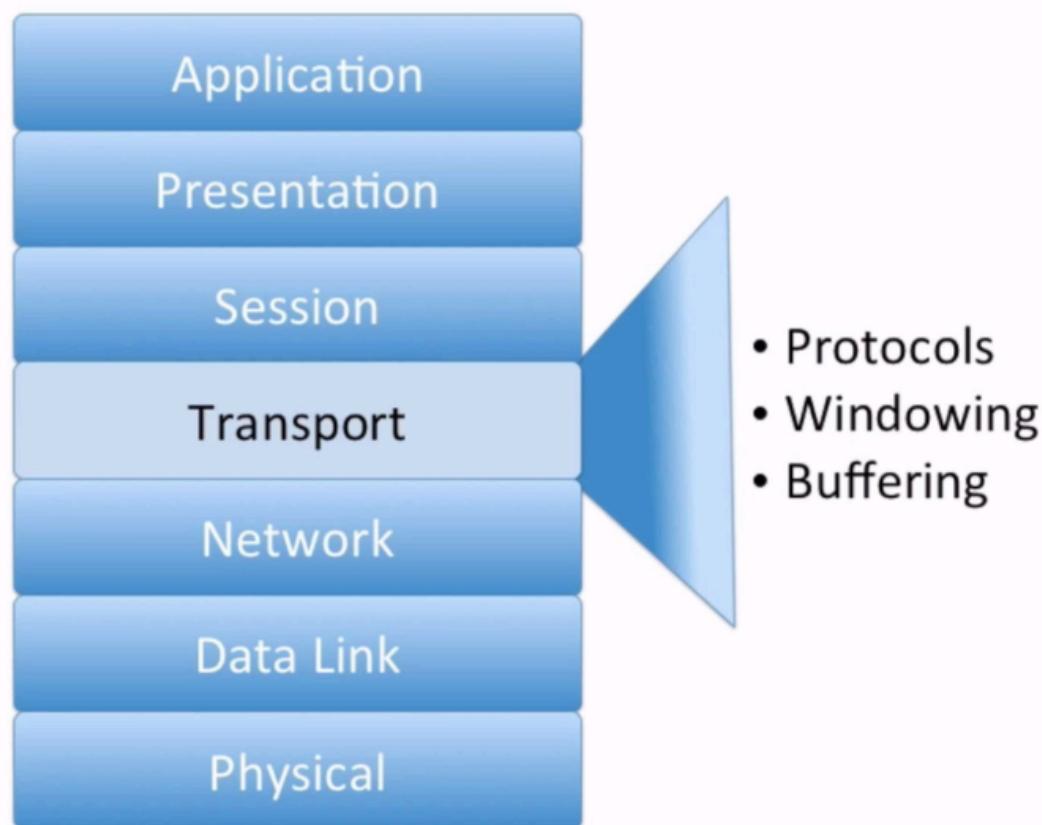
Layer 4—The Transport Layer



Completed



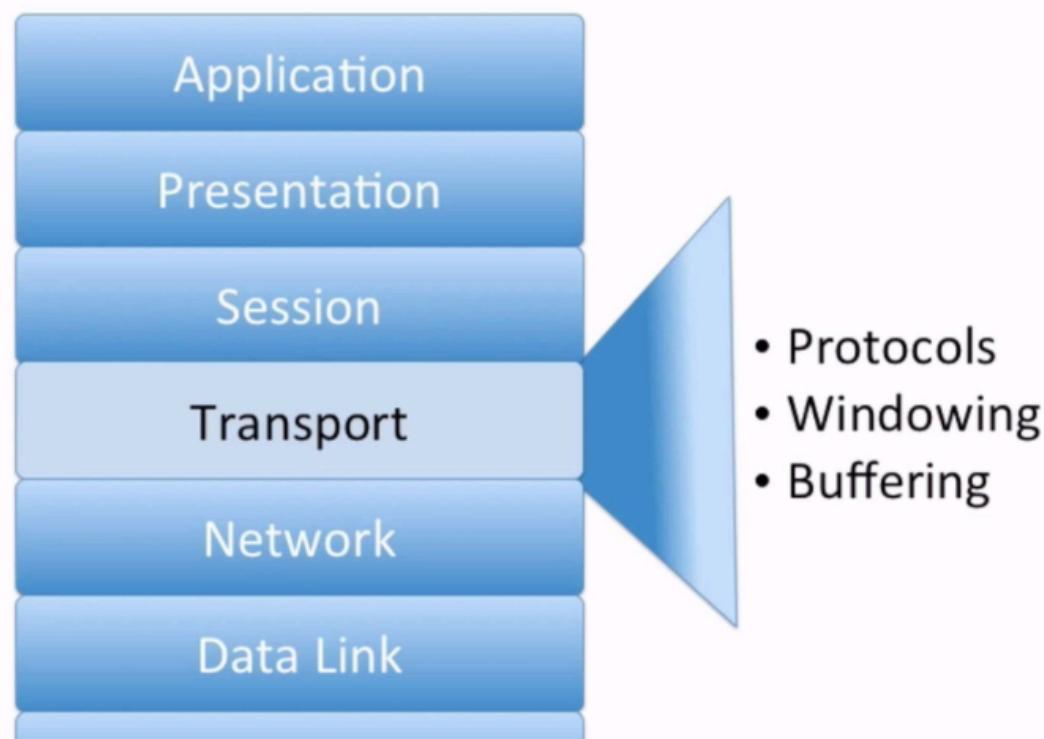
Layer 4—The Transport Layer



Completed



Layer 4—The Transport Layer



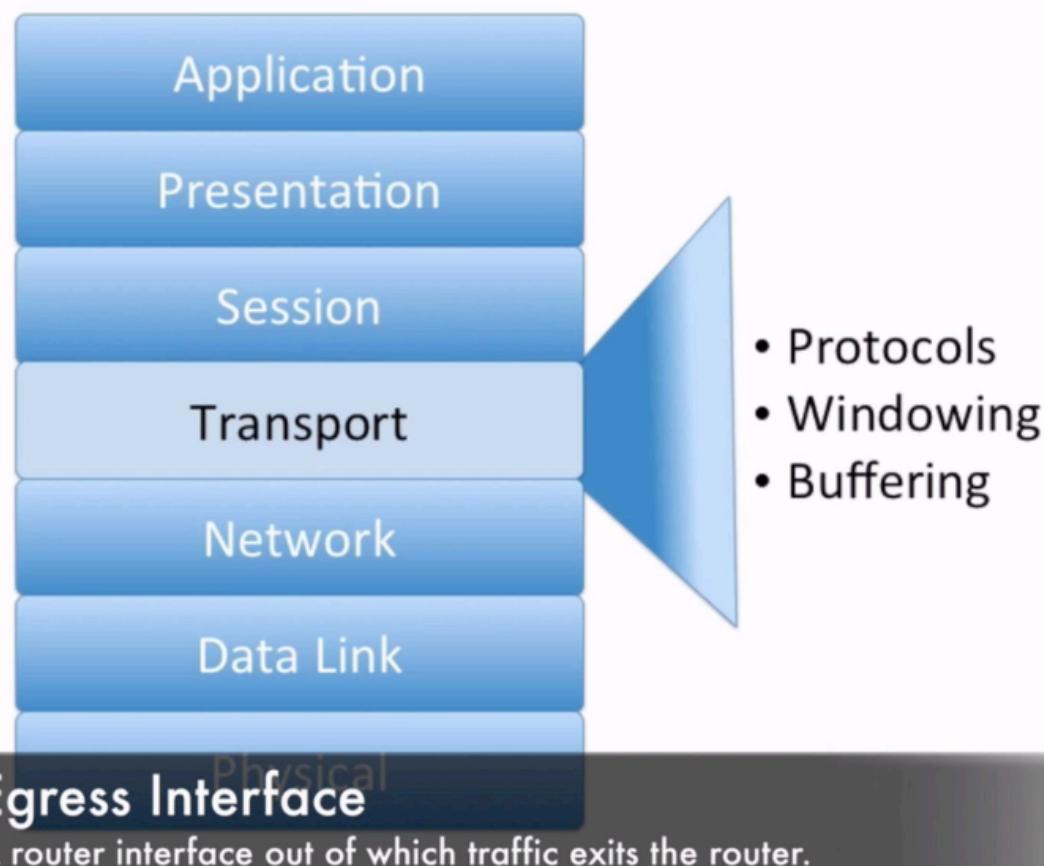
Queue (a.k.a. Buffer)

Memory used by a router's output interface to store packets