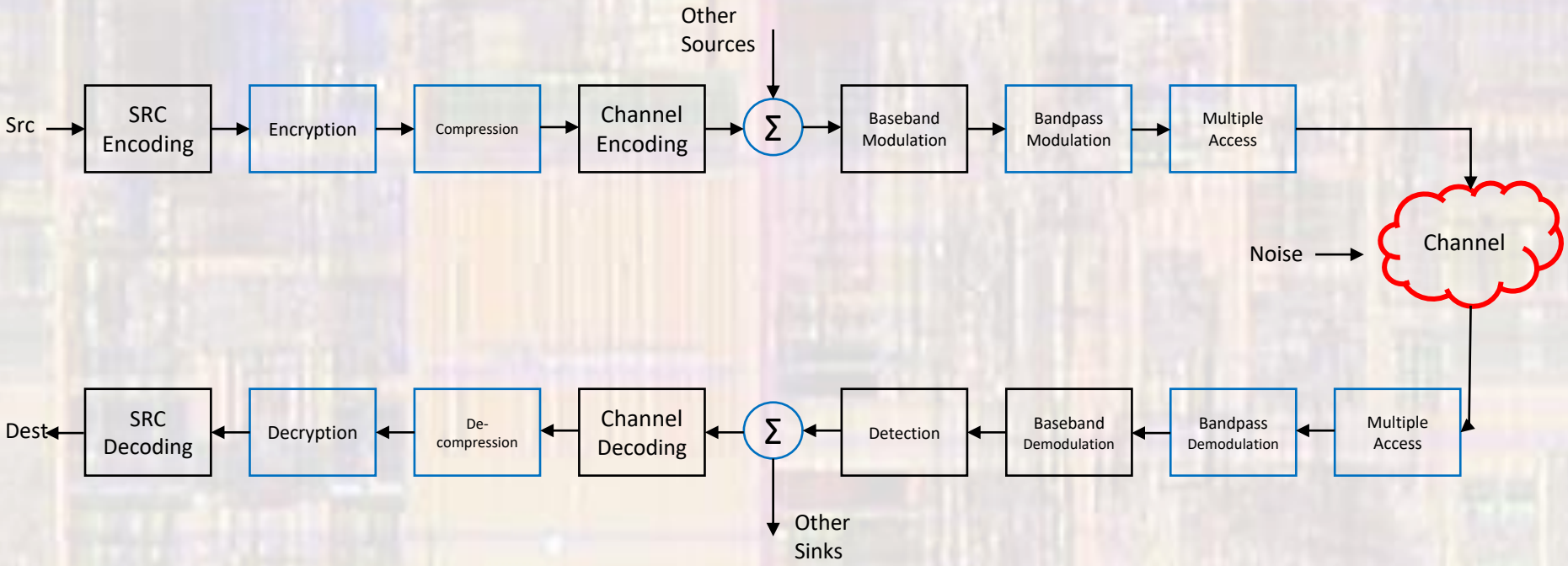
Data Communications

Last updated 4/11/24

Data Communications

- Generalized Digital Communications System



