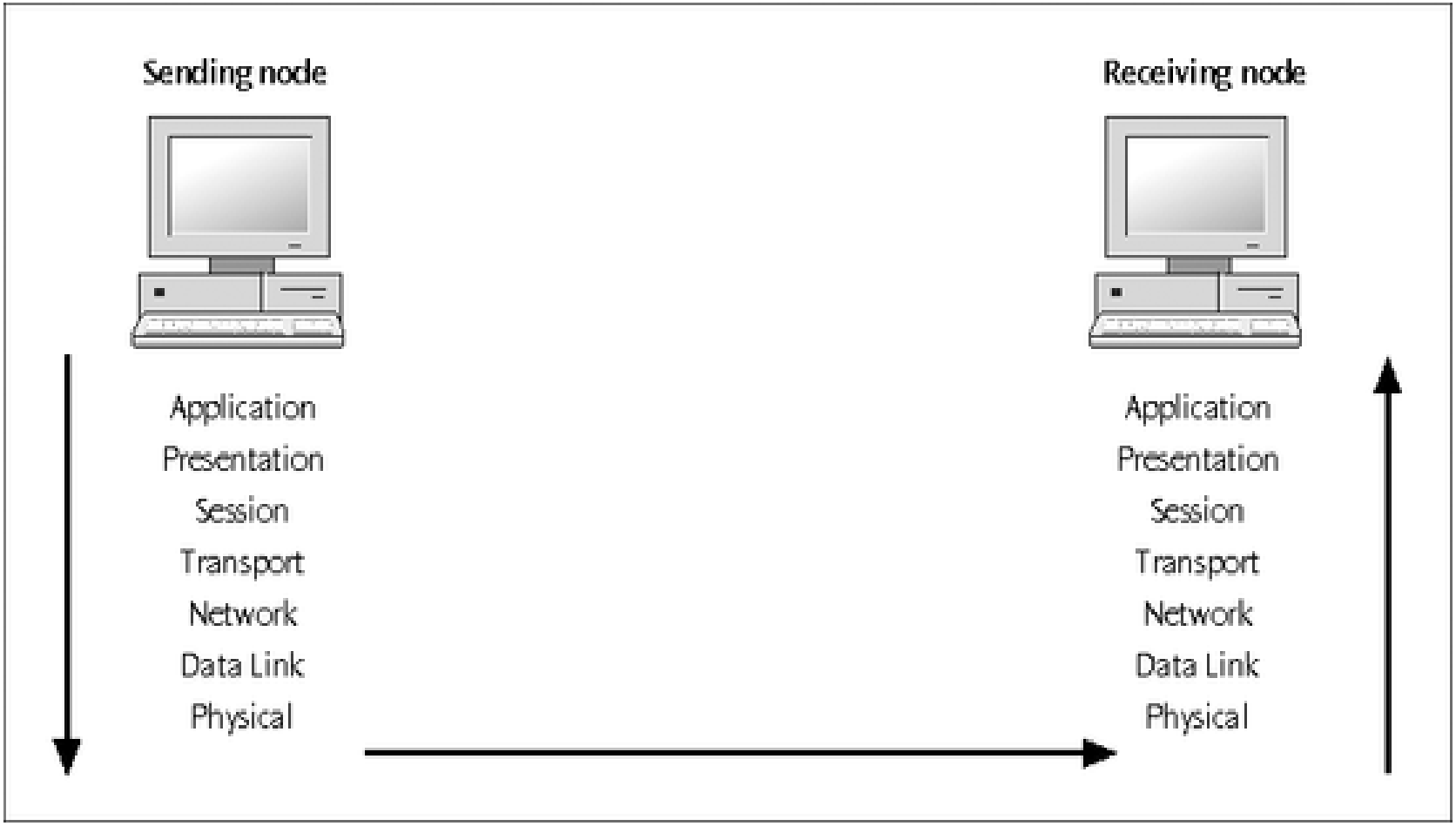