until bandwidth becomes available to transmit those packets.

Completed



Layer 4—The Transport Layer



Completed



Layers 5-7—The Upper Layers

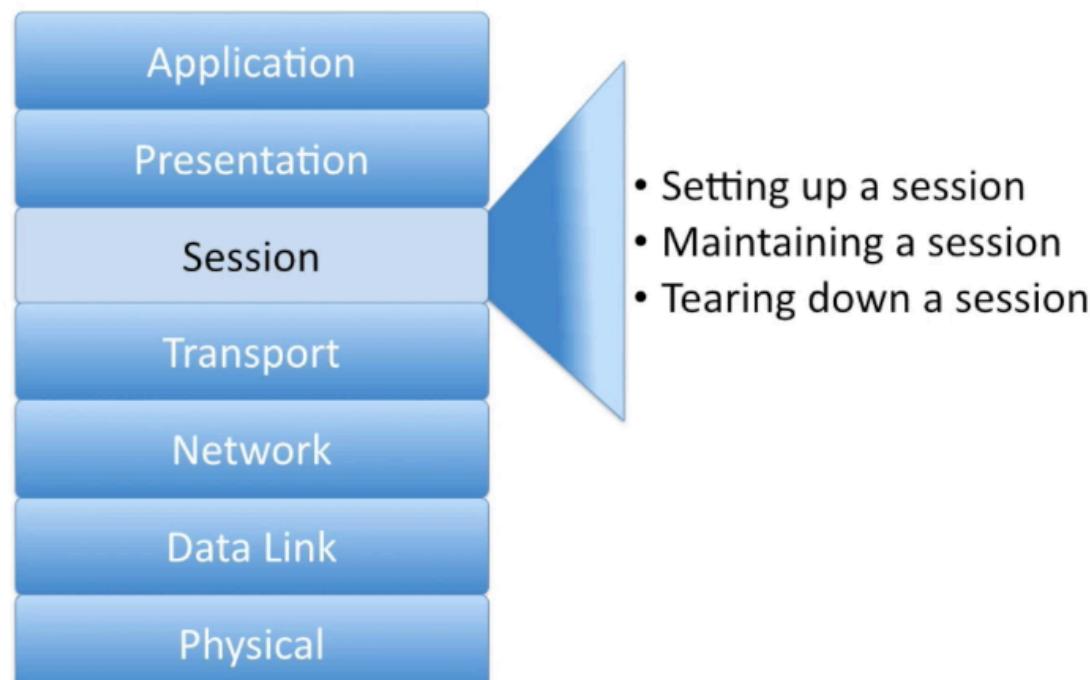
Layers 5-7 - The Upper Layers

Playback Speed

Completed



Layers 5-7—The Upper Layers



Network Basic Input/Output System (NetBIOS)