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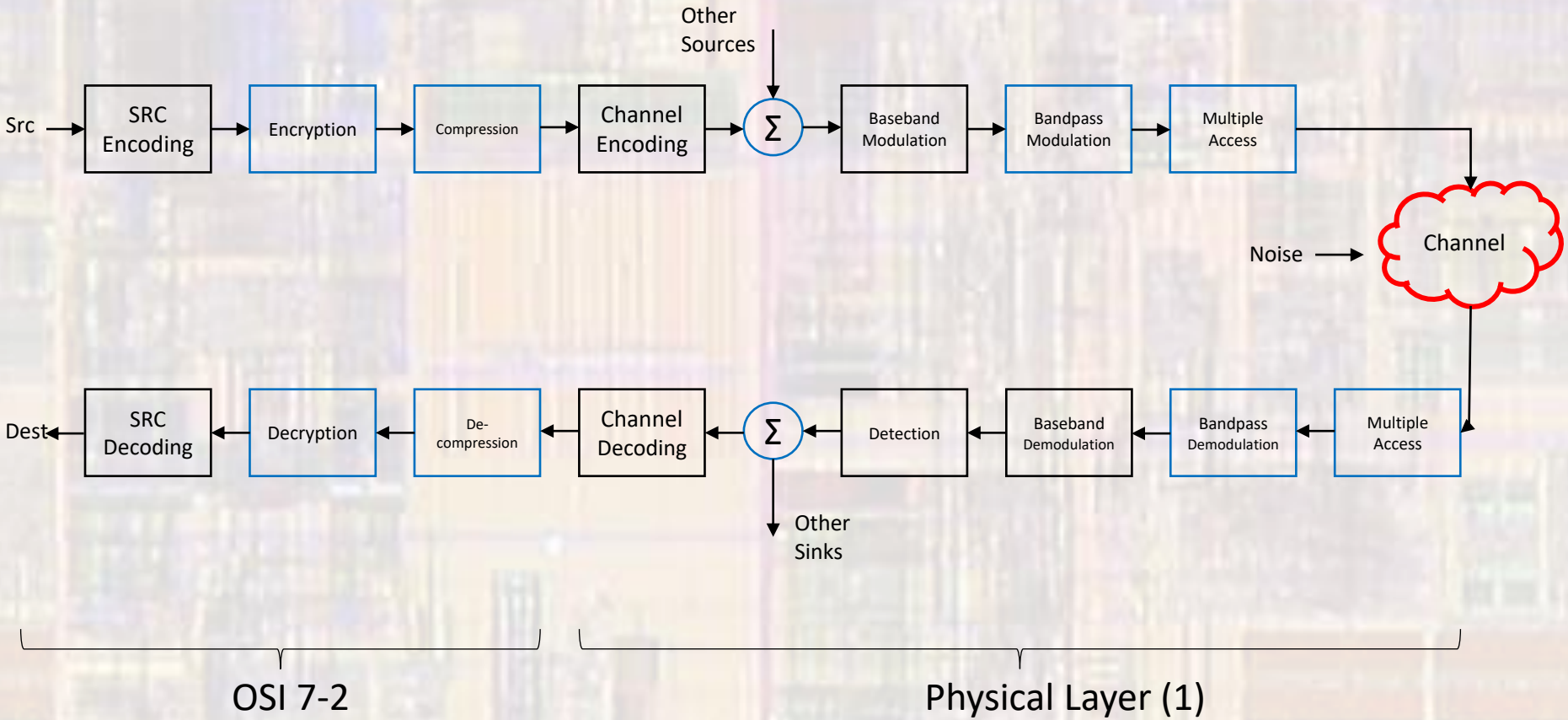
Data Communications