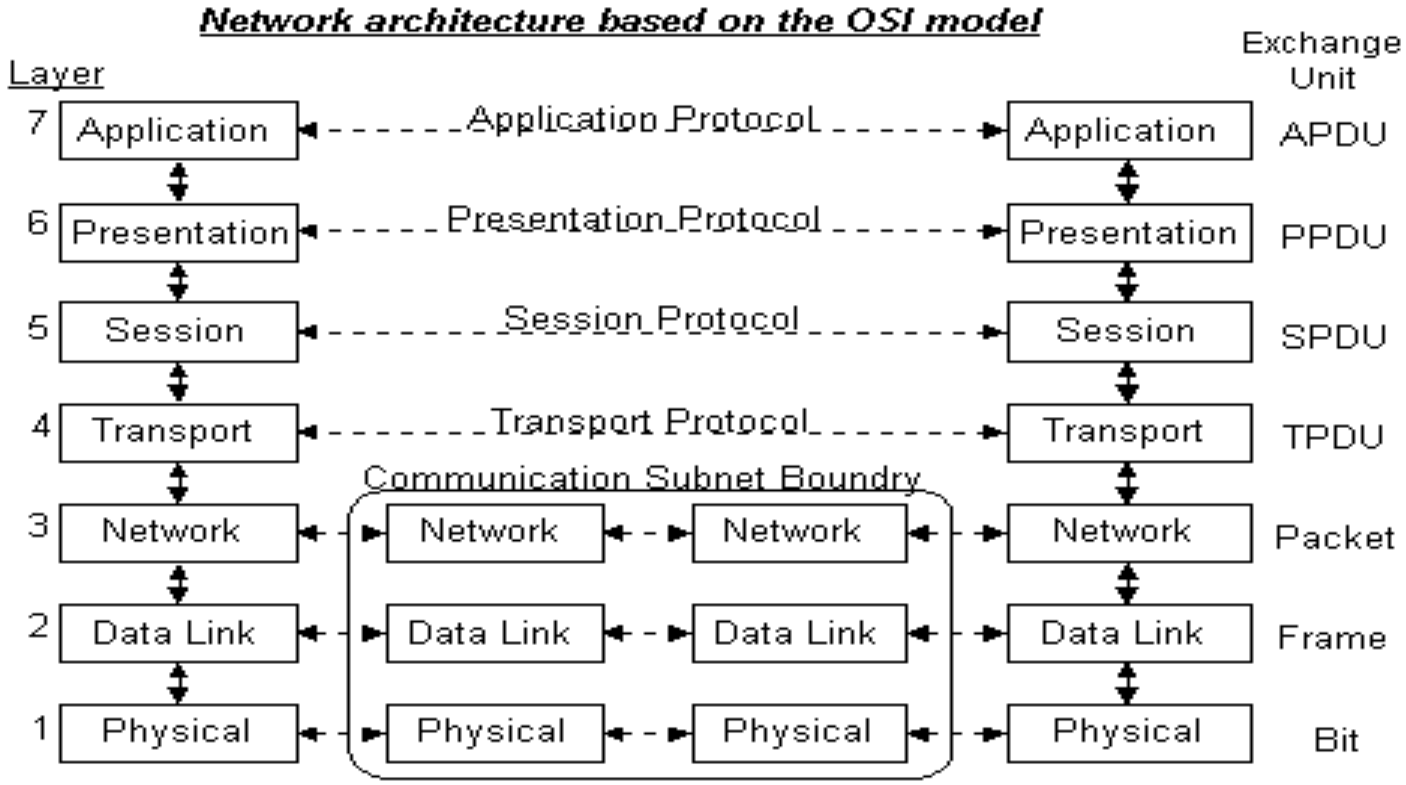
Lab Supplement Notes

