CompTIA Network +

Chapter 2
Dissecting the OSI Model

Updated 8-20-16

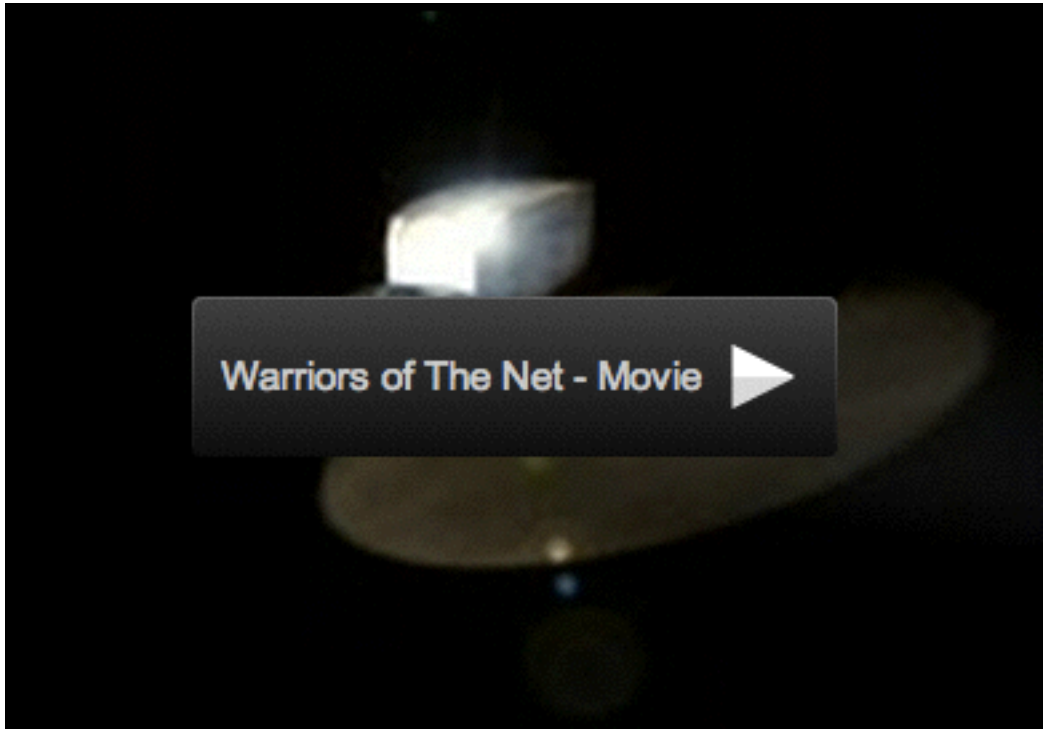
Objectives

- What is the purpose of a Network model?
- What are the layers of the OSI model?
- What are the characteristics of each layer of the OSI model?
- How does the TCP/IP stack compare to the OSI model?
- What are the well-known TCP and/or UDP port numbers for a given collection of common applications

The Purpose of Reference Models

- It breaks network communication into smaller, simpler parts that are easier to develop.
- It facilitates standardization of network components to allow multiple-vendor development and support.
- It allows different types of network hardware and software to communicate with each other.
- It prevents changes in one layer from affecting the other layers so that they can develop more quickly.
- It breaks network communication into smaller parts to make learning it easier to understand.

Warriors of the Net



- Link "Net 4"

The OSI seven-layer model

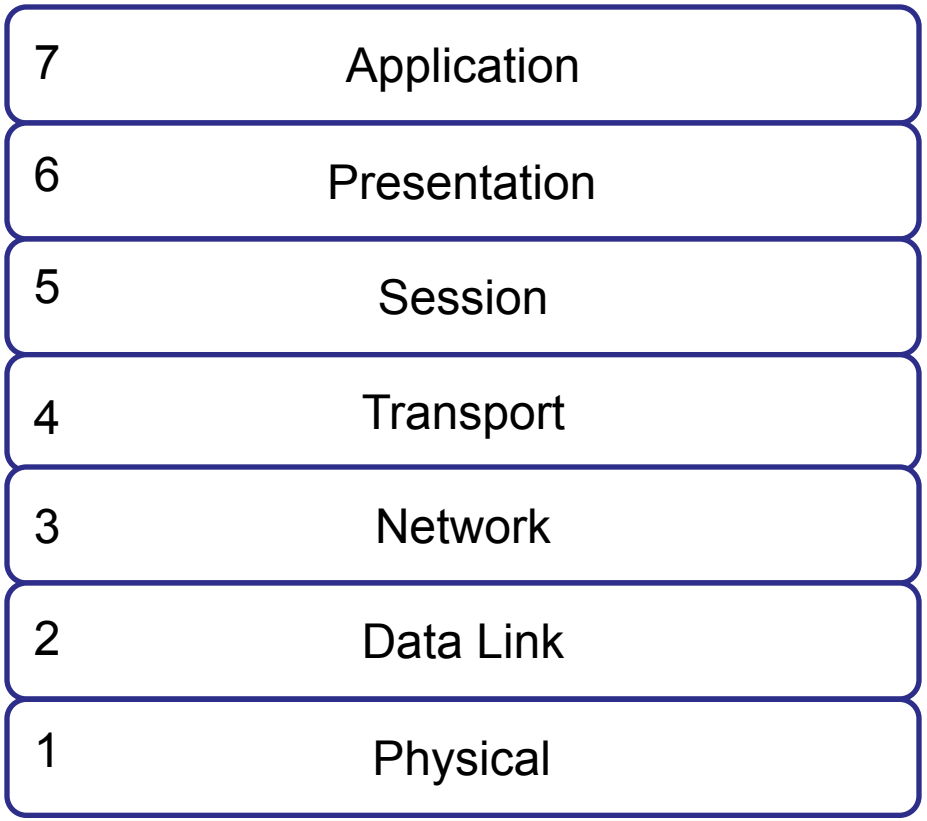


Figure 2-2 OSI Stack

Mnemonics for the OSI Model

Away
Pizza
Sausage
Throw
Not
Do
Please

All
People
Seem
To
Need
Data
Processing

Protocol Data Unit (PDU)

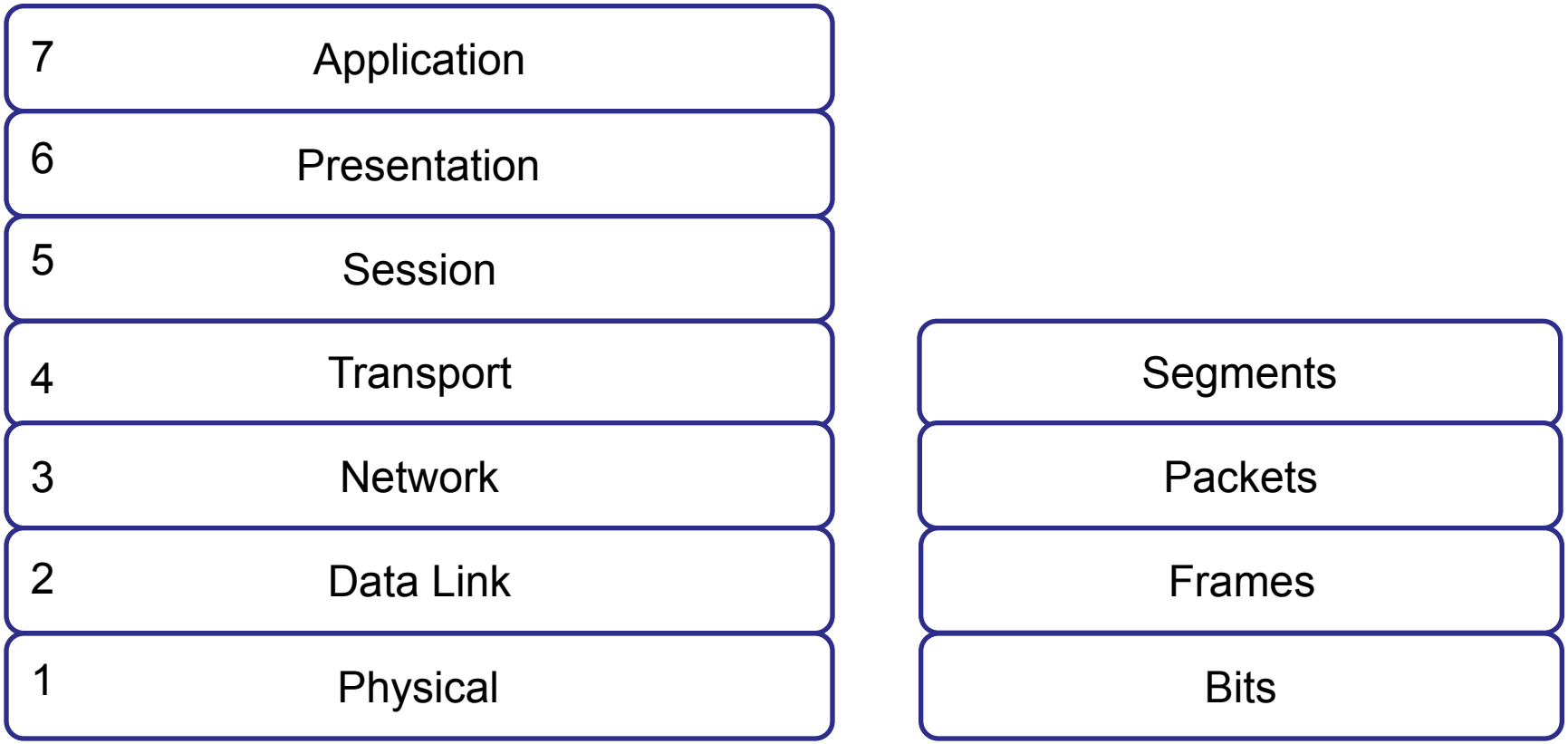
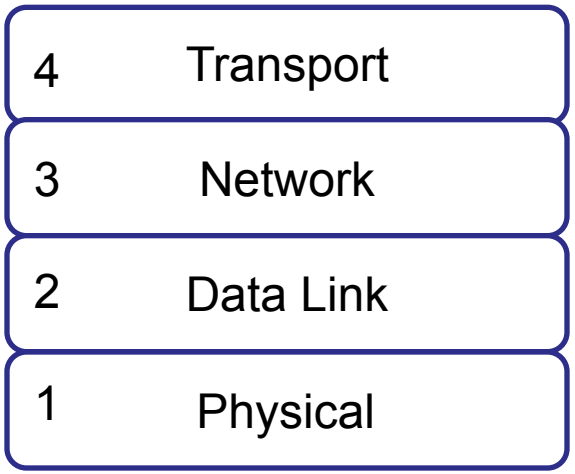


