Networking Fundamentals

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156 PUBLICATIONS **2,709** CITATIONS

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Networking Fundamentals

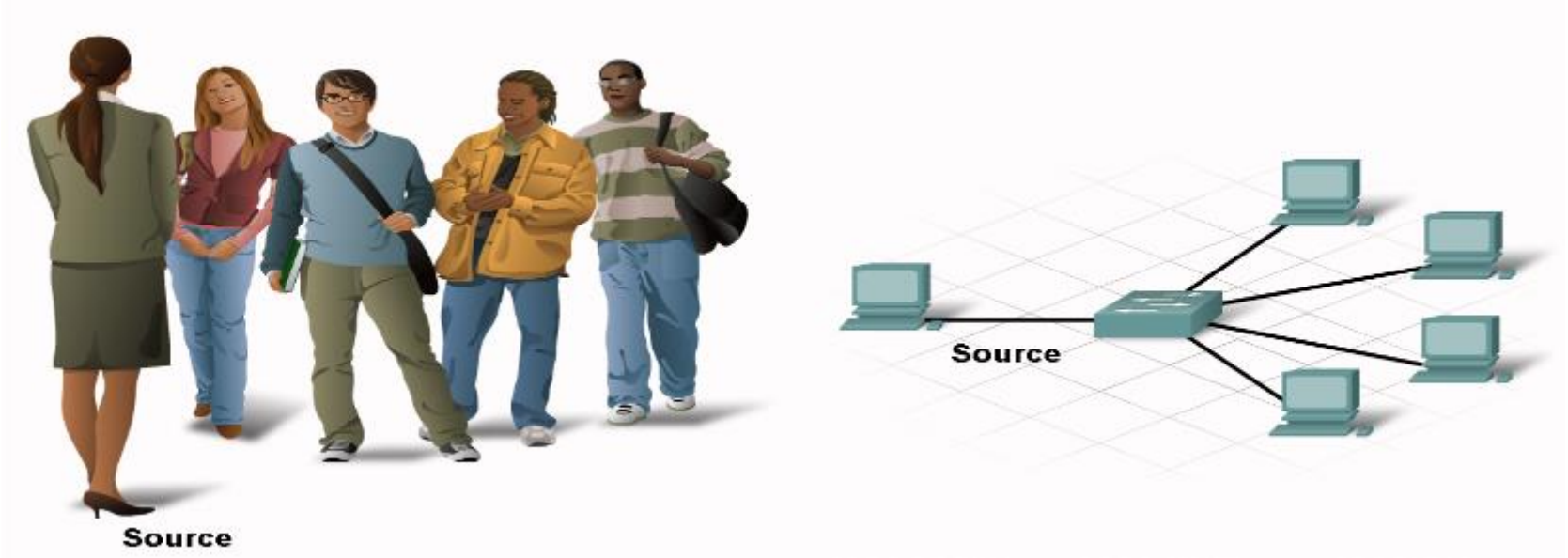
Communication Protocols

- Message formatting and encapsulation
- When a message is sent from source to destination, it must use a specific format or structure.
- Compare to parts of a letter
  - Identifier (recipient)
  - Salutation
  - Message
  - Closing
  - Identifier (sender)
- Encapsulation
  - placing the letter into the envelope
- De encapsulation
  - letter removed from the envelope

Destination (physical / hardware address)	Source (physical / hardware address)	Start Flag (start of message indicator)	Recipient (destination identifier)	Sender (source identifier)	Encapsulated Data (bits)	End of Frame (end of message indicator)
Frame Addressing		Encapsulated Message				

Communication Protocols

- Message Patterns
- **Unicast** – single destination
- **Multicast** – same message to a group
- **Broadcast** – all hosts need to receive the message



Layers

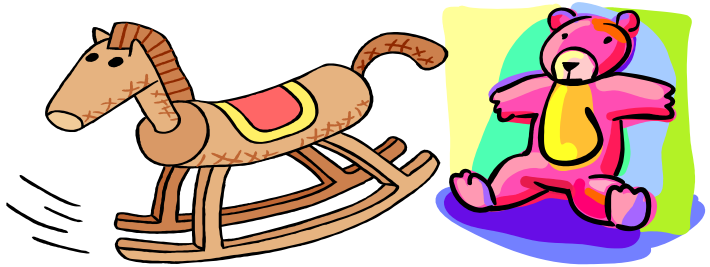
- Internet functions can be divided in layers
  - Easy to understand
  - Easy to program for
    - Change one layer without changing other layers
  - Easy to write standards for and test
- Two main models of layers are used:
  - OSI (Open Systems Interconnection) Layers
  - TCP/IP Layers