- Generalized Digital Communications System



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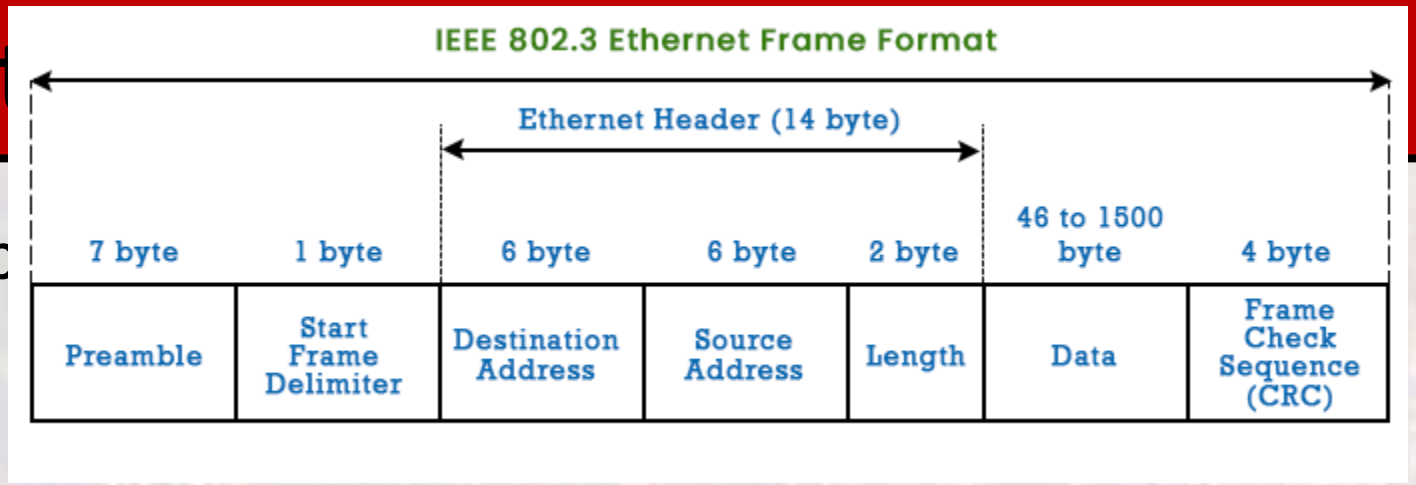
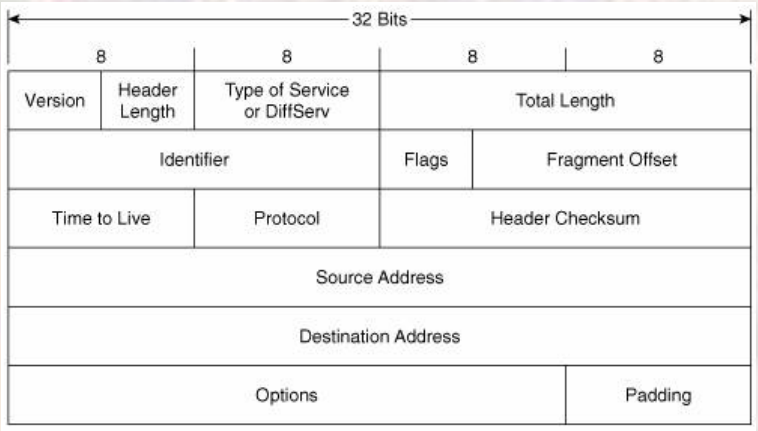
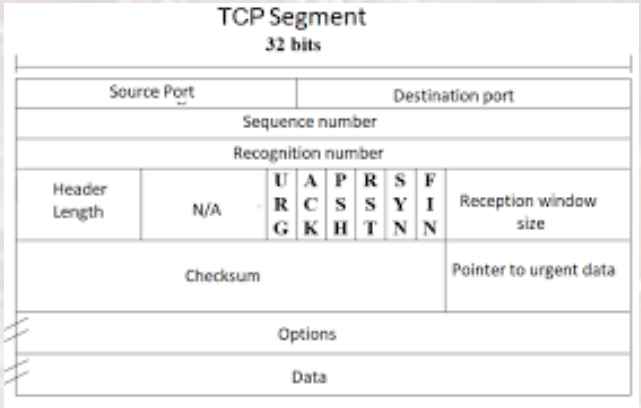

IEEE 802.3 Ethernet Frame Format
Ethernet Header (14 byte)
7 byte
1 byte
6 byte
6 byte
2 byte
46 to 1500 byte
4 byte
Preamble
Start Frame Delimiter
Destination Address
Source Address
Length
Data
Frame Check Sequence (CRC)


32 Bits
8
8
8
8
Version
Header Length
Type of Service or DiffServ
Total Length
Identifier
Flags
Fragment Offset
Time to Live
Protocol
Header Checksum
Source Address
Destination Address
Options
Padding


TCP Segment
32 bits
Source Port
Destination port
Sequence number
Recognition number
Header Length
N/A
URG
ACK
PSH
RST
SYN
FIN
Reception window size
Checksum
Pointer to urgent data
Options
Data

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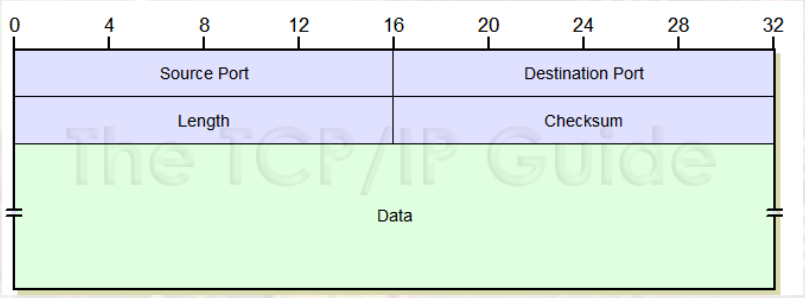
Data Communications