Figure 2-3 PDU Names

Quick Summary of Layers 1-4

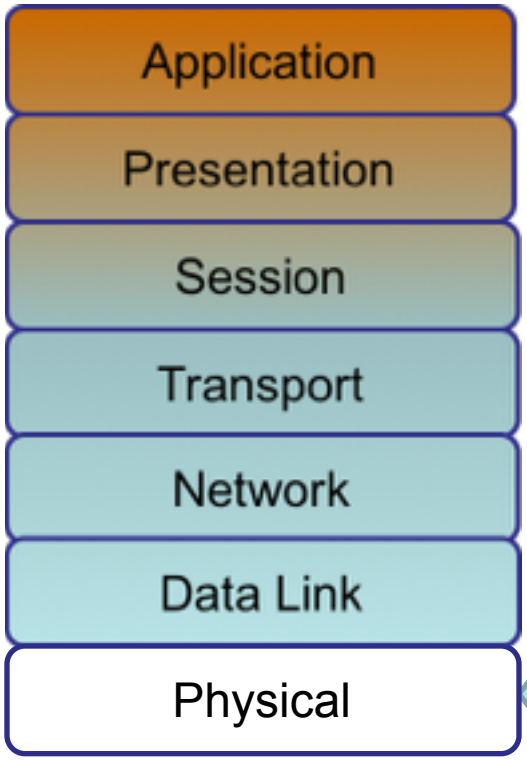


TCP & UDP Ports	Service
Routers, IP Address	WAN
Switches, MAC Address	LAN
Cables	

OSI Layers in Wireshark

1	▷ Frame 1216: 467 bytes on wire (3736 bits)
2	▷ Ethernet II, Src: Apple_4f:2b:55 (28:cf:e9:4f:2b:55)
3	▷ Internet Protocol Version 4, Src: 192.168.1.141
4	▷ Transmission Control Protocol, Src Port: 58163
7	▷ Hypertext Transfer Protocol

Physical Layer

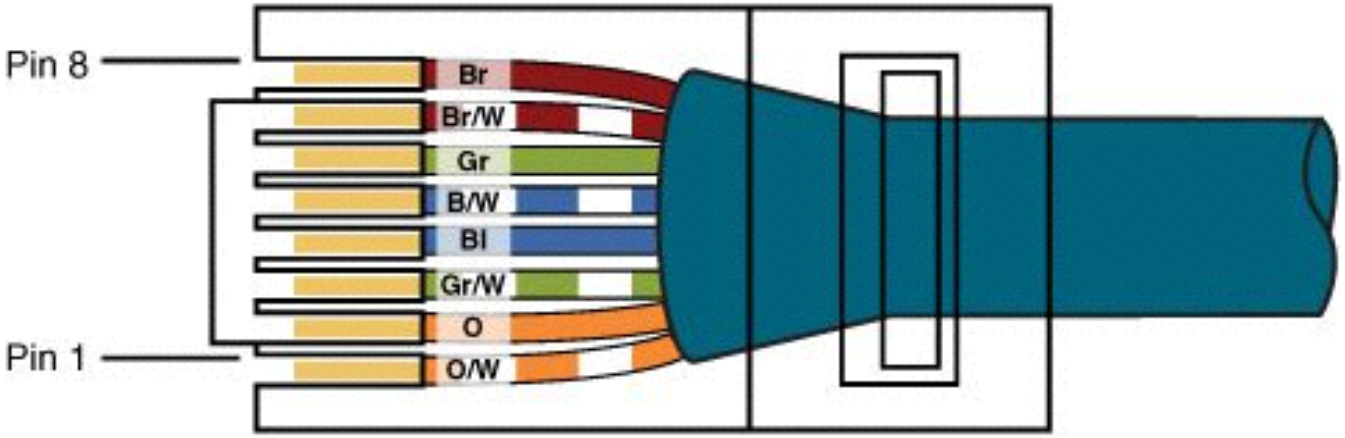


- How Bits are represented on the medium
- Wring standards for connectors and jacks
- Physical topology
- Synchronizing bits
- Bandwidth usage
- Multiplexing strategy

Figure 2-4 Layer 1: Physical Layer

Wiring Standards

Figure 2-7 TIA/EIA-568-B Wiring Standard for an RJ-45 Connector



Asynchronous and Synchronous Communications

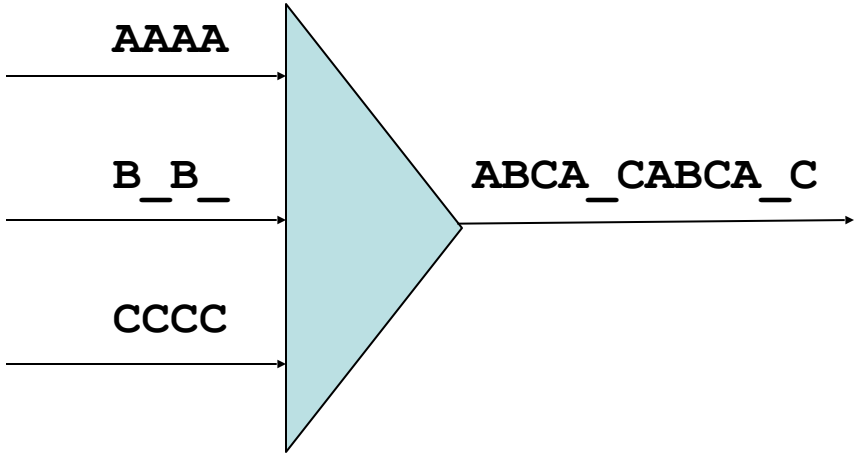
- Synchronizing Bits
  - Two devices must agree on when one bit stops and another bit starts
- **Asynchronous**
  - Uses start and stop bits
- **Synchronous**
  - Internal clocks are synchronized at each end of the cable

Bandwidth Usage

- Broadband
  - Multiple channels share the same medium
  - Ex: cable TV uses **frequency division multiplexing** (each channel uses a different frequency range)
- Baseband
  - The whole medium is used for one transmission
  - Example: Ethernet

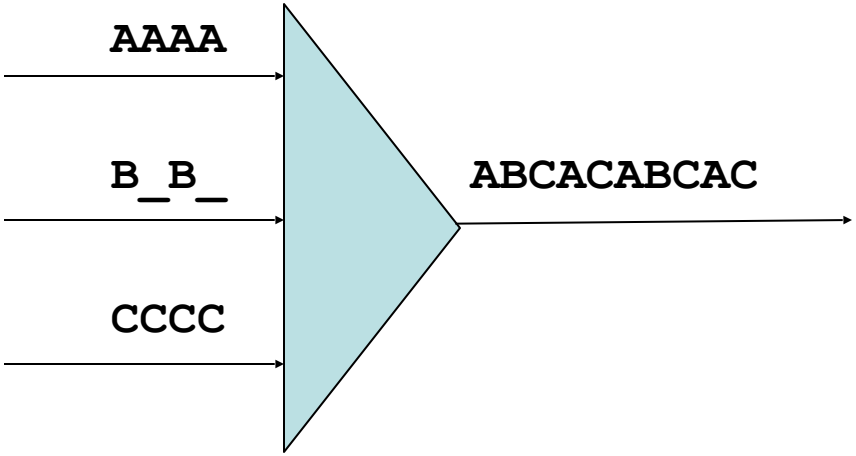
Time-Division Multiplexing (TDM)

- Each channel gets the same amount of time on the wire



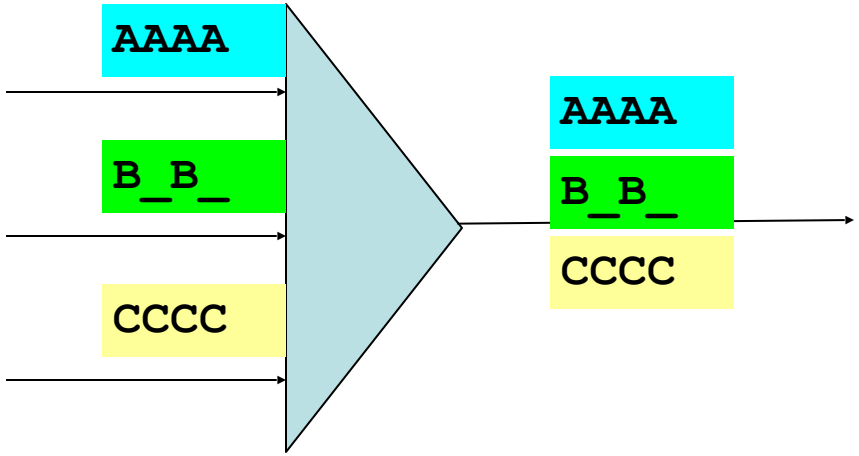
Statistical Time-Division Multiplexing (StatTDM)

- Busy channels get more time on the wire



Frequency Division Multiplexing (FDM)

- Example: signals sent with different colors through the same fiber optic cable



Layer 1 Devices

- Cables
- Wireless access points
- Hubs
  - Because they don’t pay any attention to addresses, they just deliver signals to every connected device like a crossover cable