Layers & Encapsulation

Encapsulation wraps data with the necessary protocol information before network transmit

Analogy

1



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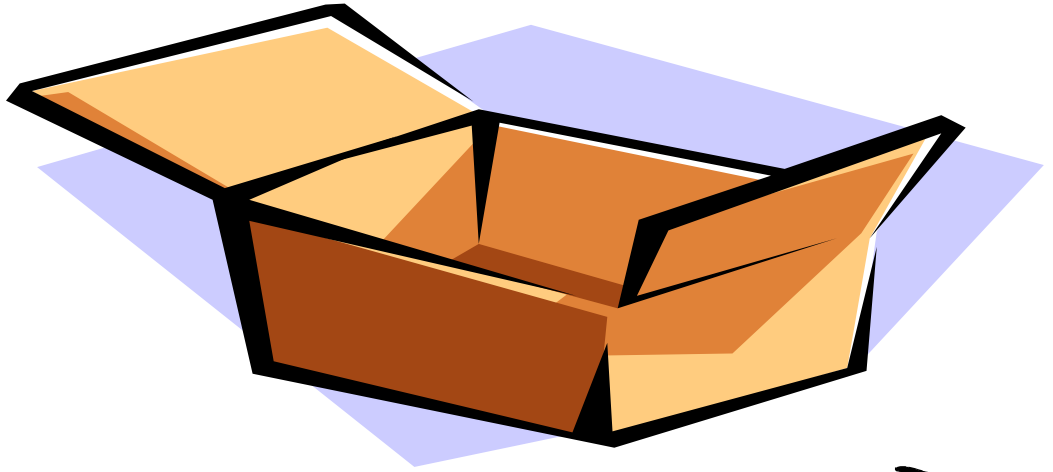

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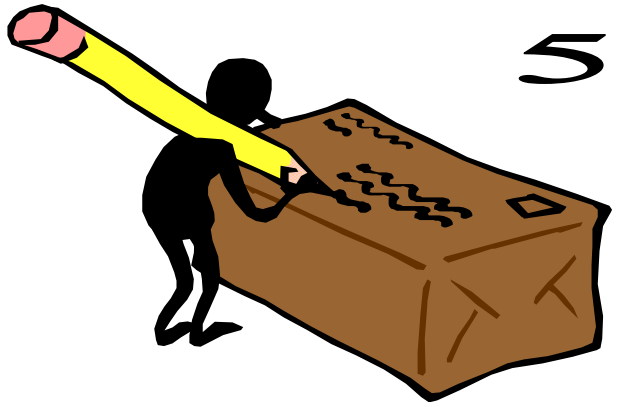