- Ethernet Example – Application Layer
  - Send an email via a web based app
  - Type in your message and hit send
  - Outlook, Gmail, … converts your message to HTTP format
    - Other examples might use FTP, SMTP, …
  - Your message is associated with a specific sending and receiving process (port) in the program/OS

UDP
User Datagram Protocol



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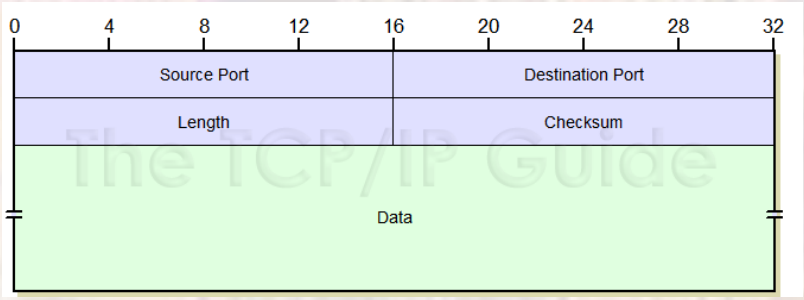
- Ethernet Example –
  - Presentation Layer
    - Encryption is performed if desired
  - Session Layer
    - Involved in managing the transaction
    - No changes to the data

UDP

User Datagram Protocol



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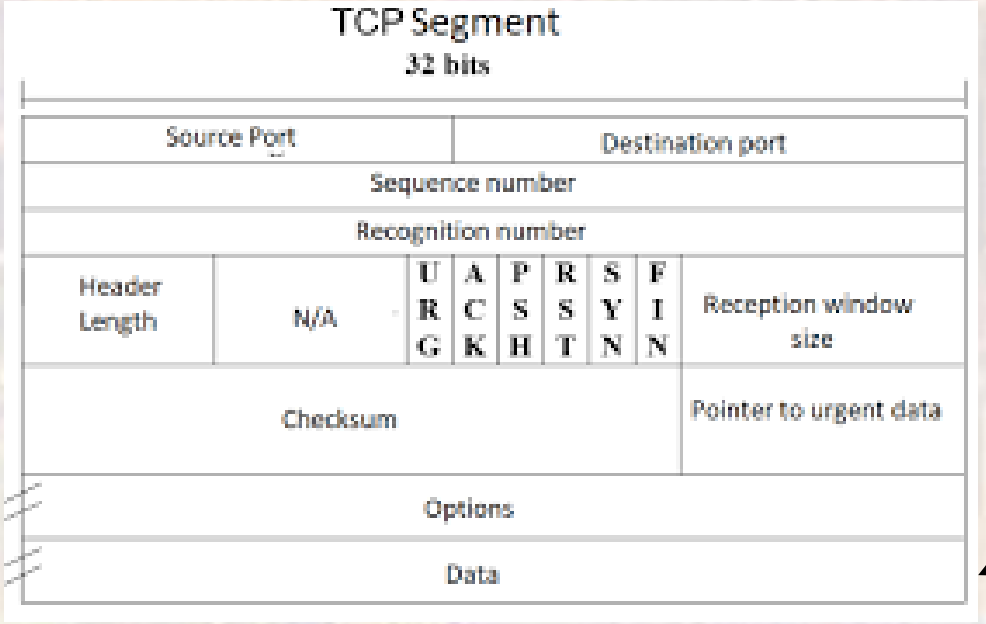
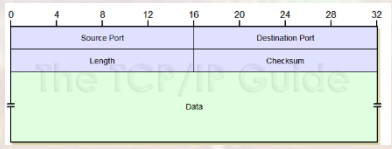
- Ethernet Example – Transport Layer
  - The data is encapsulated into the TCP (Transmission Control Protocol)
  - The data is broken into pieces as necessary
  - Additional fields are added to track which piece is being sent, what pieces have already been received, …