Network Protocol Review

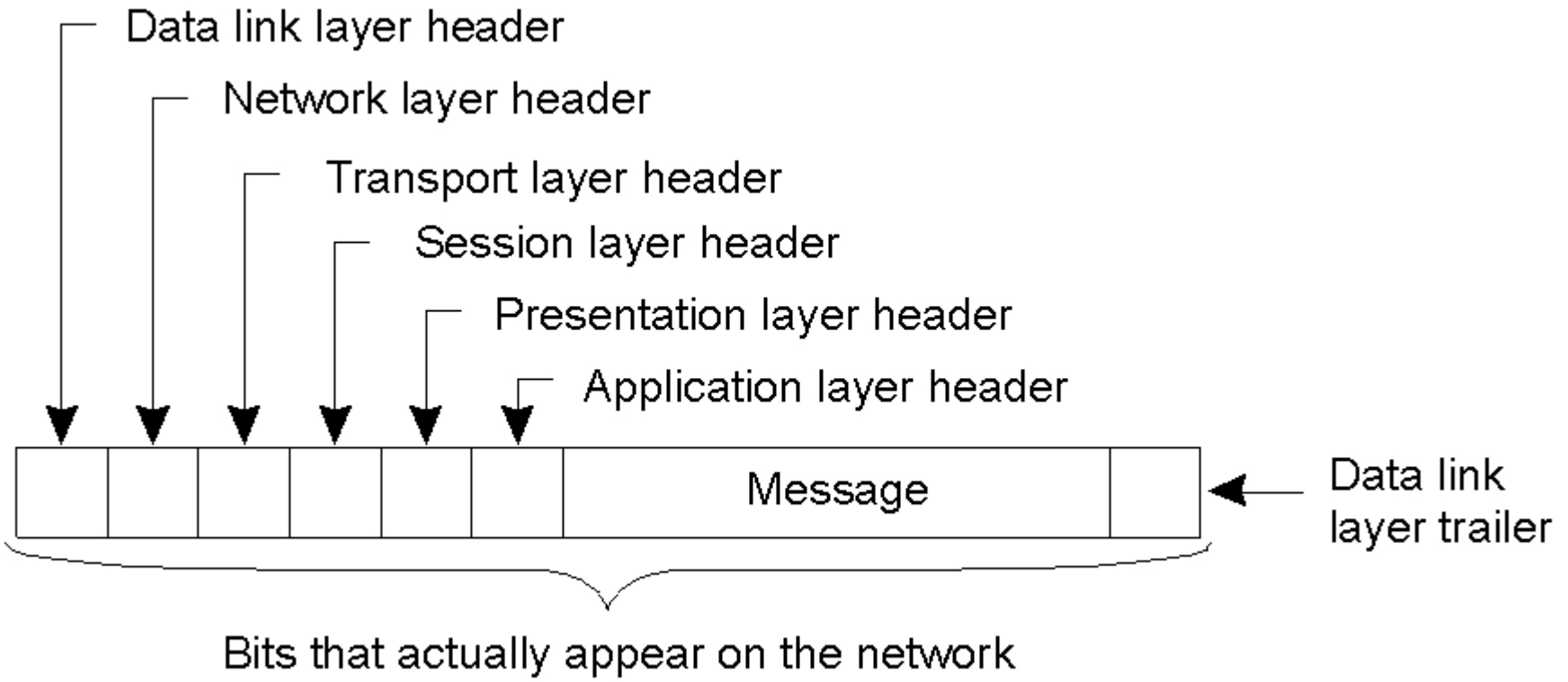
Open Systems Interconnection (OSI) Model



OSI 7-Layer Model



OSI Layers


Data link layer header
Network layer header
Transport layer header
Session layer header
Presentation layer header
Application layer header
Message
Data link layer trailer
Bits that actually appear on the network

Media Access Control (MAC)

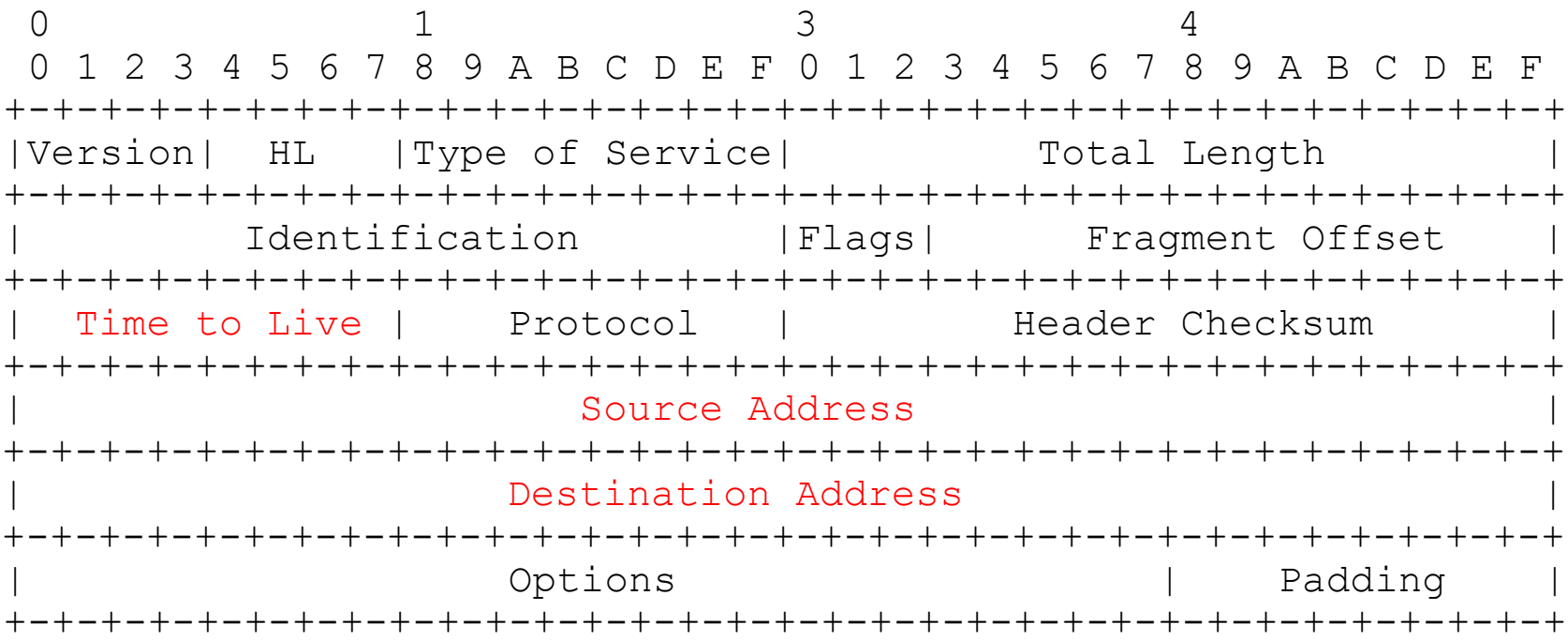
- The lower sublayer of the OSI data link layer.
- The MAC differs for various physical media
- MAC address is the hardware address of a device connected to a shared network medium