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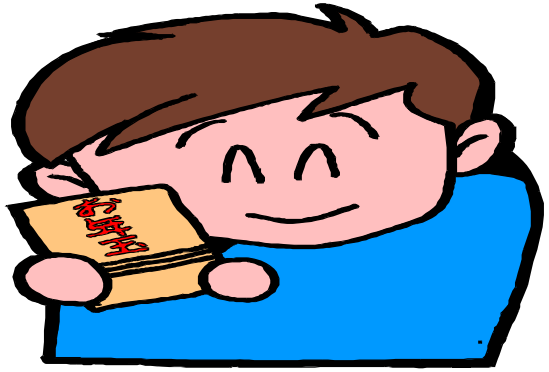
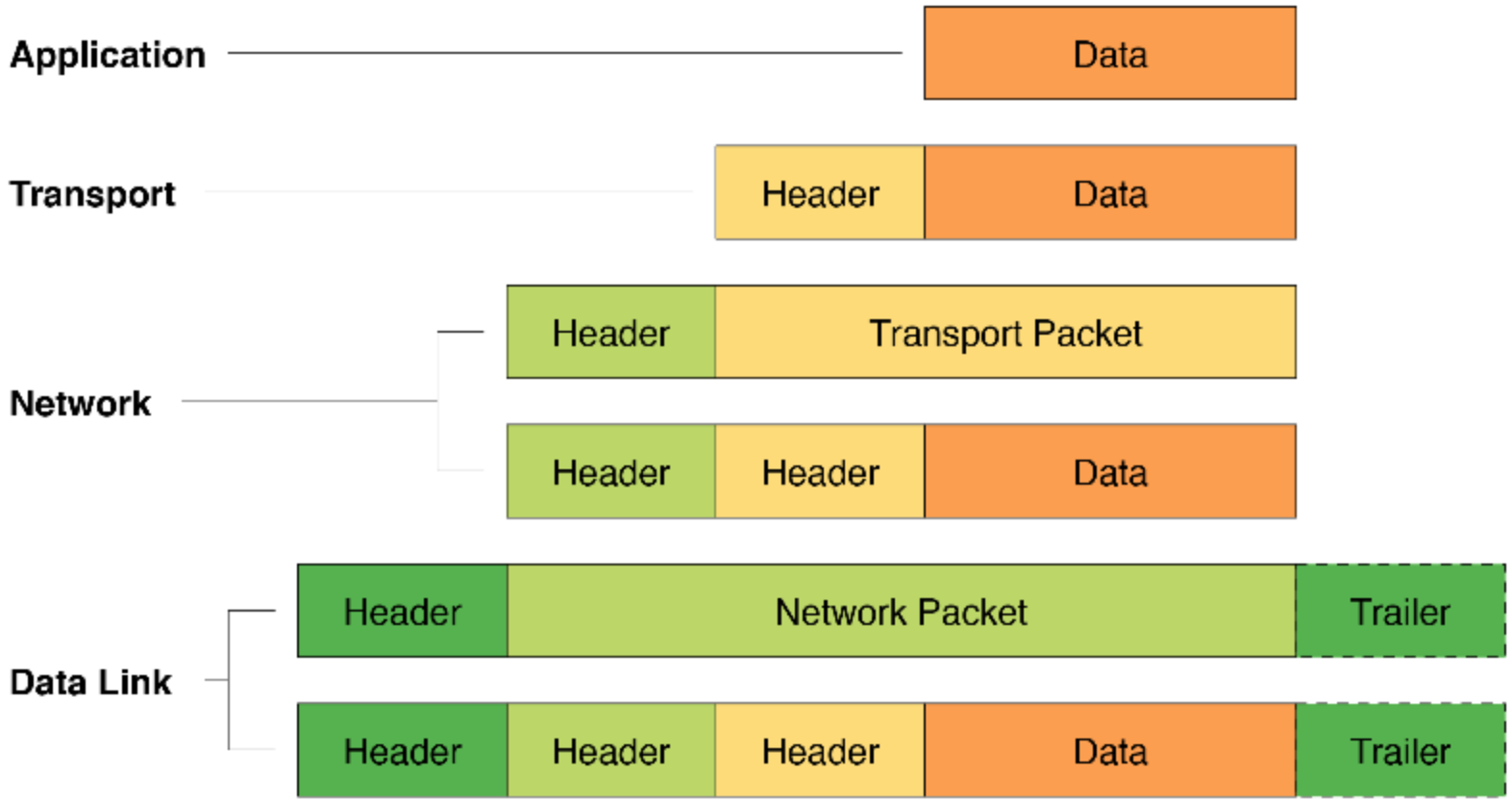
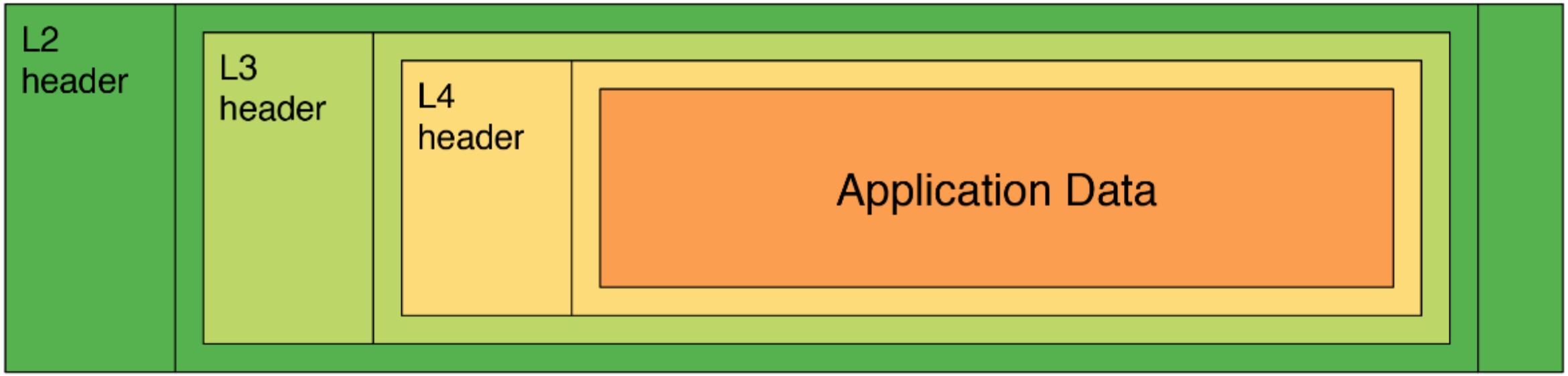