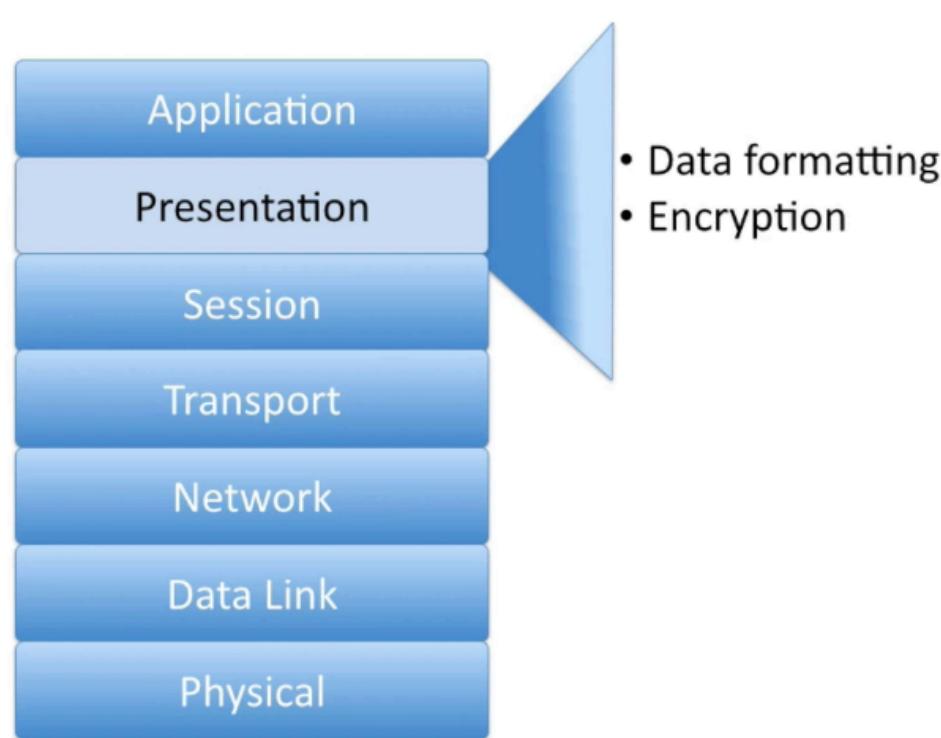
A Session Layer protocol used on IBM's early "PC Network."

Playback Speed

Completed



Layers 5-7—The Upper Layers



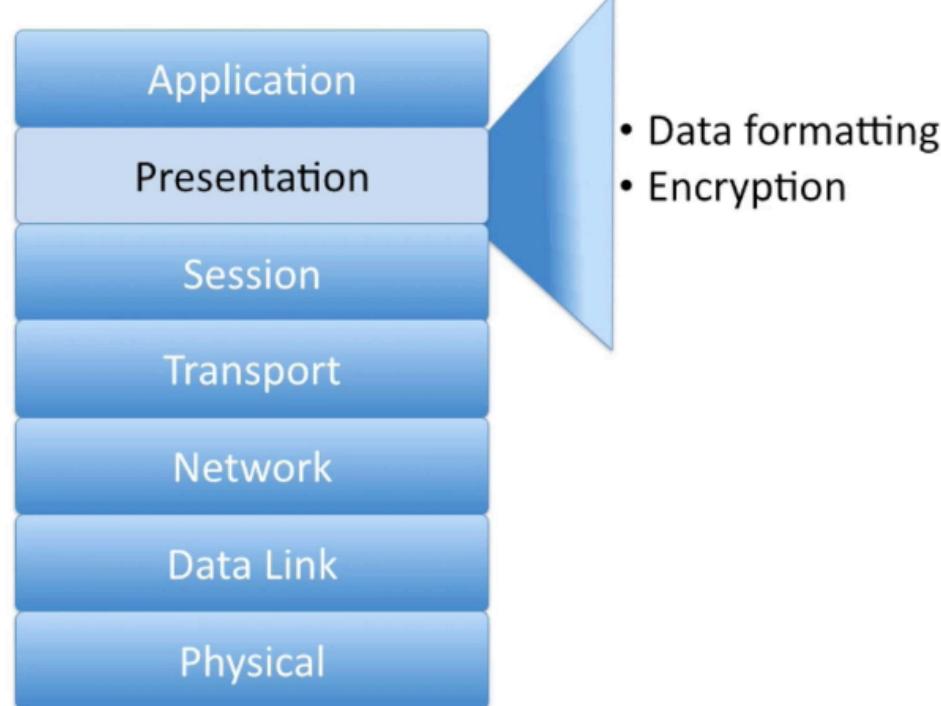
American Standard Code for Information Interchange (ASCII)

A text-encoding standard based on the English alphabet.