Data Link Layer

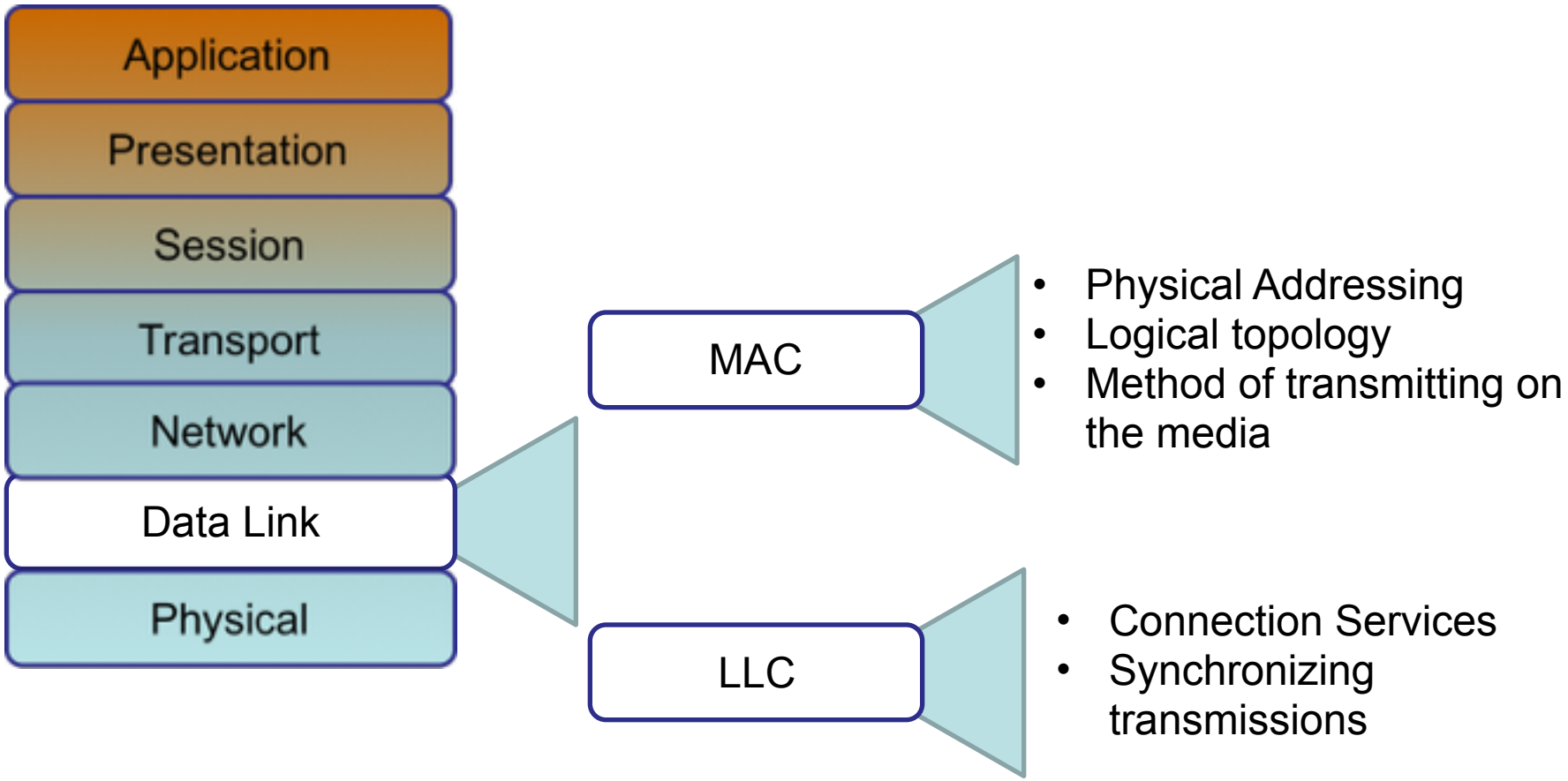
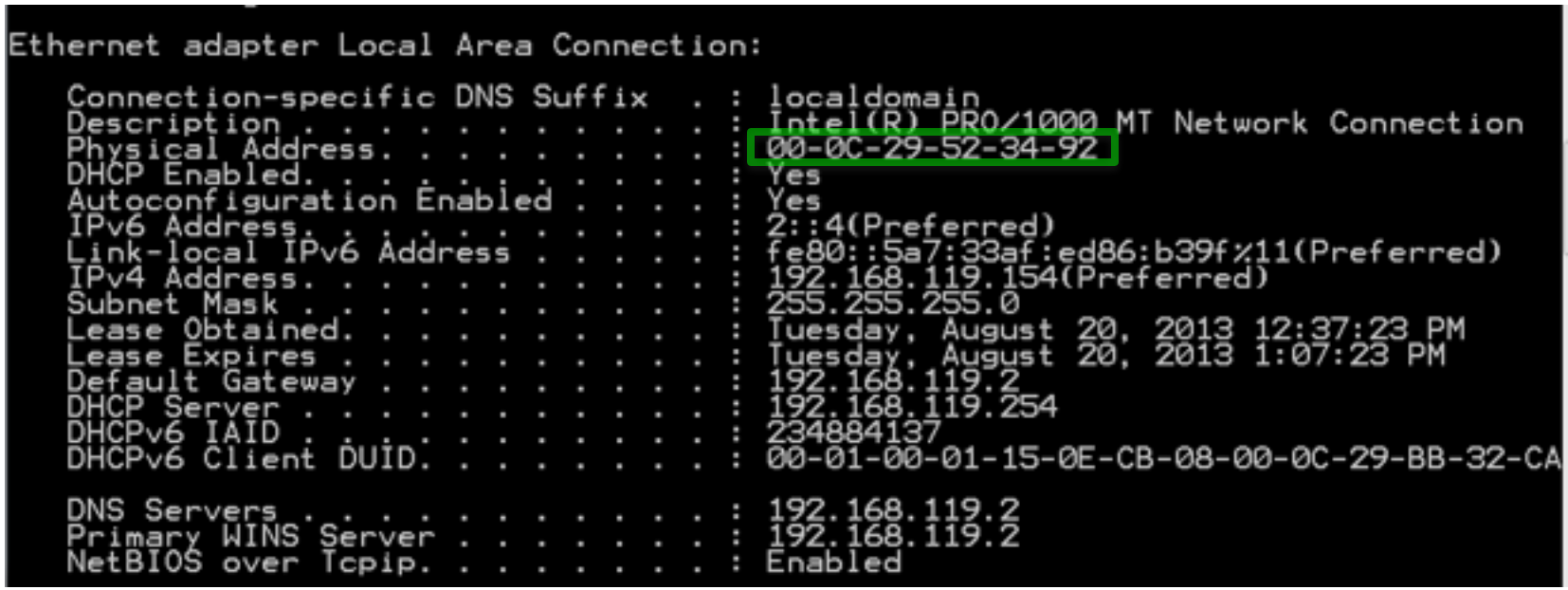


Figure 2-8 Layer 2: The Data Link Layer

MAC Addresses

- IPCONFIG /ALL
- Physical Address
- Built into the network interface



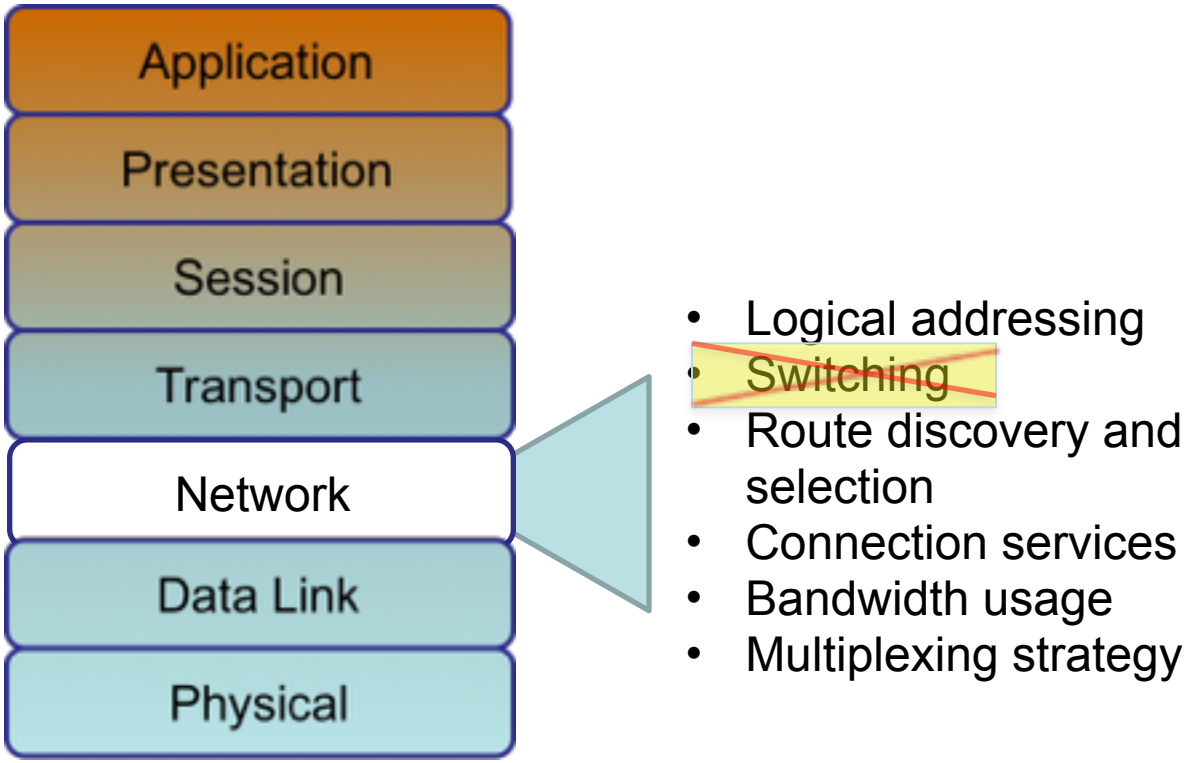
Connection Services

- Flow control
  - Prevents sender from sending data faster than the client can accept it
- Error control
  - When a frame is received, a **checksum** is used to detect errors
    - Usually a **Cyclic Redundancy Check (CRC)**
  - If the receiver's checksum does not match the sender's checksum, the frame is discarded and resent