MAC encapsulation of a packet of data

Internet Protocol (IP)

- The network layer for the TCP/IP protocol suite widely used on Ethernet networks,
- IP is a connectionless, best-effort packet switching protocol. It provides packet routing, fragmentation and re-assembly through the data link layer.

IP Header


0 1 3 4
0 1 2 3 4 5 6 7 8 9 A B C D E F 0 1 2 3 4 5 6 7 8 9 A B C D E F
Version
HL
Type of Service
Total Length
Identification
Flags
Fragment Offset
Time to Live
Protocol
Header Checksum
Source Address
Destination Address
Options
Padding

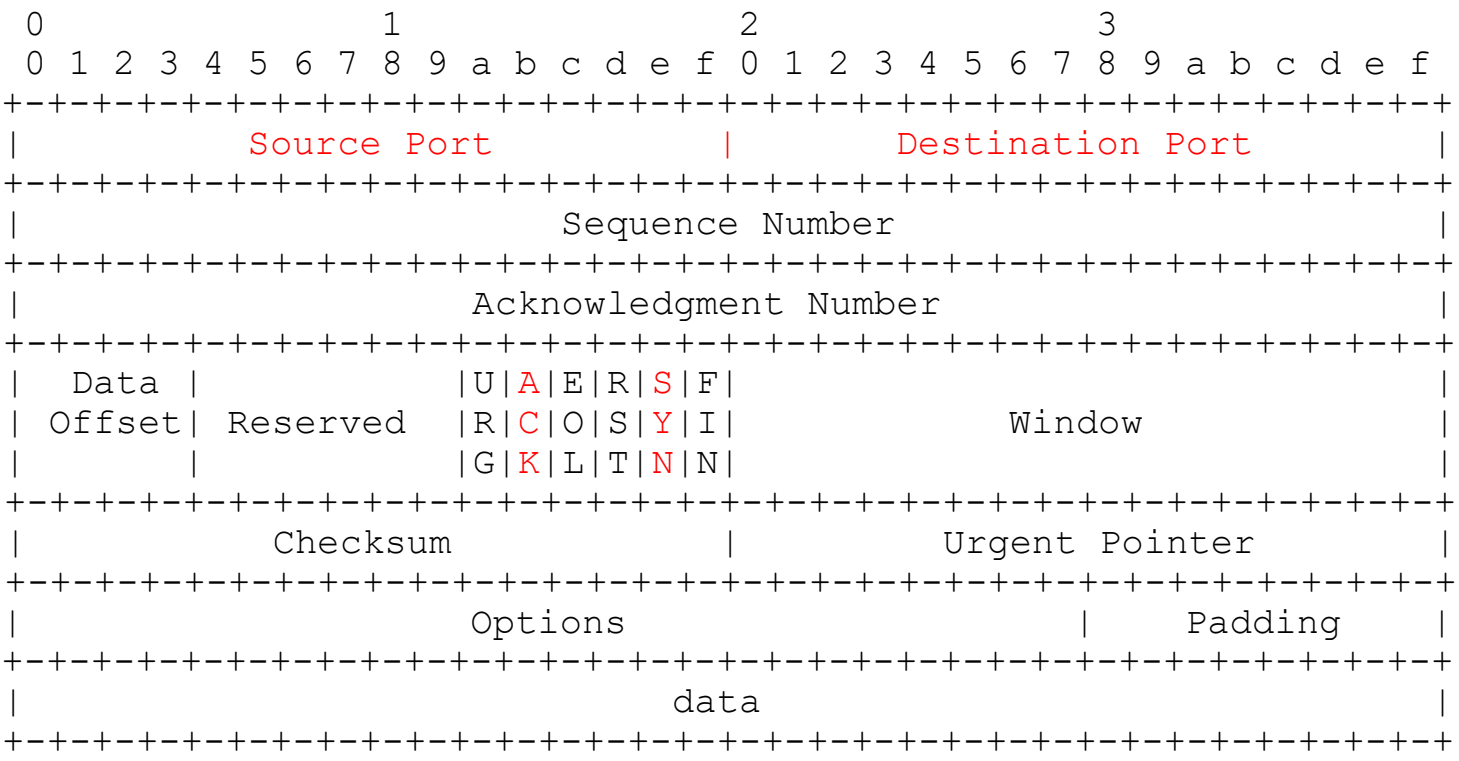
Internet address (IP address, TCP/IP address)