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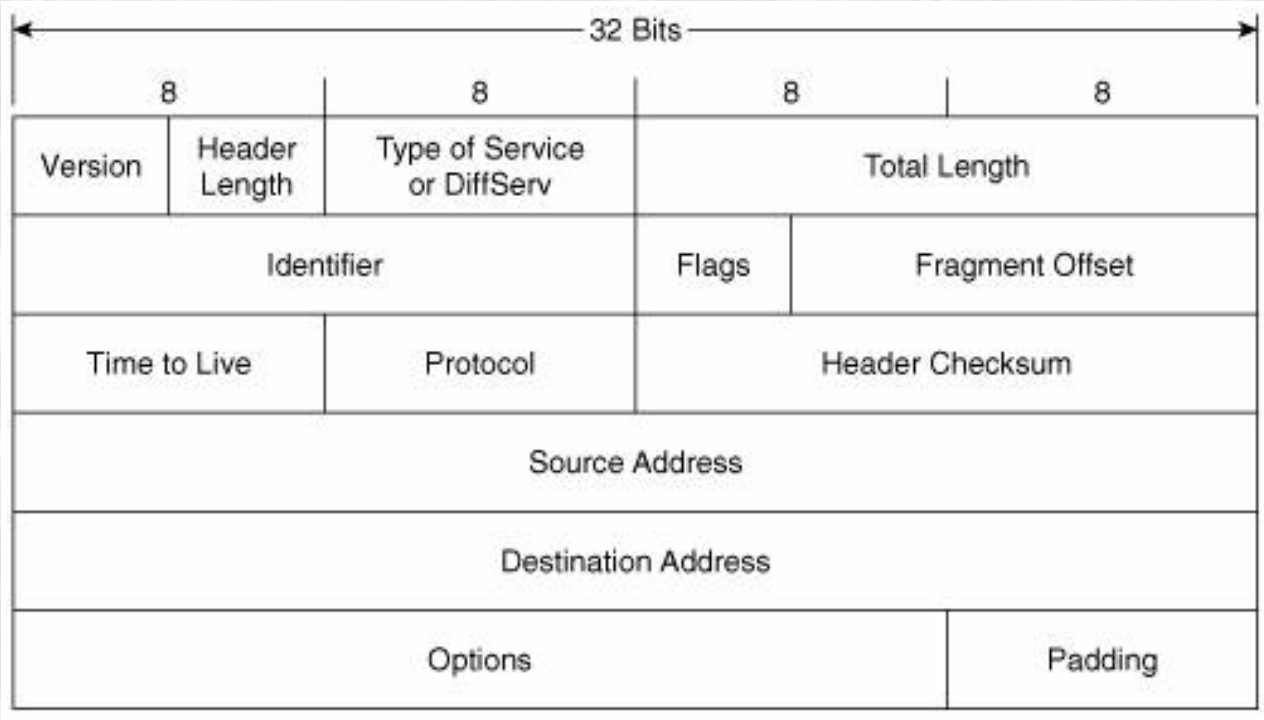
- Ethernet Example – Network Layer
  - The TCP is encapsulated into the IP (Internet Protocol)
  - Internet source and destination information is added
  - Additional information about the packet is added



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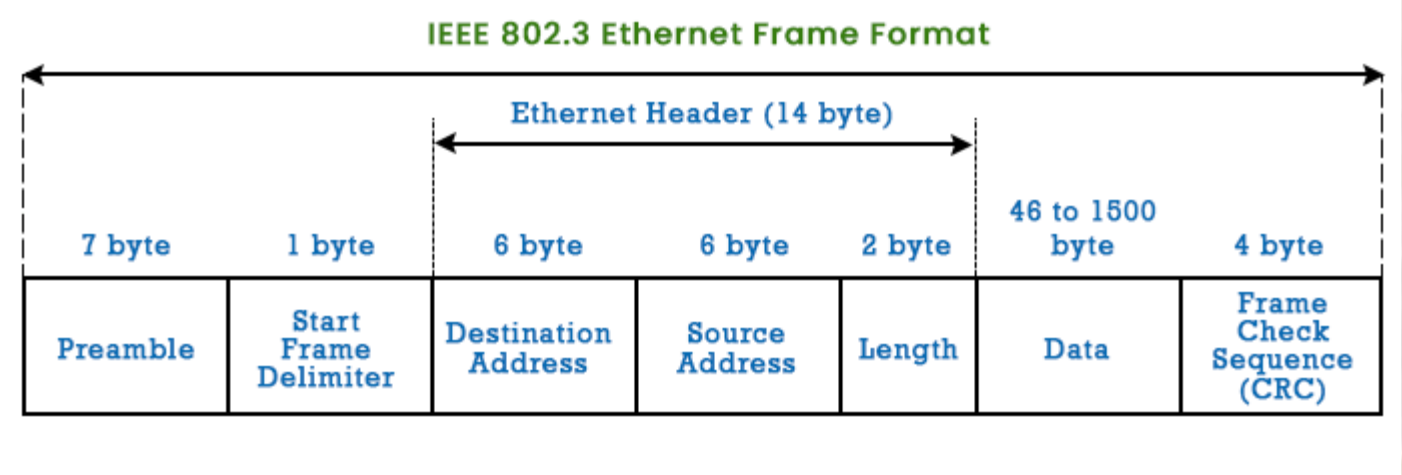
- Ethernet Example – Data Link Layer
  - The IP packet is encapsulated into the Ethernet Frame
  - MAC addresses are added (physical device)
  - Frame detection and clock recovery data is included