Layer 2 Devices

- Switches
- Bridges
- Network Interface Cards (NICs)

Network Layer

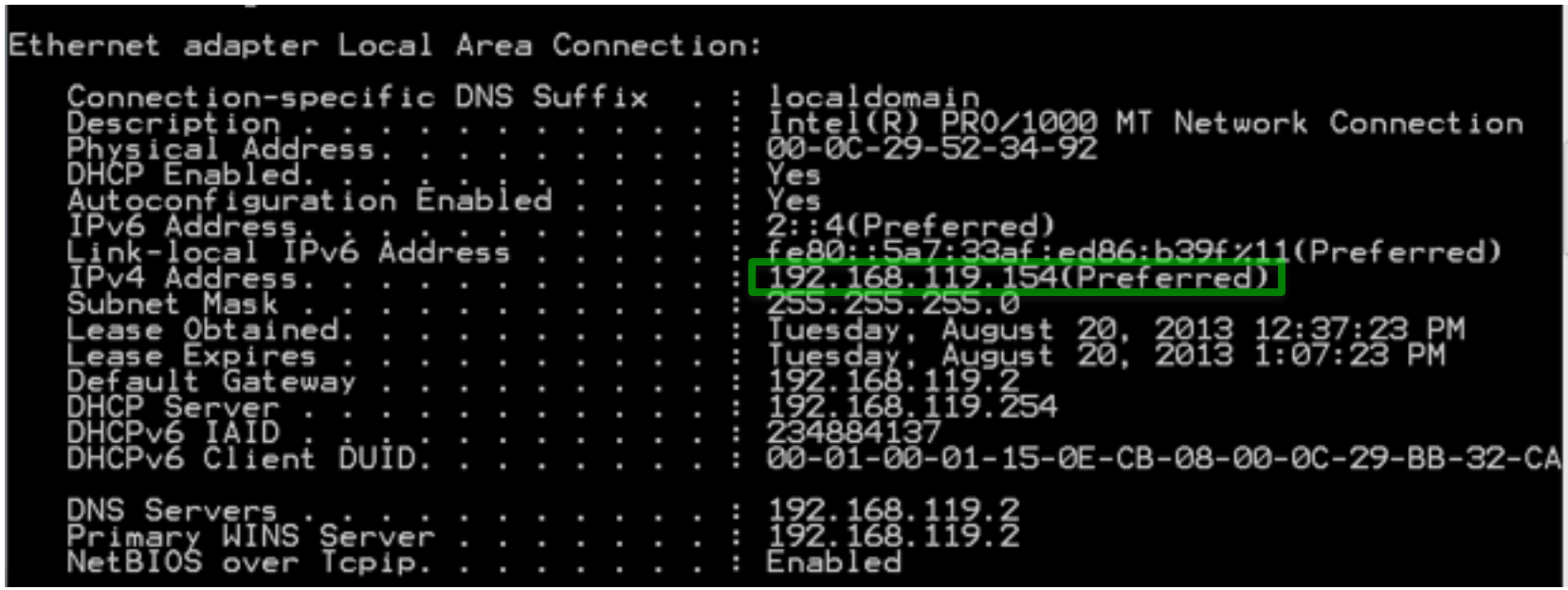


- Logical addressing
- Switching
- Route discovery and selection
- Connection services
- Bandwidth usage
- Multiplexing strategy

Figure 2-9 Layer 3: The Network Layer

IP Address

- Logical address
- Changes when the device is moved



Switching

- Packet switching
  - Data is broken into packets
  - Many packets travel along network connections like cars on a freeway
- Circuit switching
  - A physical line is dedicated to each connection
  - Ex: old copper landline phone systems
- Message switching
  - Store-and-forward, like email

Layer 3 Devices

- Routers
- Multilayer Switches

Transport Layer

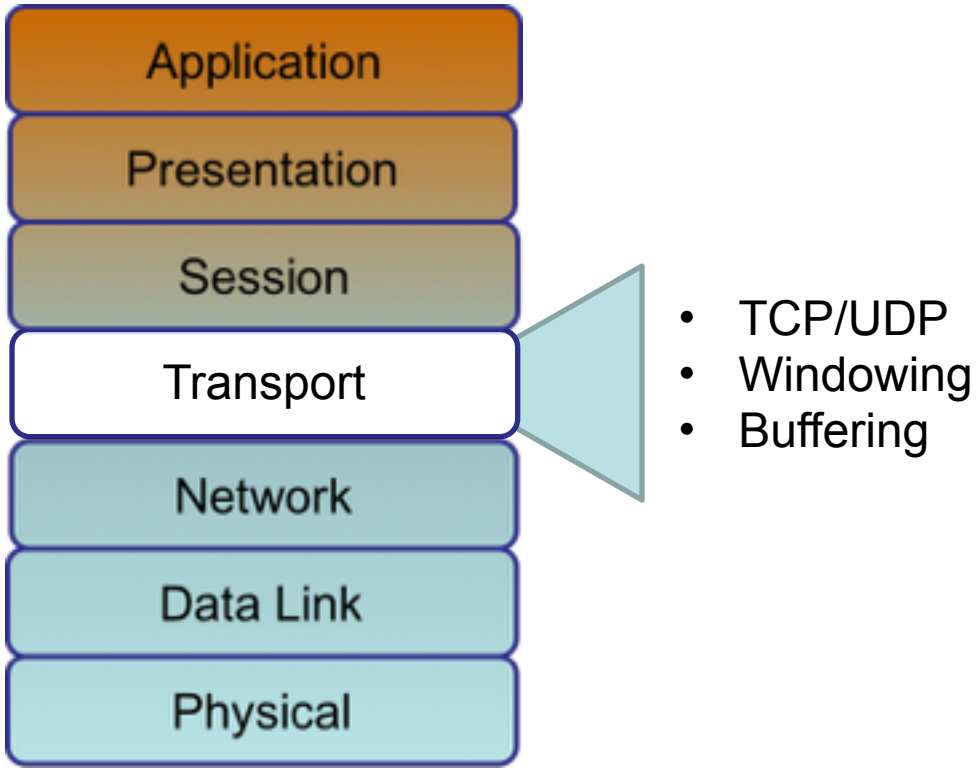


Figure 2-10 Layer 4: The Transport Layer

TCP and UDP

- Transmission Control Protocol (TCP)
  - Connection-oriented and reliable
  - Handshake makes sure both ends are ready
  - Segments are acknowledged and resent if necessary
- User Datagram Protocol (UDP)
  - Connectionless and unreliable
  - No handshake
  - Best-effort delivery, no acknowledgements