- The 32-bit host address defined by the Internet Protocol
- It is represented in dotted decimal notation. e.g. 192.168.11.10

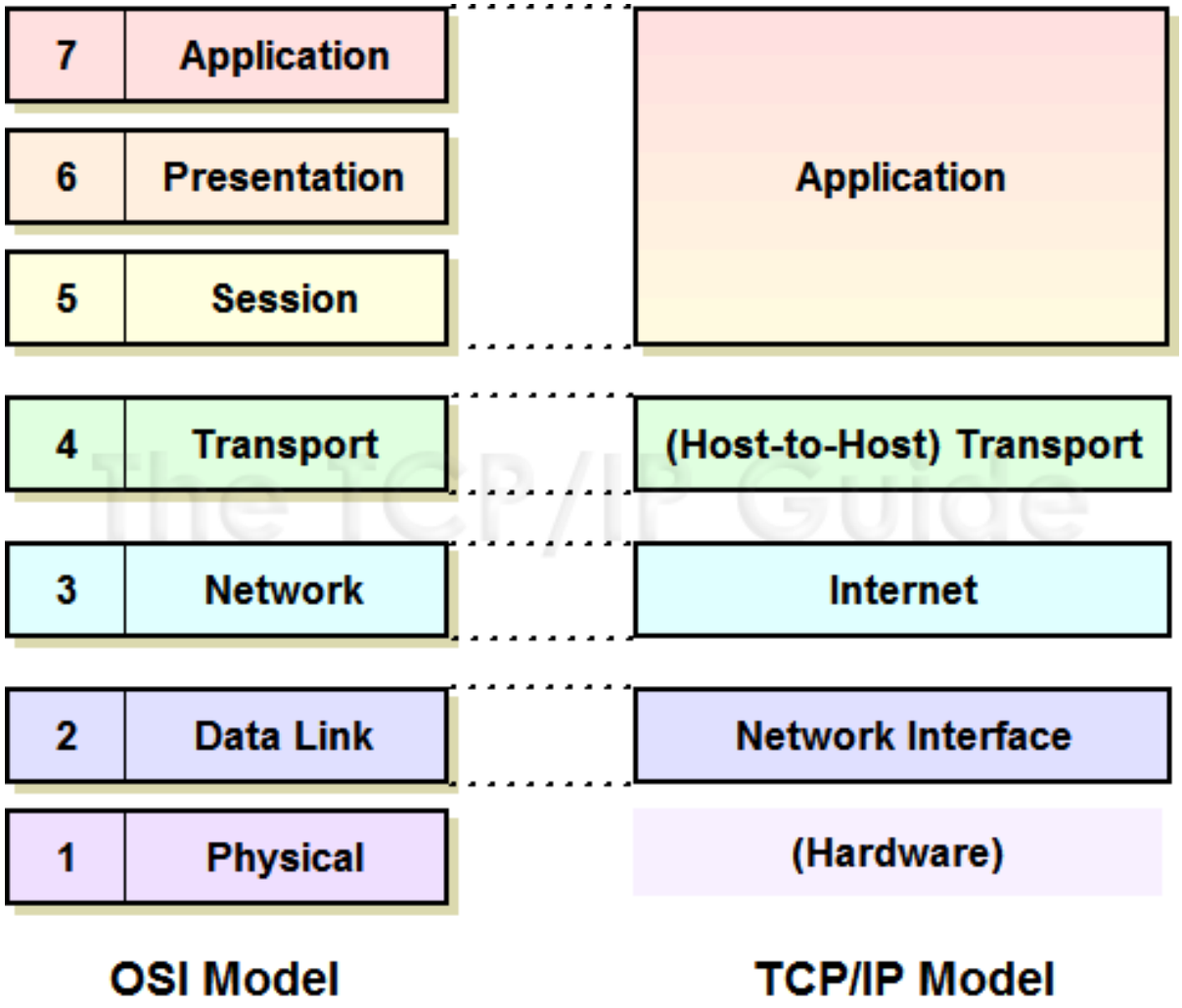
Transmission Control Protocol (TCP)

- The most common transport layer protocol used on Ethernet and the Internet.
- TCP is the connection-oriented protocol built on top of Internet Protocol (IP) and is nearly always seen in the combination TCP/IP (TCP over IP).
- It adds reliable communication and flow-control and provides full-duplex, process-to-process connections.