Encapsulation & Decapsulation

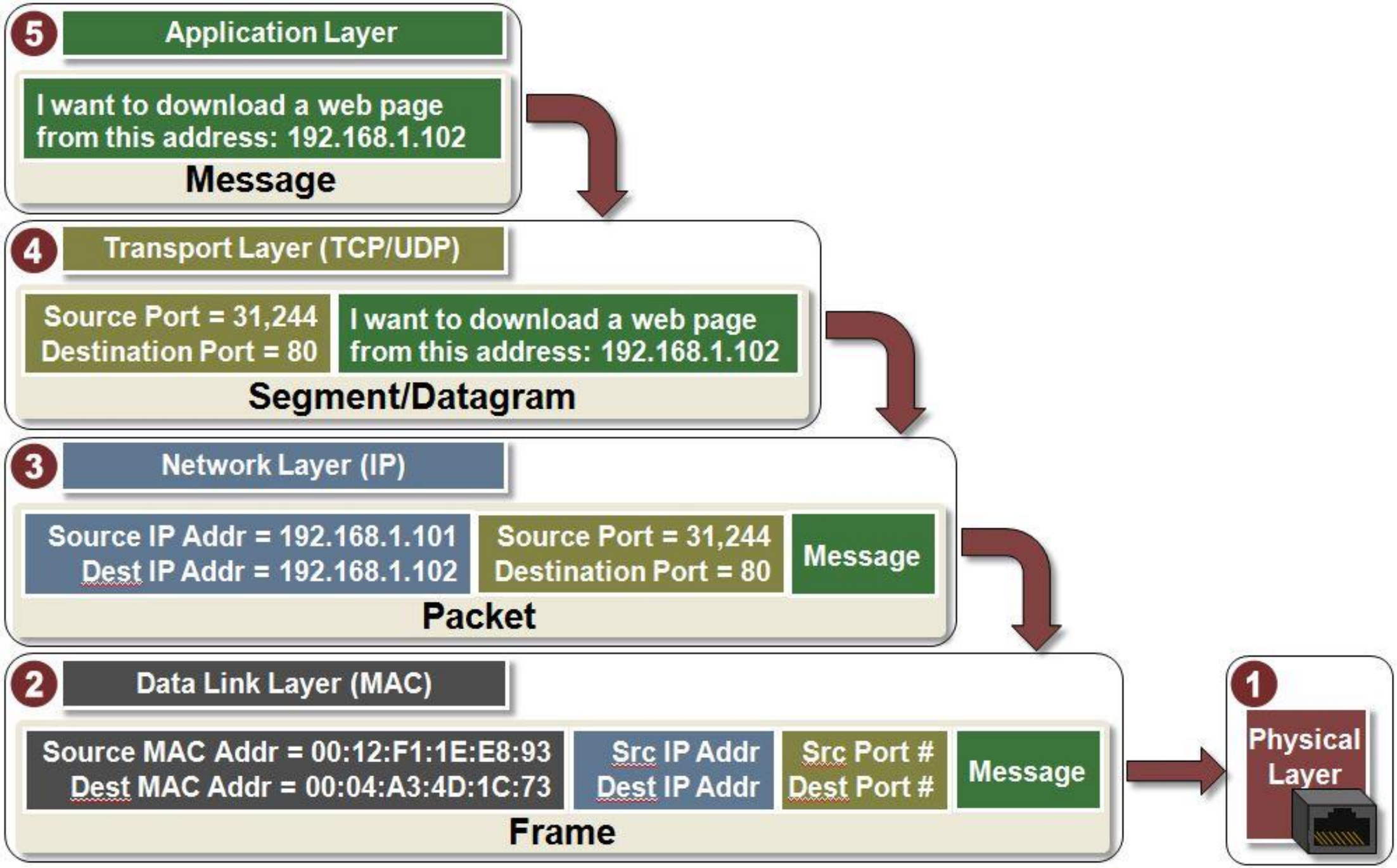
- Lower layers add headers (& trailers) to upper layer packets