TCP Sliding Window

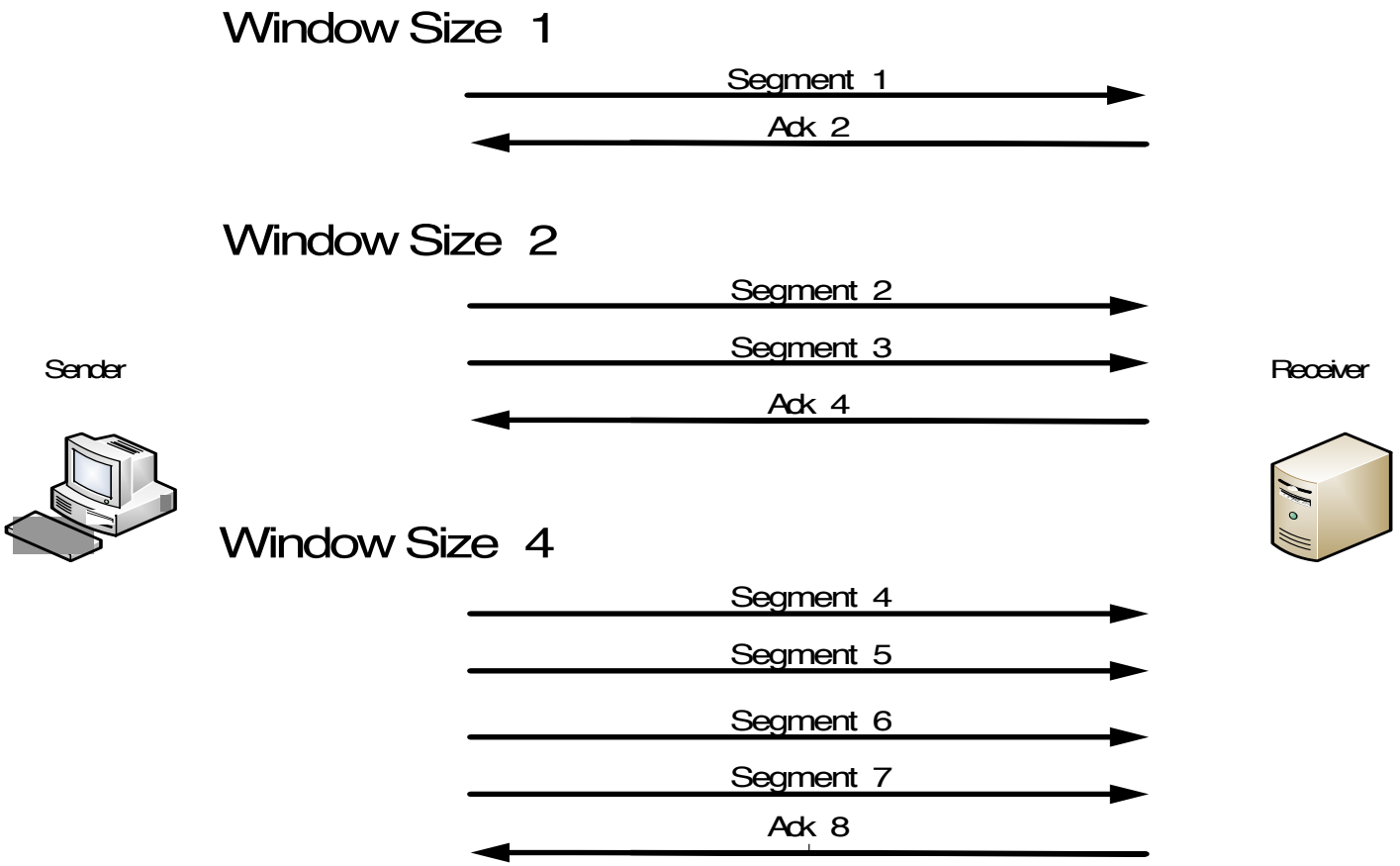
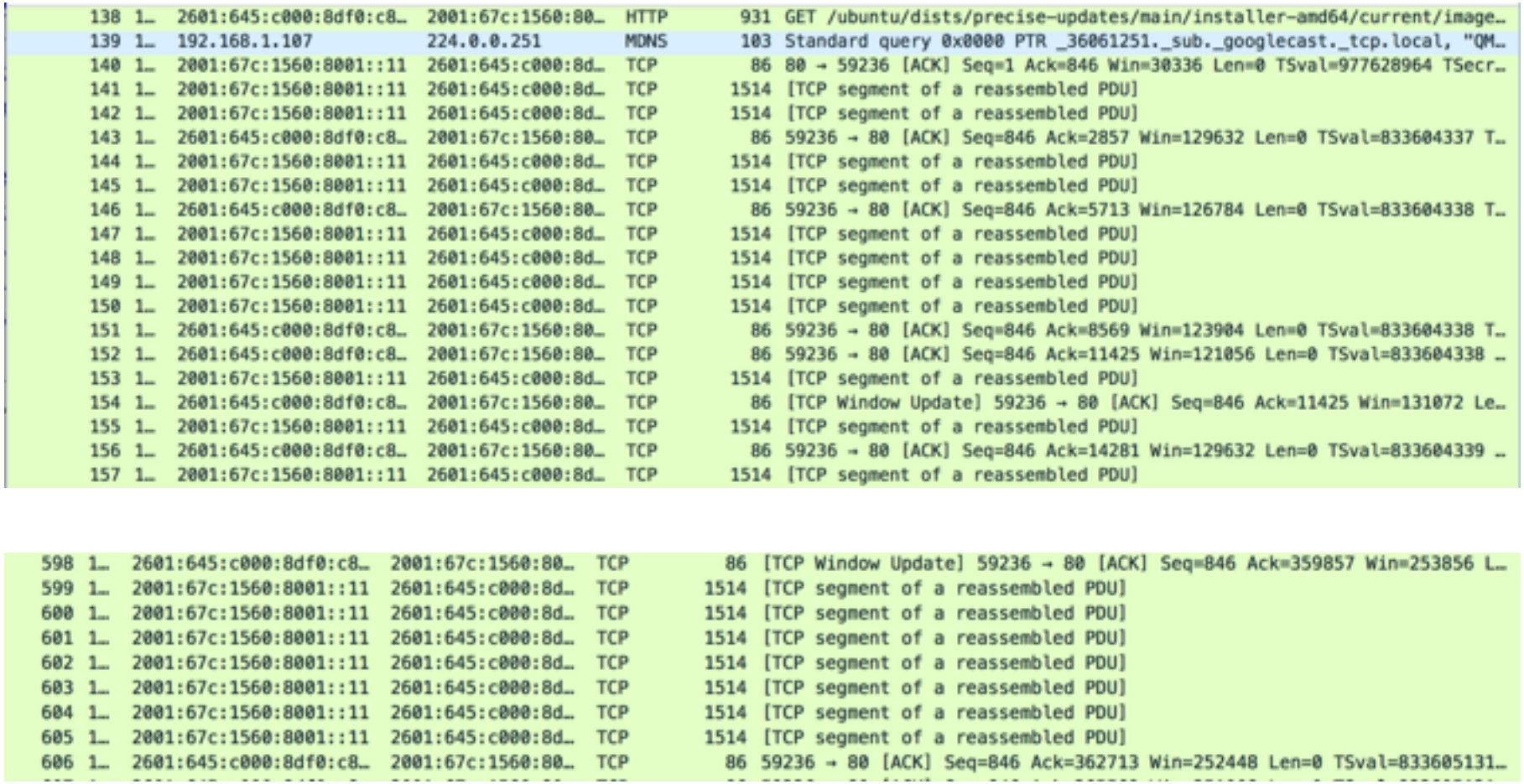


Figure 2-11 TCP Sliding Window

Demo: Downloading a Large File



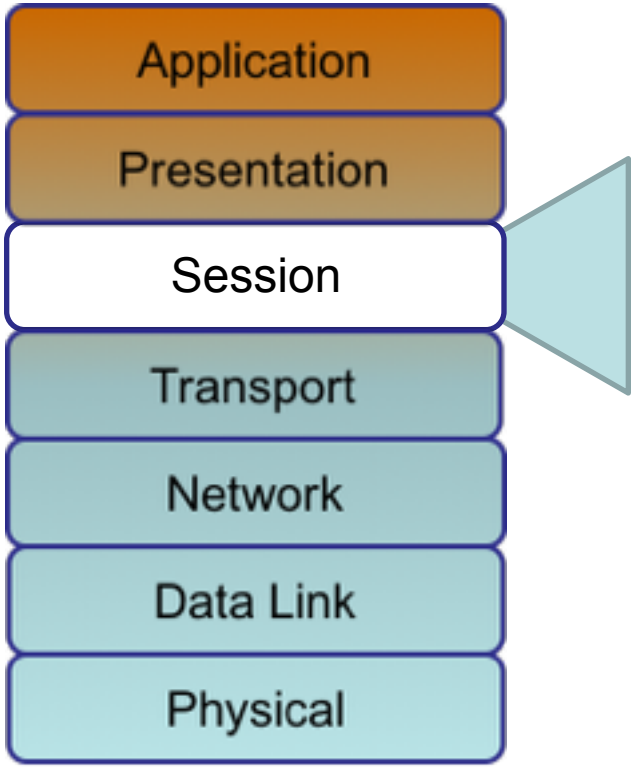
138	1…	2601:645:c000:8df0:c8…	2001:67c:1560:80…	HTTP	931	GET /ubuntu/dists/precise-updates/main/installer-amd64/current/image…
139	1…	192.168.1.107	224.0.0.251	MDNS	103	Standard query 0x0000 PTR _36061251._sub._googlecast._tcp.local, "QM…
140	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	86	80 → 59236 [ACK] Seq=1 Ack=846 Win=30336 Len=0 TSval=977628964 TSecr…
141	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
142	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
143	1…	2601:645:c000:8df0:c8…	2001:67c:1560:80…	TCP	86	59236 → 80 [ACK] Seq=846 Ack=2857 Win=129632 Len=0 TSval=833604337 T…
144	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
145	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
146	1…	2601:645:c000:8df0:c8…	2001:67c:1560:80…	TCP	86	59236 → 80 [ACK] Seq=846 Ack=5713 Win=126784 Len=0 TSval=833604338 T…
147	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
148	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
149	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
150	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
151	1…	2601:645:c000:8df0:c8…	2001:67c:1560:80…	TCP	86	59236 → 80 [ACK] Seq=846 Ack=8569 Win=123904 Len=0 TSval=833604338 T…
152	1…	2601:645:c000:8df0:c8…	2001:67c:1560:80…	TCP	86	59236 → 80 [ACK] Seq=846 Ack=11425 Win=121056 Len=0 TSval=833604338 …
153	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
154	1…	2601:645:c000:8df0:c8…	2001:67c:1560:80…	TCP	86	[TCP Window Update] 59236 → 80 [ACK] Seq=846 Ack=11425 Win=131072 Le…
155	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
156	1…	2601:645:c000:8df0:c8…	2001:67c:1560:80…	TCP	86	59236 → 80 [ACK] Seq=846 Ack=14281 Win=129632 Len=0 TSval=833604339 …
157	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]

598	1…	2601:645:c000:8df0:c8…	2001:67c:1560:80…	TCP	86	[TCP Window Update] 59236 → 80 [ACK] Seq=846 Ack=359857 Win=253856 L…
599	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
600	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
601	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
602	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
603	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
604	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
605	1…	2001:67c:1560:8001::11	2601:645:c000:8d…	TCP	1514	[TCP segment of a reassembled PDU]
606	1…	2601:645:c000:8df0:c8…	2001:67c:1560:80…	TCP	86	59236 → 80 [ACK] Seq=846 Ack=362713 Win=252448 Len=0 TSval=833605131…

ICMP
(Internet Control Message Protocol)

- At layer 4
- Used by ping and traceroute, and to indicate errors such as dropped packets

Session Layer



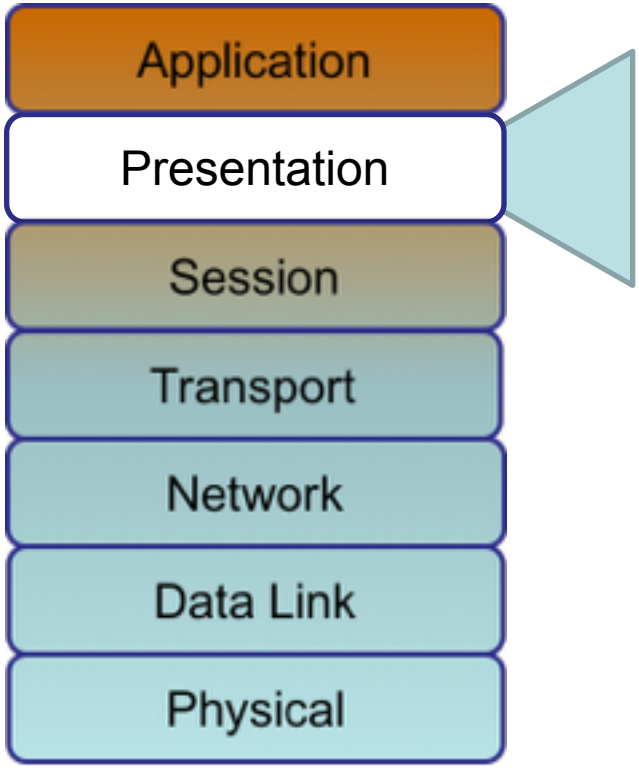
- Setting up a session
- Maintaining a session
- Tearing down a session