TCP Header


0 1 2 3
0 1 2 3 4 5 6 7 8 9 a b c d e f 0 1 2 3 4 5 6 7 8 9 a b c d e f
Source Port
Destination Port
Sequence Number
Acknowledgment Number
Data Offset
Reserved
U R G
A C K
E O L
R S T
S Y N
F I N
Window
Checksum
Urgent Pointer
Options
Padding
data

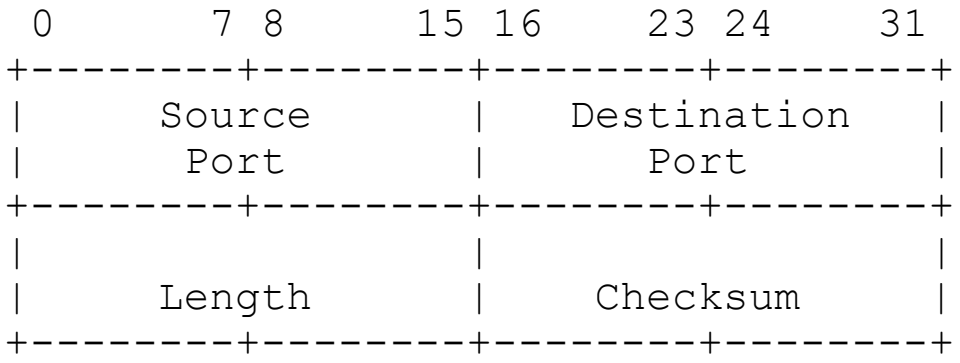
OSI Reference Model and TCP/IP Model Layers



Universal Datagram Protocol (UDP)

- An implementation of transport layer on top of IP
- Unreliable data transmission
  - No guaranteed on delivery
  - Packets could be received out of order
- Add port identification numbers and payload checksum to IP
  - Ports allow multiplexing of data streams
- Highly efficient because of low overhead
  - Suitable for delivering data that is small amount and needs to be sent frequently
  - Typically used for latency-sensitive or low-overhead applications (video, time, DNS, etc.)

UDP Header


0 7 8 15 16 23 24 31
Source Port
Destination Port
Length
Checksum

Internet Control Message Protocol (ICMP)

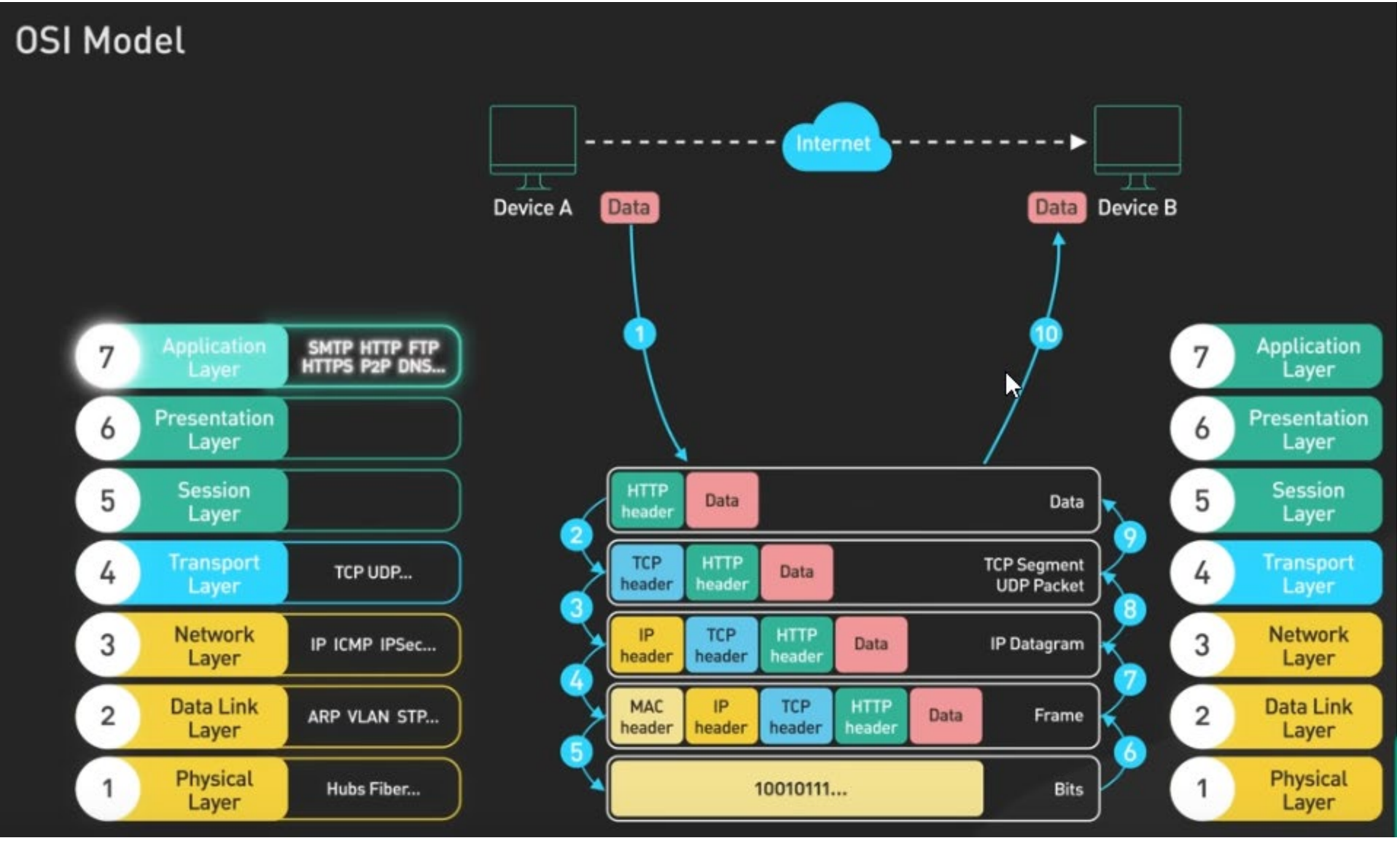
- An extension to the Internet Protocol (IP) that allows for the generation of error messages, test packets, and informational messages related to IP
- The ping command sends ICMP ECHO_REQUEST packets to a network host and print the response of the host