Completed



Layers 5-7—The Upper Layers



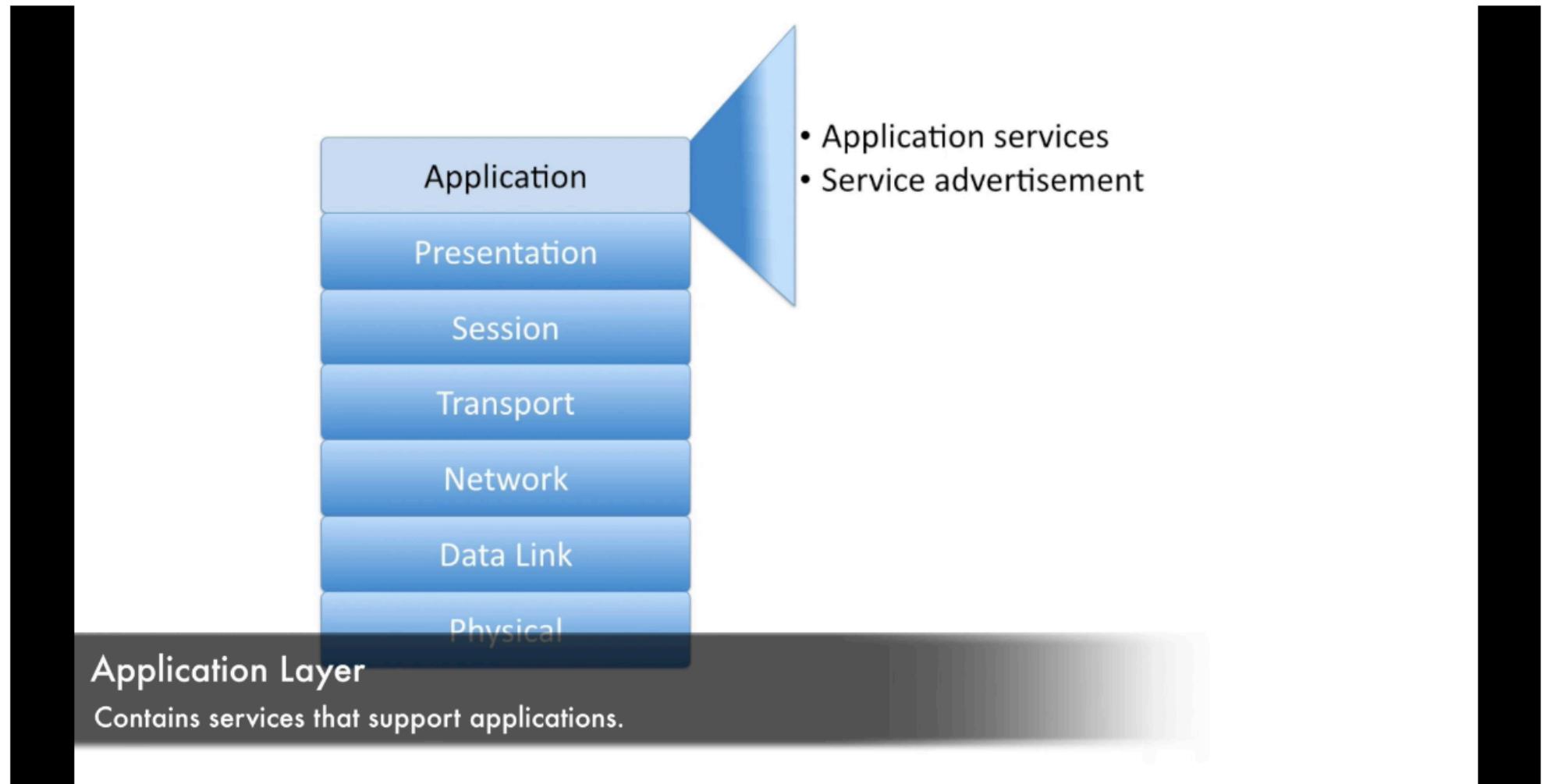
Encryption

Scrambles data so that the data can only be read by an intended recipient. The recipient might need a secret key to read the data.