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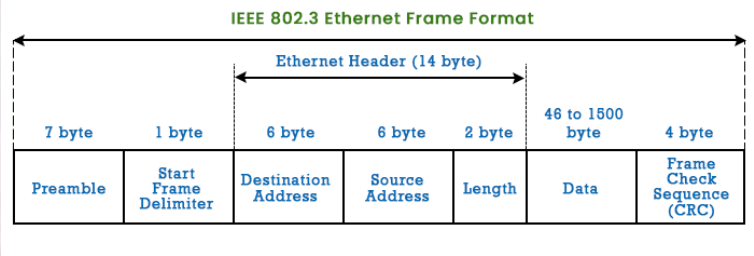
- Ethernet Example – Data Link Layer
  - Preamble
    - Used for clock synchronization
    - 7 bytes of 10101010
  - Start Frame
    - 10101011
  - Physical Address Structure (MAC)
    - NOT the IP address
    - 24 bits assigned to the manufacturer
      - Organizationally Unique Identifier (OUI)
    - 24 bits assigned by manufacturer to the specific device
    - 00-20-C3-C0-B3-EA

      OUI | Unique



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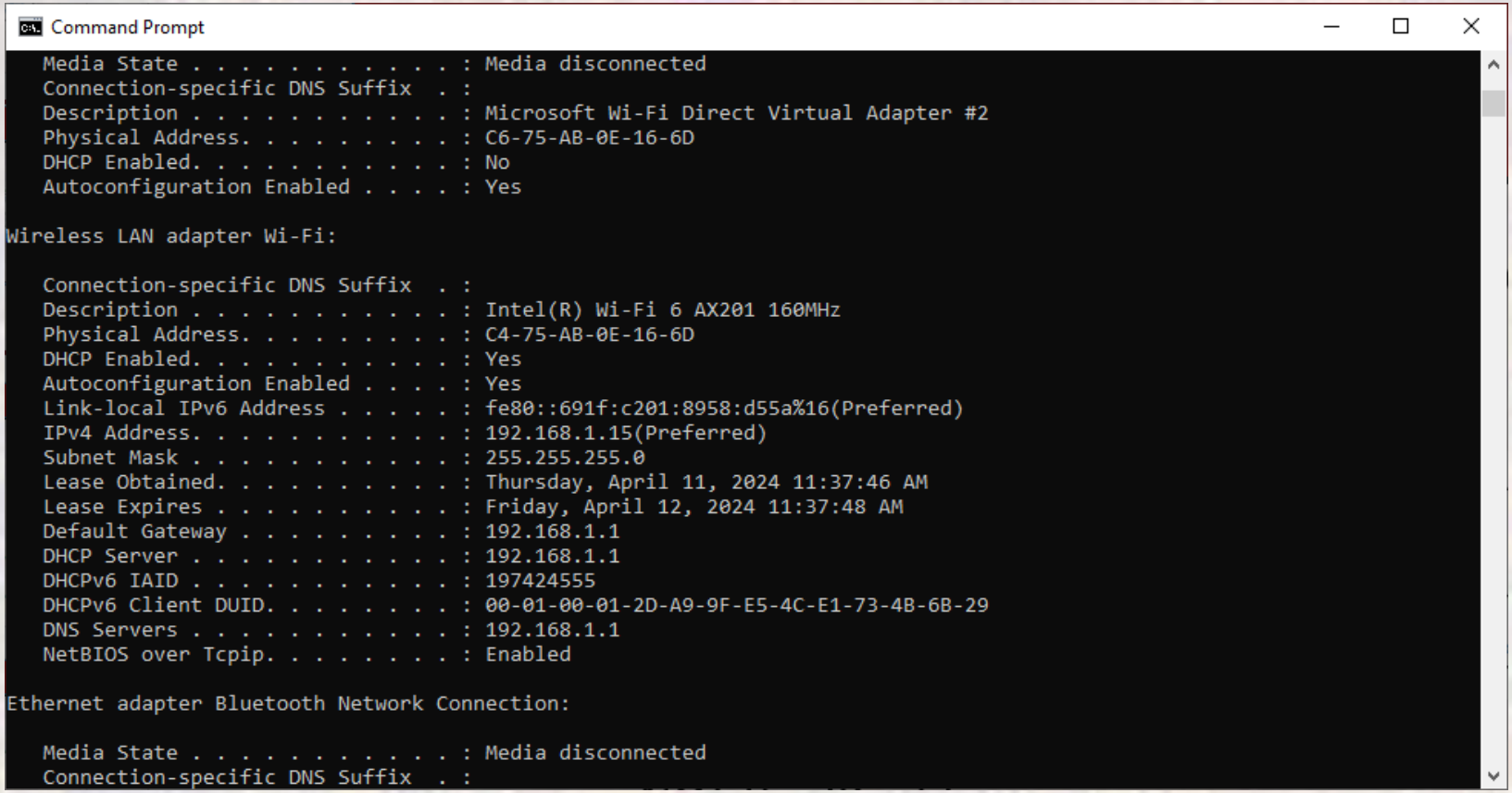
- MAC (Media Access)



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- Ethernet Example – Web Page request
  - Application Layer

GET /index.html HTTP/1.1
Host: www.example.com

  - Transport Layer

Source Port:	30 39 (12345 in hex)
Destination Port:	00 50 (80 in hex)
Sequence Number:	00 00 00 00 (0 in hex)
Acknowledgment Number:	00 00 00 00 (0 in hex)
Data Offset:	50 (Data offset = 5, multiplied by 4 for header length)
Flags:	02 (SYN flag set for connection establishment)
Window Size:	FF FF (65535 in hex)
Checksum:	xx xx (Checksum value, calculated by the protocol)