Figure 2-12 Layer 5: The Session Layer

Example of a Session

- User logs in with a username & password
- All data now has a special significance until that user logs off, or the session times out, or is terminated some other way
- Layer 6 Protocol
  - H.323 (voice or video)
  - NetBIOS (file sharing)

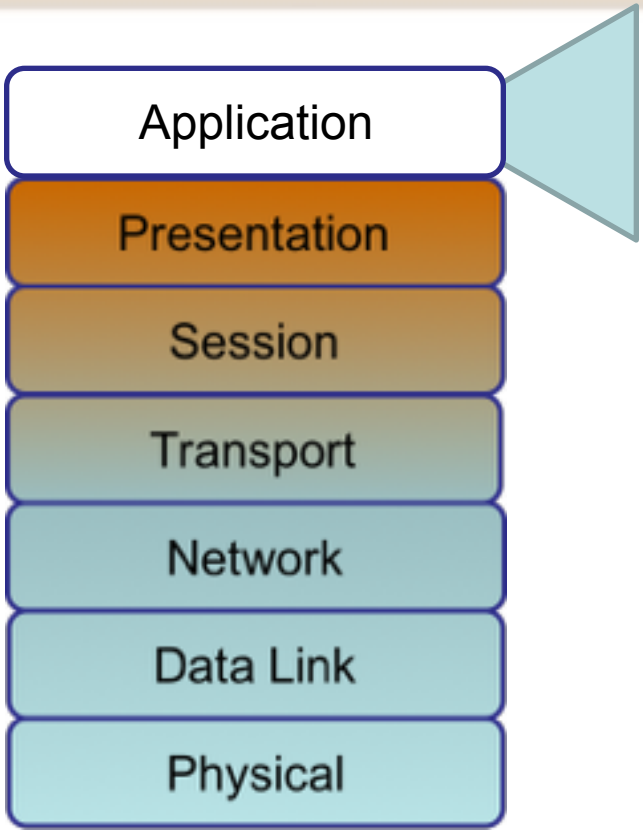
Presentation Layer



- Data formatting
- Encryption

Figure 2-13 Layer 6: The Presentation Layer

Application Layer

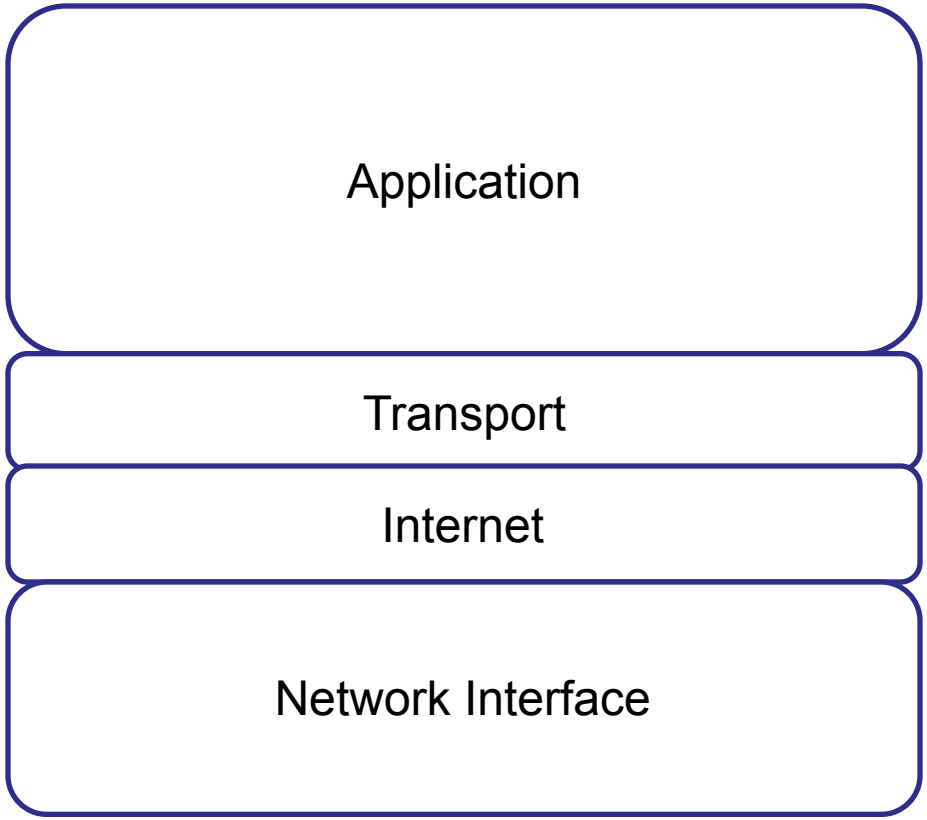


- Application services
- Service advertisement

Application Layer

- Closest to the user
- Hands data to an application in the format it expects, with no addresses or other transmission artifacts
- Examples: a downloaded file, an email message

The TCP/IP Stack



The TCP/IP and OSI Models Compared

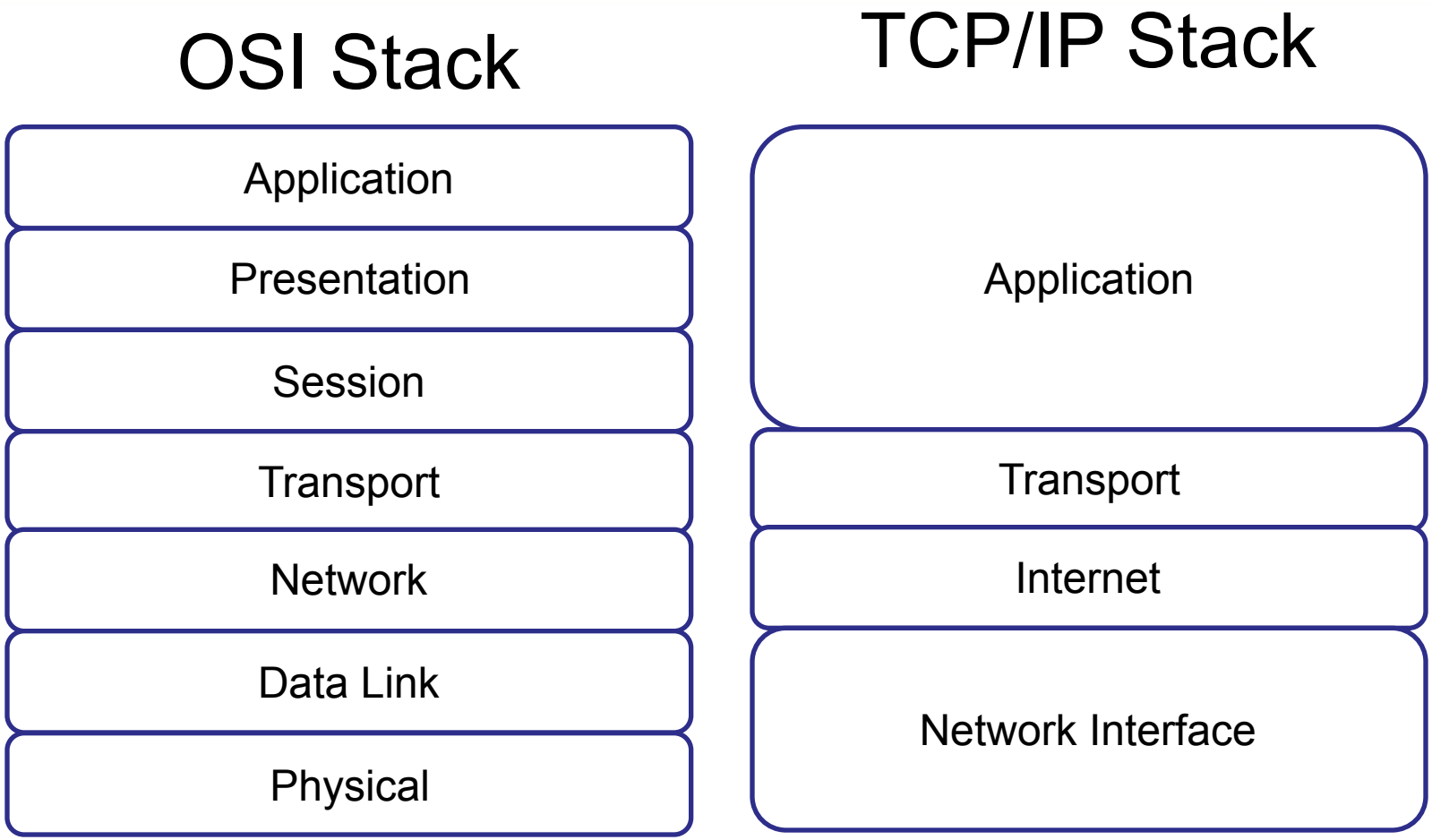
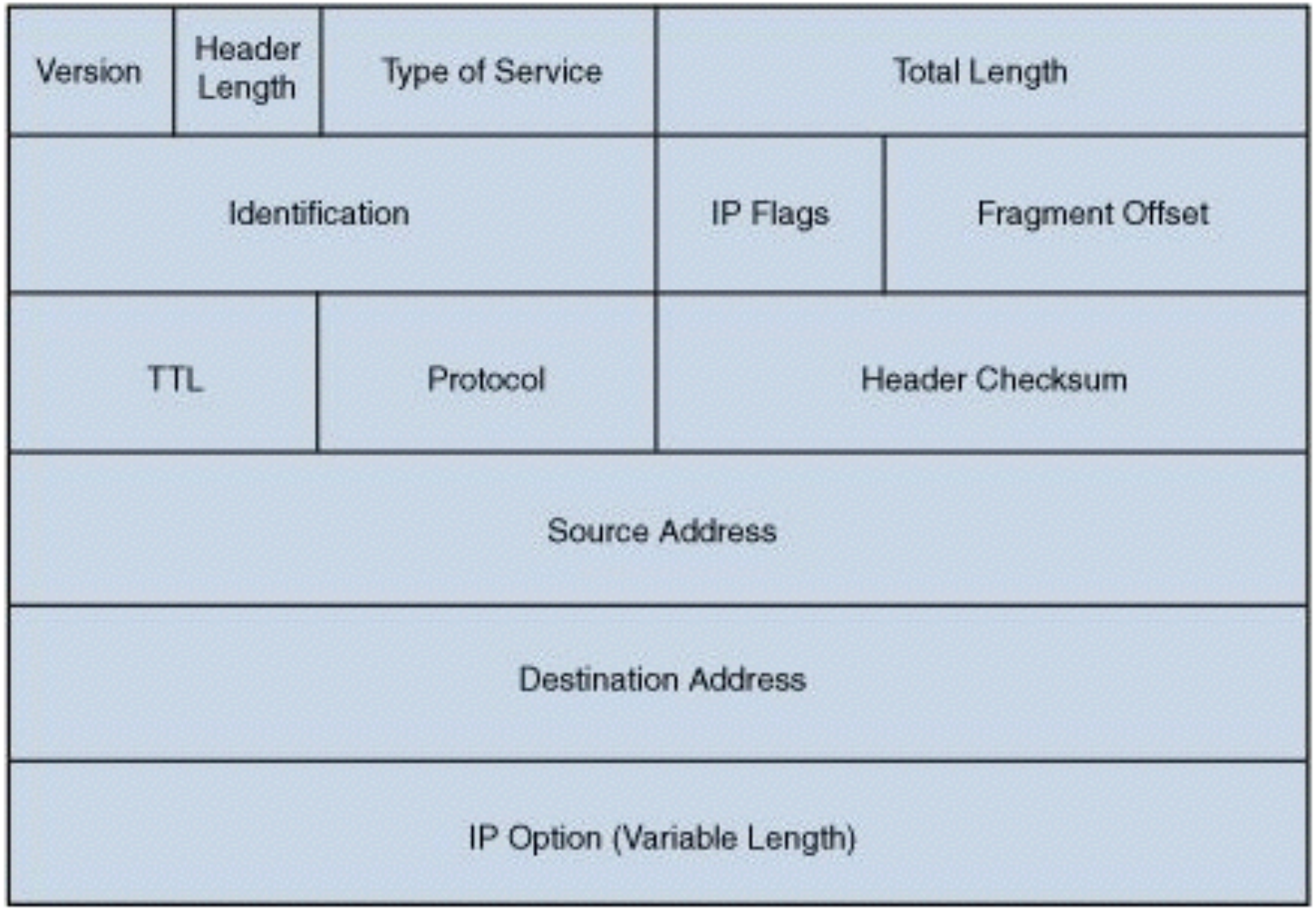