Completed



Layers 5-7—The Upper Layers



Completed



The DoD Model

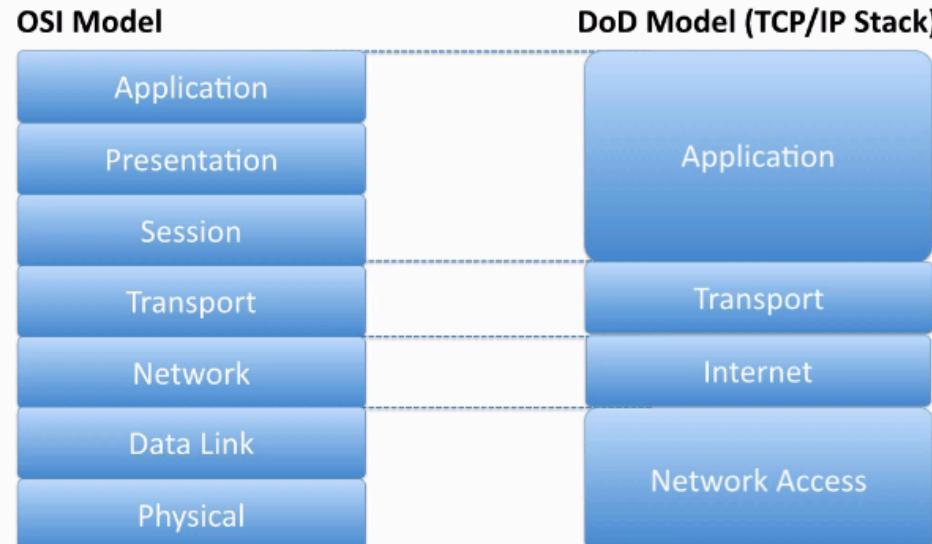
The DoD Model

Completed



The DoD Model

The DoD Model

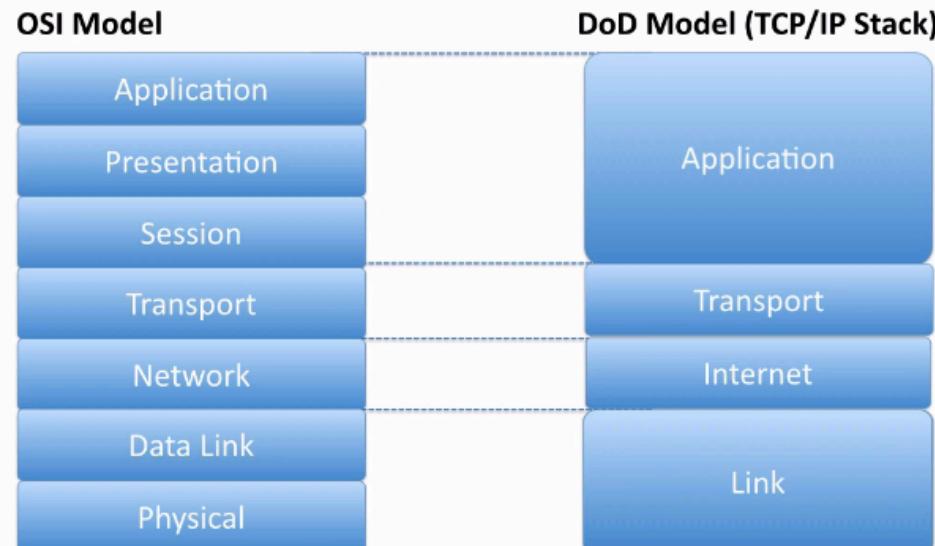


Completed



The DoD Model

The DoD Model

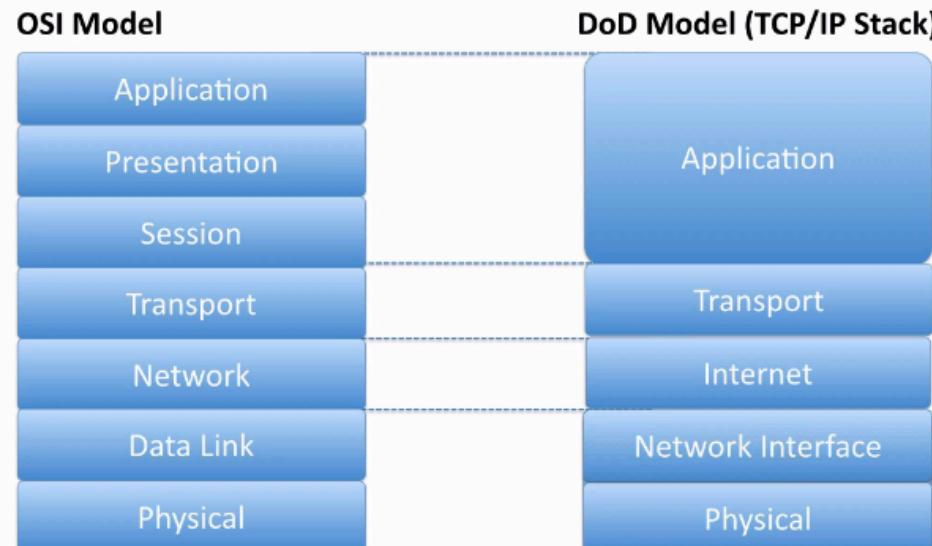


Completed



The DoD Model

The DoD Model



Completed



IP, ICMP, UDP, and TCP

IP, ICMP, UDP, and TCP

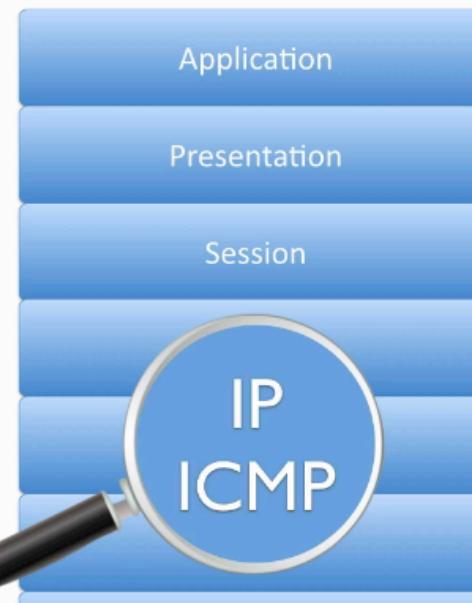
Playback Speed

Completed



IP, ICMP, UDP, and TCP

IP, ICMP, UDP, and TCP



ICMP (Internet Control Message Protocol)

A Layer 3 protocol commonly used to test reachability to a remote network device and to report error conditions in a network.