Urgent Pointer:	00 00 (No urgent data)
Encapsulated Presentation Layer Data:	GET /index.html HTTP/1.1\r\nHost: www.example.com\r\n\r\n

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Data Communications

- Ethernet Example – Web Page request
  - Network Layer

Version and IHL:	45 (Version = 4, IHL = 5)
Type of Service:	00 (No specific priority)
Total Length:	00 28 (40 in hex, 20 bytes IP header + 20 bytes TCP segment)
Identification:	30 39 (12345 in hex)
Flags and Offset:	00 00 (No fragmentation)
TTL:	40 (64 in hex)
Protocol:	06 (TCP)
Header Checksum:	xx xx (Calculated checksum)
Source IP Address:	C0 A8 01 02 (192.168.1.2 in hex)
Destination IP Address:	5D B8 D8 22 (93.184.216.34 in hex)
Source Port:	30 39 (12345 in hex)
Destination Port:	00 50 (80 in hex)
Sequence Number:	00 00 00 00 (0 in hex)
Acknowledgment Number:	00 00 00 00 (0 in hex)
Data Offset:	50 (Data offset = 5, multiplied by 4 for header length)
Flags:	02 (SYN flag set for connection establishment)
Window Size:	FF FF (65535 in hex)
Checksum:	xx xx (Checksum value, calculated by the protocol)
Urgent Pointer:	00 00 (No urgent data)
Encapsulated Presentation Layer Data:	GET /index.html HTTP/1.1\r\nHost: www.example.com\r\n\r\n