Figure 2-15 TCP/IP Stack

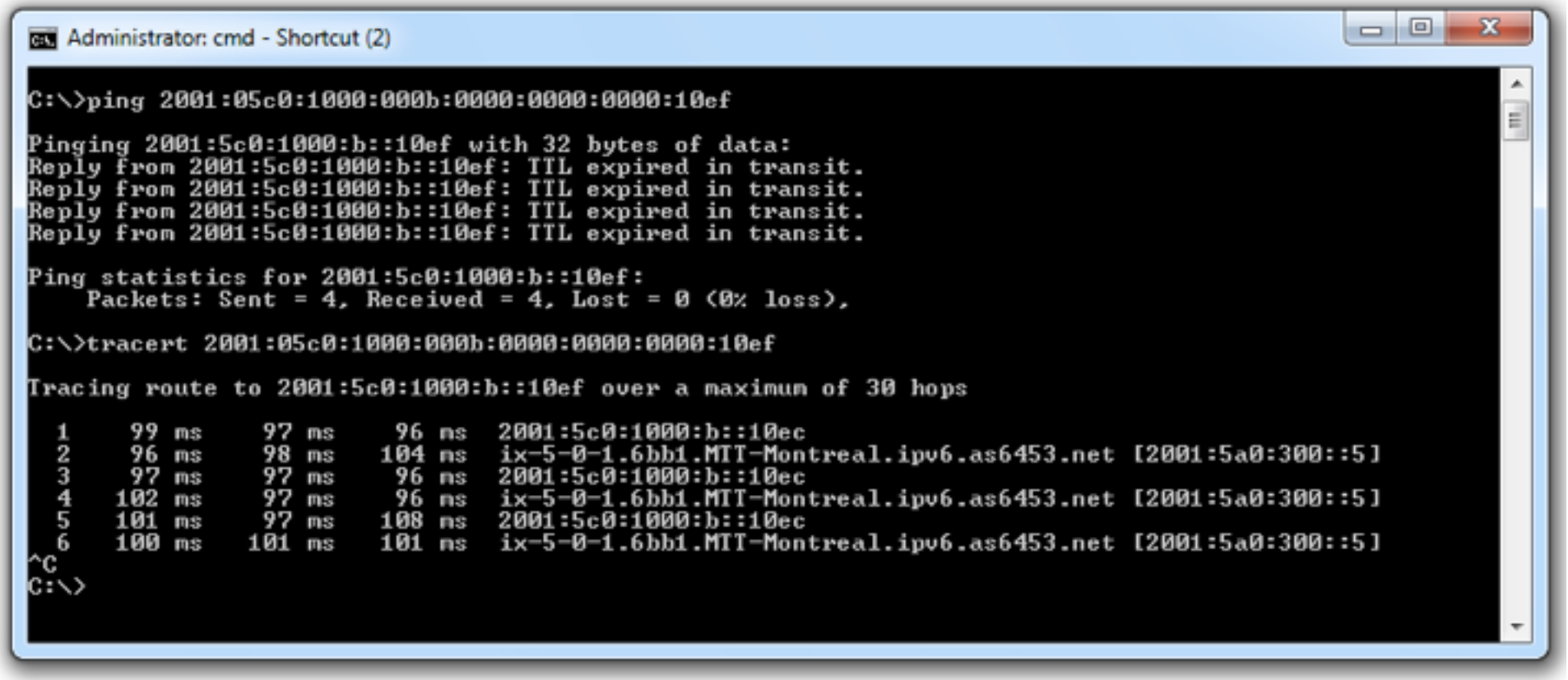
IP Ver4 Header



TTL (Time-to-Live)

- TTL decreases by one each time the packet is forwarded by a router
- If TTL reaches zero, the packet is discarded
- This eliminates packets trapped in **routing loops**