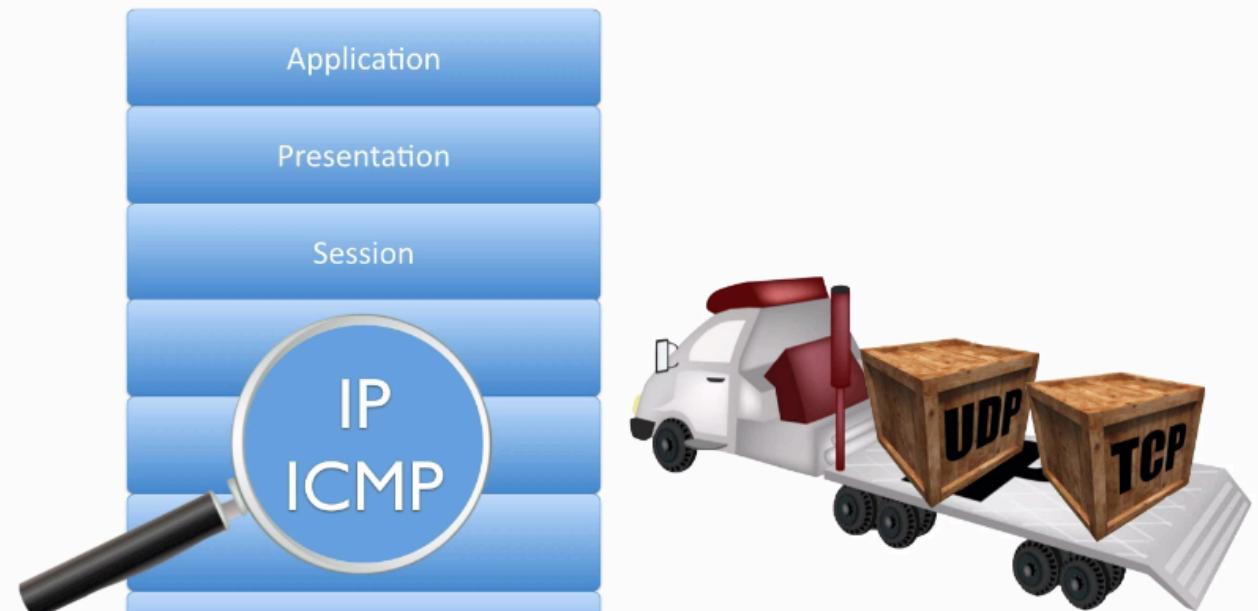
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IP, ICMP, UDP, and TCP

IP, ICMP, UDP, and TCP



Ping

A utility commonly used to determine if one network device can reach another network device.

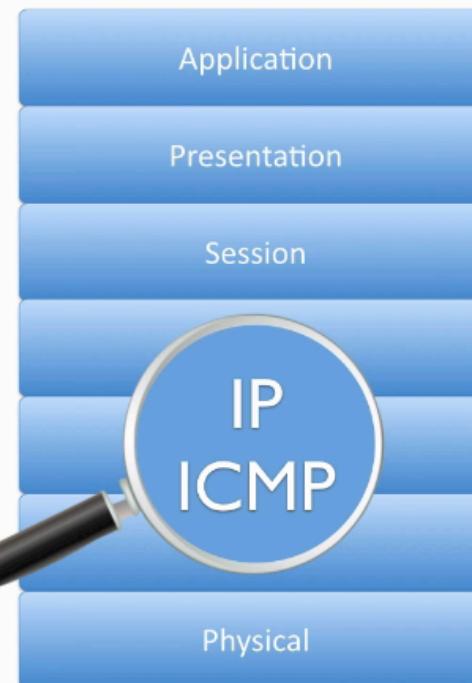
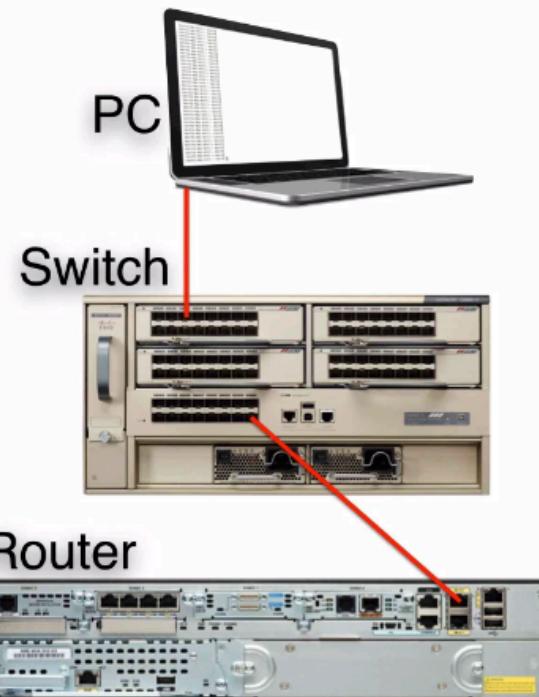
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IP, ICMP, UDP, and TCP