Broadcast

- To simultaneously send the same message to multiple recipients.
- In networking, a distinction is made between broadcasting and multicasting. Broadcasting sends a message to everyone on the network whereas multicasting sends a message to a select list of recipients.

Address Resolution Protocol (ARP)

A network layer protocol used to find a host's MAC address from its Internet address. The sender broadcasts an ARP packet containing the Internet address of another host and waits for it (or some other host) to send back its MAC address.



Screen shot from https://youtu.be/0y6FtKsg6J4

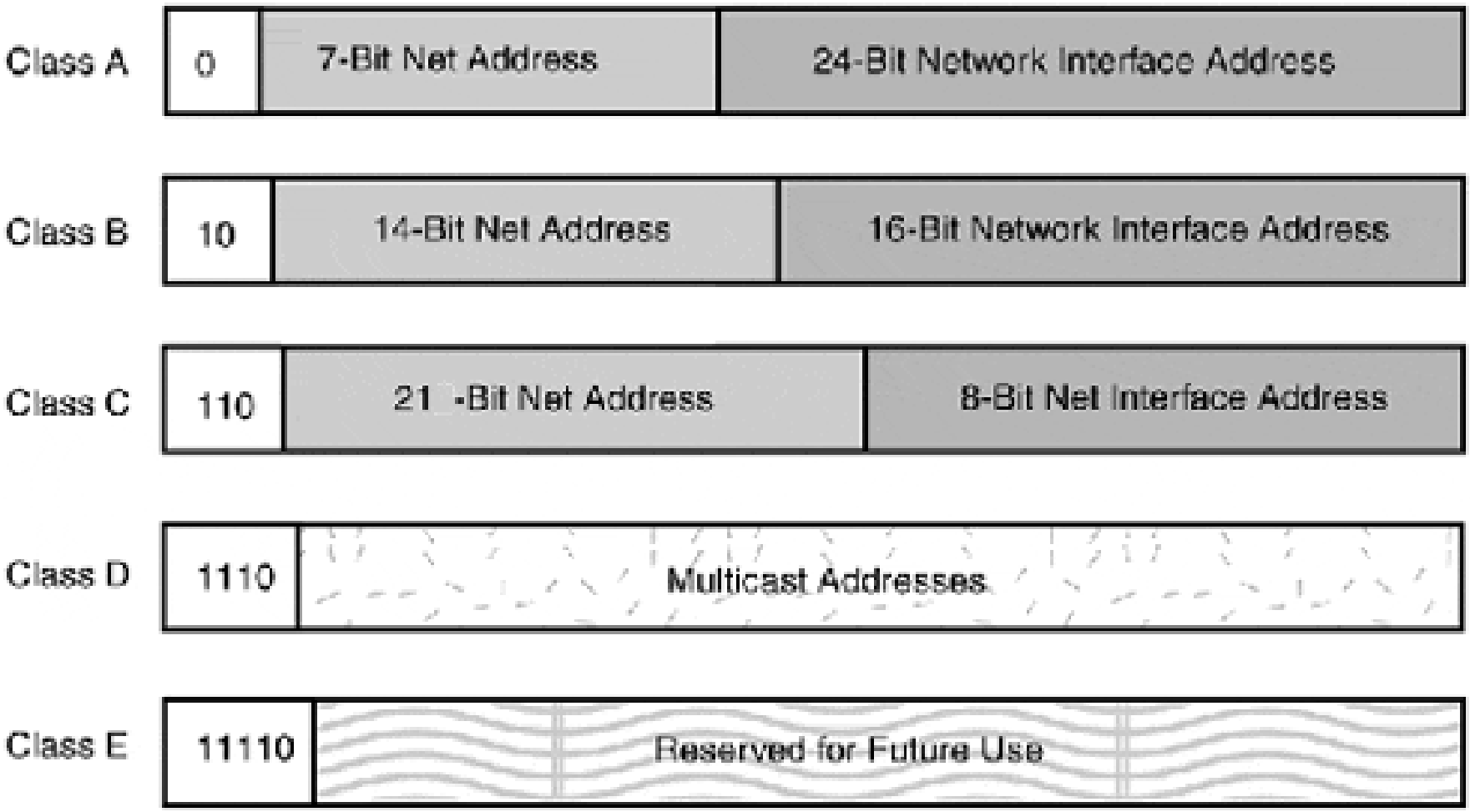
netmask

- A 32-bit bit mask which shows how an Internet address is to be divided into network, subnet and host parts
- EG. 255.255.255.0

Classful IP Address

- The IP address can be split into a network number (or network address) and a host number unique to each host on the. The way the address is split depends on its "class", A, B or C as determined by the high address bits

Classful IP Address (2)



Classless Inter-Domain Routing (CIDR)

- An IP addressing scheme that replaces the older system based on classes A, B, and C
- With CIDR, a single IP address can be used to designate many unique IP addresses.

A comparison of classful and classless network address expressions

The Classful Way	The Classless Way
192.160.0.0 255.255.255.0	192.160.0.0 /21 (255.255.248.0)
192.160.2.0 255.255.255.0	
192.160.3.0 255.255.255.0	
192.160.4.0 255.255.255.0	
192.160.1.0 255.255.255.0	
192.160.5.0 255.255.255.0	
192.160.6.0 255.255.255.0	
192.160.7.0 255.255.255.0	

IP Netmask examples

Network	192.168.20.0/24	192.168.20.0/22
Netmask bit	24	22
Netmask inDecimal	255.255.255.0	255.255.252.0
Netmask in Binary	11111111 11111111 11111111 00000000	11111111 11111111 11111100 0000000