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Data Communications

- Ethernet Example – Web Page request
  - Data Link Layer

Destination MAC Address:	00 1A 2B 3C 4D 5E
Source MAC Address:	11 22 33 44 55 66
EtherType:	08 00 (0x0800, indicates the payload is an IP packet)
Version and IHL:	45 (Version = 4, IHL = 5)
Type of Service:	00 (No specific priority)
Total Length:	00 28 (40 in hex, 20 bytes IP header + 20 bytes TCP segment)
Identification:	30 39 (12345 in hex)
Flags and Offset:	00 00 (No fragmentation)
TTL:	40 (64 in hex)
Protocol:	06 (TCP)
Header Checksum:	xx xx (Calculated checksum)
Source IP Address:	C0 A8 01 02 (192.168.1.2 in hex)
Destination IP Address:	5D B8 D8 22 (93.184.216.34 in hex)
Source Port:	30 39 (12345 in hex)
Destination Port:	00 50 (80 in hex)
Sequence Number:	00 00 00 00 (0 in hex)
Acknowledgment Number:	00 00 00 00 (0 in hex)
Data Offset:	50 (Data offset = 5, multiplied by 4 for header length)
Flags:	02 (SYN flag set for connection establishment)
Window Size:	FF FF (65535 in hex)
Checksum:	xx xx (Checksum value, calculated by the protocol)
Urgent Pointer:	00 00 (No urgent data)
Encapsulated Presentation Layer Data:	GET /index.html HTTP/1.1\r\nHost: www.example.com\r\n\r\n

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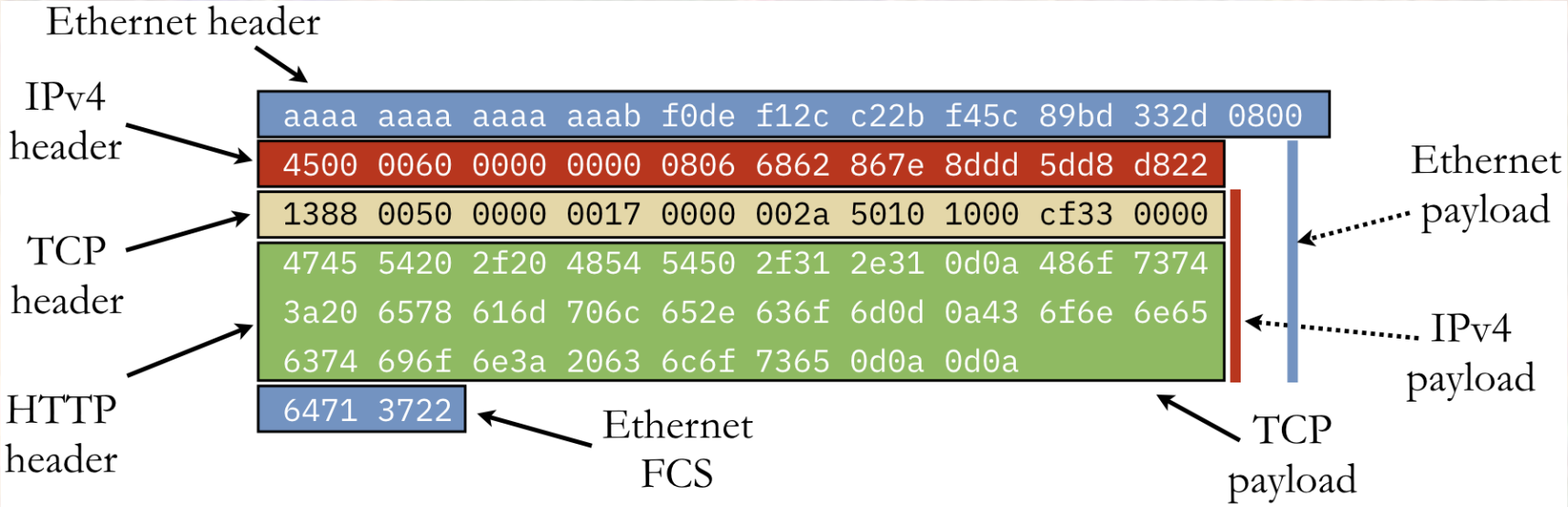
- Ethernet Example – Web Page request
  - Complete Ethernet Message



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