IP, ICMP, UDP, and TCP



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IP, ICMP, UDP, and TCP

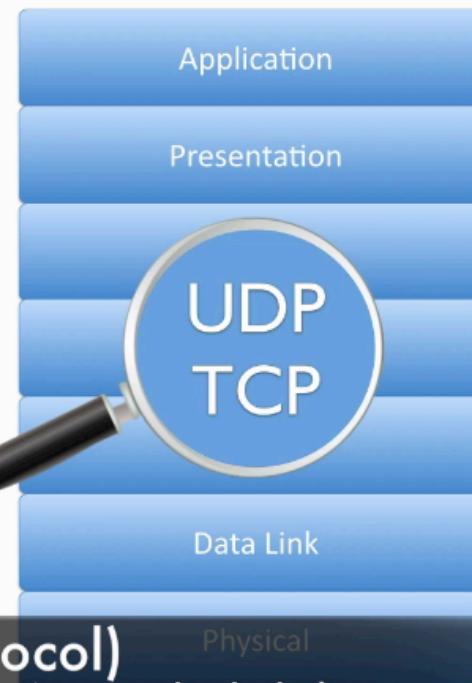
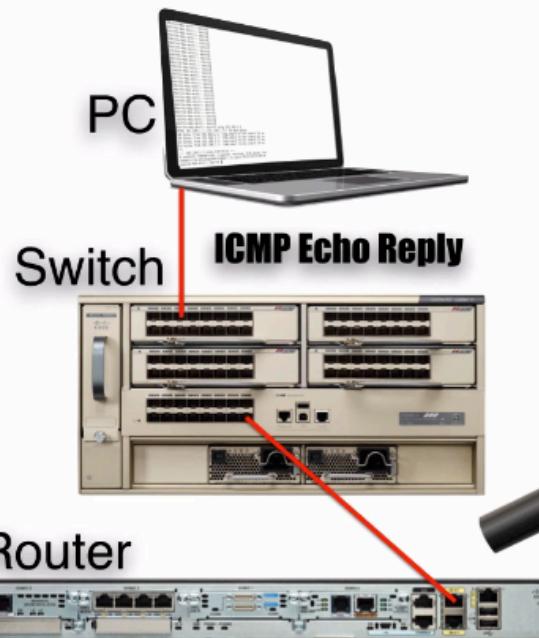
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IP, ICMP, UDP, and TCP

IP, ICMP, UDP, and TCP



UDP (User Datagram Protocol)
An "unreliable" or "connectionless" Layer 4 protocol, which does not receive acknowledgements for the segments it transmits.

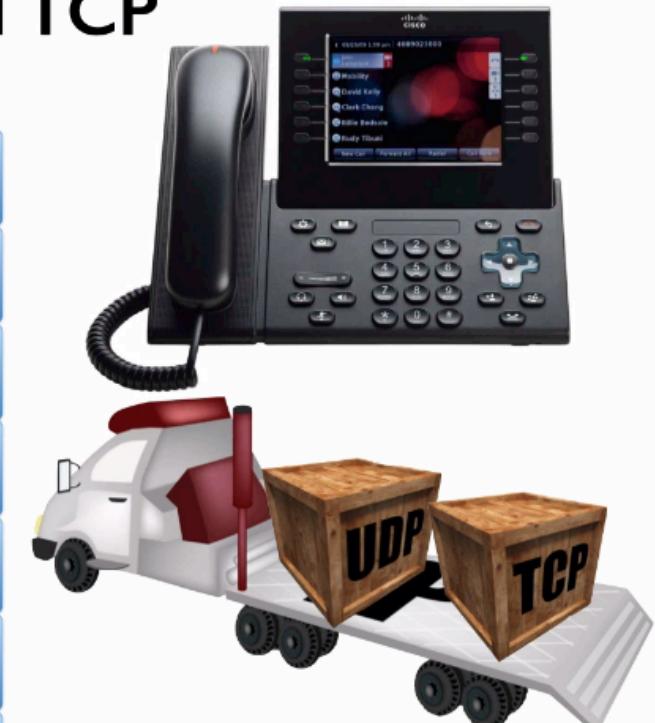
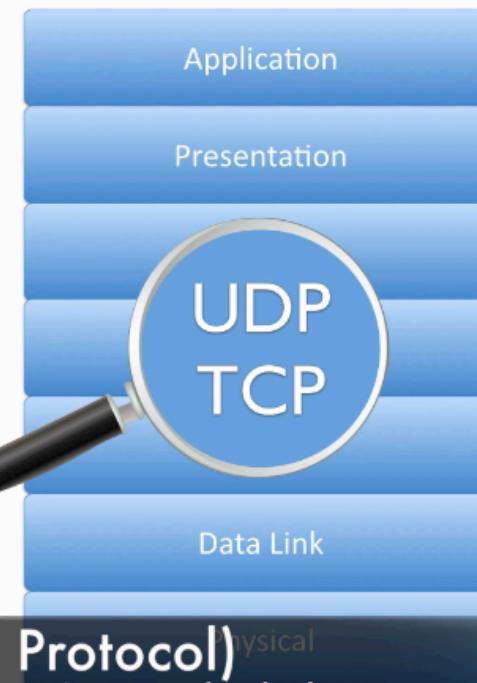
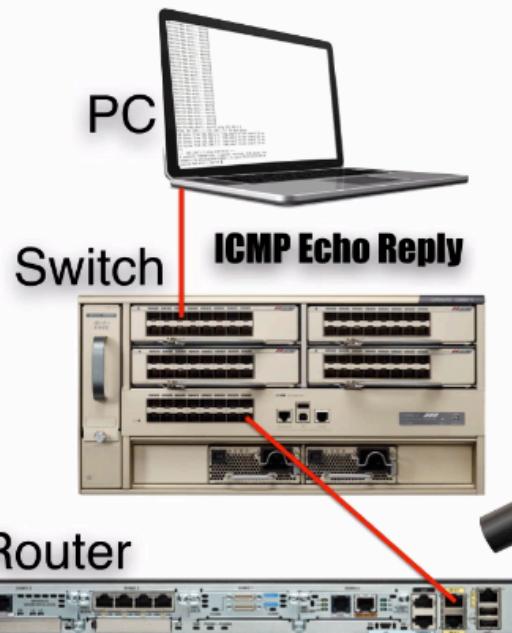
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IP, ICMP, UDP, and TCP