IP Range	192.168.20.1 - 192.168.20.254	192.168.20.1 - 192.168.23.254
Broadcast IP	192.168.20.255	192.168.23.255

Network	192.168.20.0/25	192.168.20.0/26
Netmask bit	25	26
Netmask inDecimal	255.255.255.128	255.255.255.192
Netmask in Binary	11111111 11111111 11111111 10000000	11111111 11111111 11111111 11000000
IP Range	192.168.20.1 - 192.168.20.126	192.168.20.1 - 192.168.20.62
Broadcast IP	192.168.20.127	192.168.20.63

Network	192.168.20.0/27	192.168.20.0/28
Netmask bit	27	28
Netmask inDecimal	255.255.255.224	255.255.255.192
Netmask in Binary	11111111 11111111 11111111 11100000	11111111 11111111 11111111 11110000
IP Range	192.168.20.1 - 192.168.20.30	192.168.20.1 - 192.168.20.14
Broadcast IP	192.168.20.31	192.168.20.15

Network	192.168.20.0/29	192.168.20.0/30
Netmask bit	29	30
Netmask inDecimal	255.255.255.248	255.255.255.252
Netmask in Binary	11111111 11111111 11111111 11111000	11111111 11111111 11111111 11111100
IP Range	192.168.20.1 - 192.168.20.6	192.168.20.1 - 192.168.20.2
Broadcast IP	192.168.20.7	192.168.20.3

/31 Netmask

- Netmask: 255.255.255.254
- Binary Representation**: 11111111.11111111.11111111.11111110
- Number of IP Addresses**: 2
- Usable IP Addresses**: 2 (since it's typically used for point-to-point links, both addresses are usable)

A `/31` netmask is often used for point-to-point links where only two IP addresses are needed. This helps conserve IP address space by not requiring a broadcast address.

/32 Netmask

- Netmask: 255.255.255.255
- Binary Representation: 11111111.11111111.11111111.11111111
- Number of IP Addresses: 1
- Usable IP Addresses: 1

A `/32` netmask is used to specify a single IP address. This is often used for identifying a specific host in routing tables or for assigning a unique IP address to a device.

Ref: IP Subnet Calculator

Screen shot from https://youtu.be/s_Ntt6eTn94