Demo: Routing Loop



TCP Header

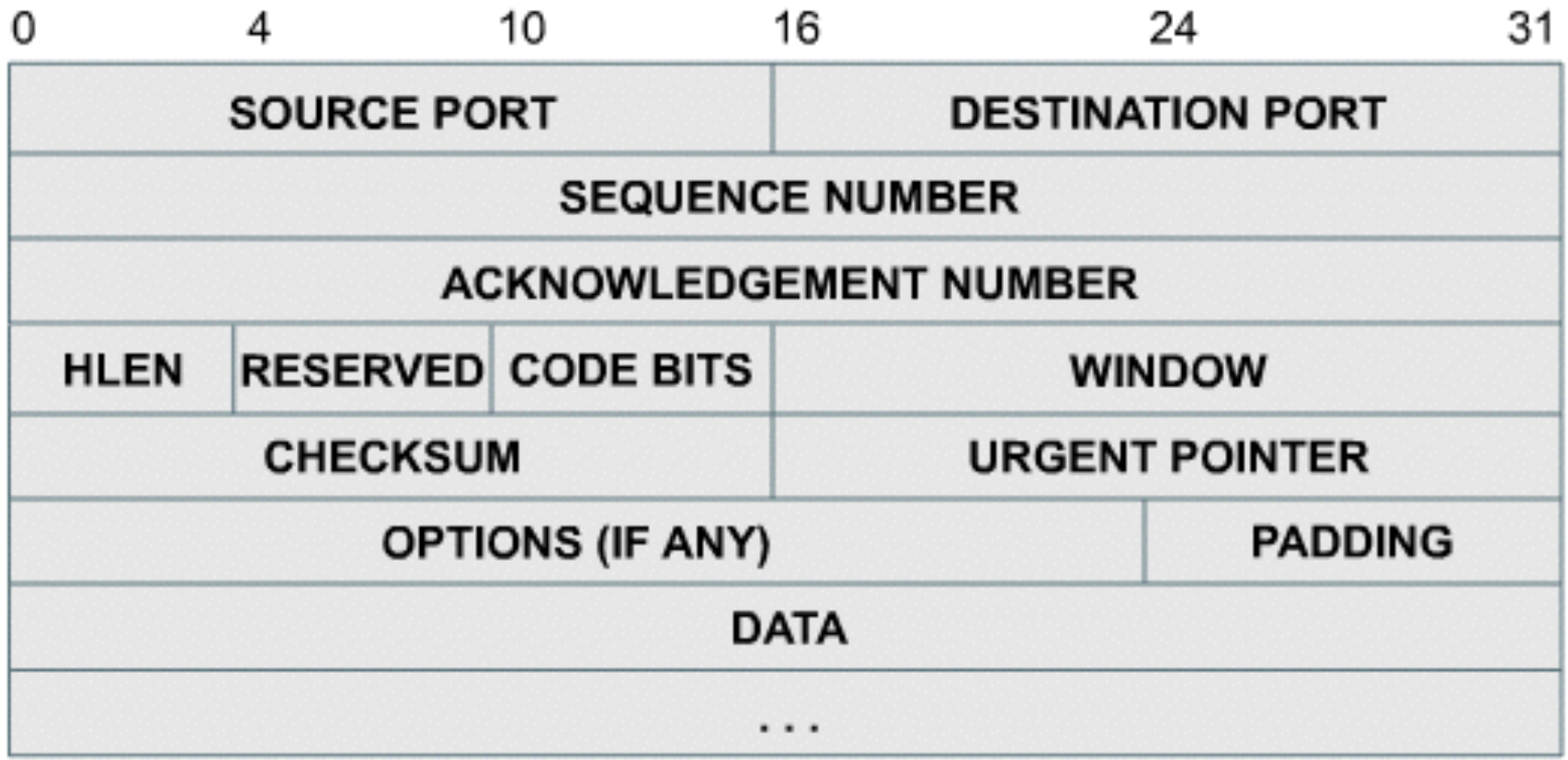


Figure 2-17 TCP Segment Format

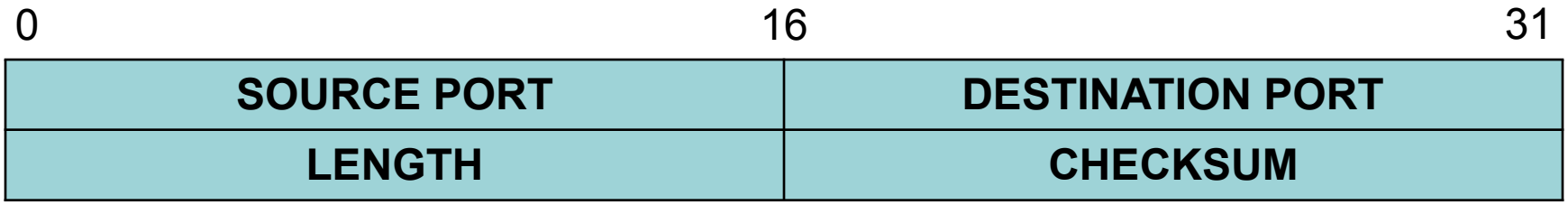
TCP Header Fields

- Port numbers
  - Indicate which program on the end device should receive the data
  - Examples: Port 25 for email, 80 for HTTP
- Window size
  - Number of bytes that can be sent before waiting for an ACK

TCP Header Fields

- Sequence and Acknowledgement numbers
  - Used to put packets in order to reassemble files and other large messages
- Flags like SYN and ACK are used for the TCP handshake and to acknowledge data received

UDP Header



- No handshake, acknowledgements, sequencing, or flow control

Common Ports

Link "Net 5" for flash cards

DNS (Domain Name System)	TCP/UDP 53
HTTP (Hypertext Transfer Protocol)	TCP 80
SMTP (Simple Mail Transfer Protocol)	TCP 25
POP (Post Office Protocol)	TCP 110
Telnet	TCP 23
DHCP (Dynamic Host Configuration Protocol)	UDP 67 (IPv4 client) and 68 (IPv4 server);
FTP (File Transfer Protocol)	TCP 20 (data) and 21 (control)
TFTP (Trivial File Transfer Protocol)	UDP 69
NBNS (NetBIOS Name Service)	UDP/TCP 137
IMAP4 (Internet Message Access Protocol)	TCP 143
SNMP (Simple Network Management Protocol)	TCP/UDP 161
HTTPS (Hypertext Transfer Protocol Secure)	TCP 443
NTP (Network Time Protocol)	UDP 123
SSL (Secure Sockets Layer)	TCP 443
SSH (Secure Shell)	TCP 22

Port Types

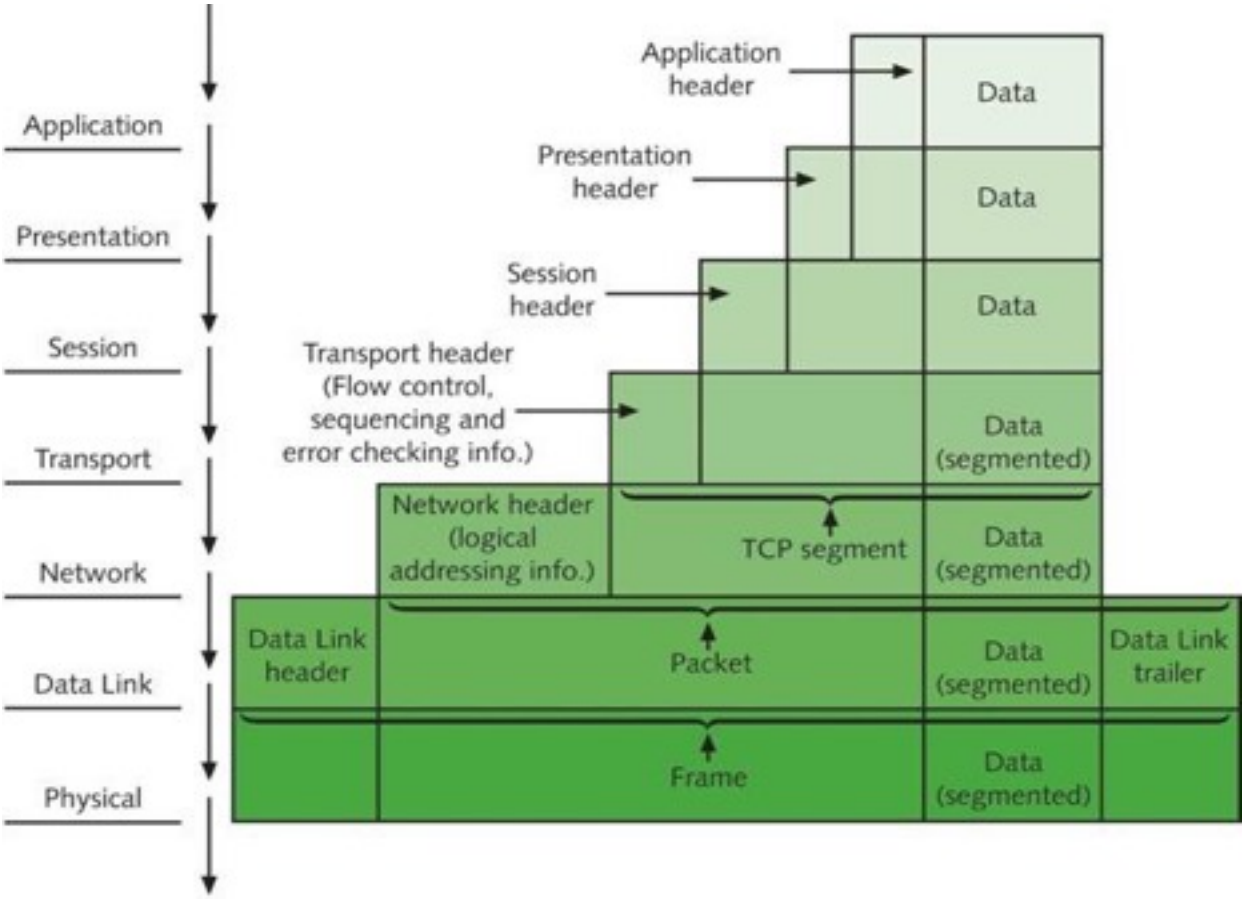
Port numbers are assigned in various ways, based on three ranges:

- System Ports (0-1023), System Ports are assigned by IETF process for standards-track protocols, as per RFC6335. **Also known as *well-known-ports***

- User Ports (1024-49151) ,User Ports are assigned by IANA using the "Expert Review" process, as per RFC6335

- Dynamic and/or Private Ports (49152-65535), Dynamic Ports are not assigned, they are dynamically created as your computer need them. **Also known as *ephemeral ports*.**

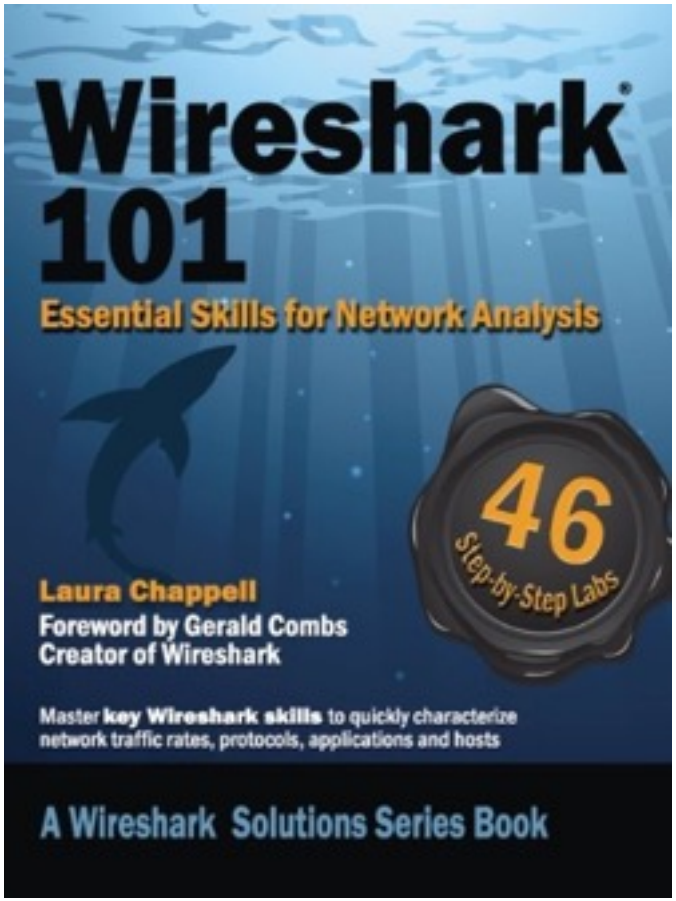
Communication Between Two Systems



Next Steps

- **Excellent book**
- **Many hands-on projects**
- **Downloadable PCAP files**
- **Also a certification "WCNA"**

- **Links: "Net 1" & "Net 2"**



Next Steps

Excellent videos

Link: "Net 3"