IP, ICMP, UDP, and TCP



TCP (Transmission Control Protocol)
A "reliable" or "connection-oriented" Layer 4 protocol, which receives acknowledgements for the segments it transmits.

Completed



IP, ICMP, UDP, and TCP



Completed



IP, ICMP, UDP, and TCP



Completed



IP, ICMP, UDP, and TCP



Completed



IP, ICMP, UDP, and TCP





IP, ICMP, UDP, and TCP

TCP 3-Way Handshake

- (1) SYN
- (2) SYN + ACK
- (3) ACK



Completed



IP, ICMP, UDP, and TCP

Sliding Window





IP, ICMP, UDP, and TCP

Sliding Window



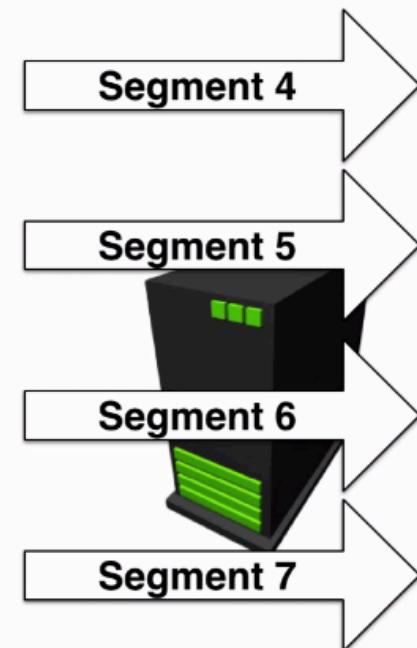


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IP, ICMP, UDP, and TCP

Sliding Window



Completed



Port and Protocols

Ports and Protocols

Completed



Port and Protocols



Well-Known Port Numbers

Ports numbered 1023 or less.

Completed



Port and Protocols

**Client****10.1.1.1****Web Server****172.16.1.2**

Ephemeral Port Numbers

Ports numbered 1024 or greater.

Completed



Port and Protocols



Completed



Port and Protocols

Protocol	Description	TCP Port	UDP Port
FTP	File Transfer Protocol: Transfers files with a remote host (typically requires authentication of user credentials)	20 and 21	
SSH	Secure Shell: Securely connect to a remote host (typically via a terminal emulator)	22	
SFTP	Secure FTP: Provides FTP file-transfer service over an SSH connection	22	
SCP	Secure Copy: Provides a secure file-transfer service over an SSH connection and offers a file's original date and time information, which is not available with SFTP	22	
Telnet	Telnet: Used to connect to a remote host (typically via a terminal emulator)	23	
SMTP	Simple Mail Transfer Protocol: Used for sending e-mail	25	
DNS	Domain Name System: Resolves domain names to corresponding IP addresses	53	53
TFTP	Trivial File Transfer Protocol: Transfers files with a remote host (does not require authentication of user credentials)		69
DHCP	Dynamic Host Configuration Protocol: Dynamically assigns IP address information (for example, IP address, subnet mask, DNS server's IP address, and default gateway's IP address) to a network device		67
HTTP	Hypertext Transfer Protocol: Retrieves content from a web server	80	
POP3	Post Office Protocol version 3: Retrieves e-mail from an e-mail server	110	
NNTP	Network News Transport Protocol: Supports the posting and reading of articles on Usenet news servers	119	
NTP	Network Time Protocol: Used by a network device to synchronize its clock with a time server (NTP server)		123
SNTP	Simple Network Time Protocol: Supports time synchronization among network devices, similar to Network Time Protocol (NTP), although SNTP uses a less complex algorithm in its calculation and is slightly less accurate than NTP		123
IMAP4	Internet Message Access Protocol version 4: Retrieves e-mail from an e-mail server	143	
LDAP	Lightweight Directory Access Protocol: Provides directory services (for example, a user directory—including username, password, e-mail, and phone number information) to network clients	389	
HTTPS	Hypertext Transfer Protocol Secure: Used to securely retrieve content from a web server	443	
rsh	Remote Shell: Allows commands to be executed on a computer from a remote user	514	
RTSP	Real Time Streaming Protocol: Communicates with a media server (for example, a video server) and controls the playback of the server's media files	554	554
RDP	Remote Desktop Protocol: A Microsoft protocol that allows a user to view and control the desktop of a remote computer	3389	