Encapsulation in Action



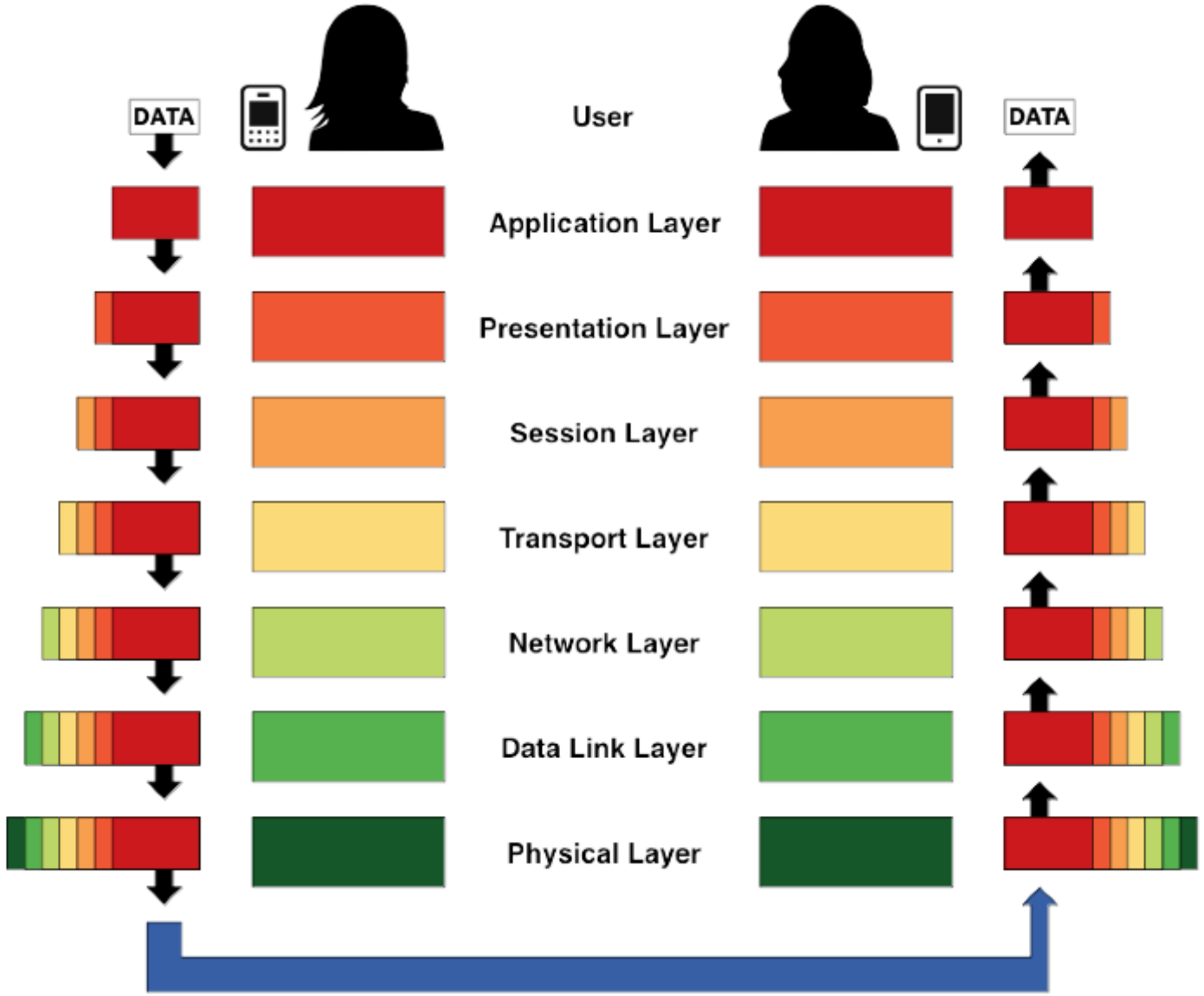
- L4 segment contains part of stream of application protocol
- L3 datagram contains L4 segment
- L2 frame has L3 datagram in data portion


5
Application Layer
I want to download a web page from this address: 192.168.1.102
Message
4
Transport Layer (TCP/UDP)
Source Port = 31,244
Destination Port = 80
I want to download a web page from this address: 192.168.1.102
Segment/Datagram
3
Network Layer (IP)
Source IP Addr = 192.168.1.101
Dest IP Addr = 192.168.1.102
Source Port = 31,244
Destination Port = 80
Message
Packet
2
Data Link Layer (MAC)
Source MAC Addr = 00:12:F1:1E:E8:93
Dest MAC Addr = 00:04:A3:4D:1C:73
Src IP Addr
Dest IP Addr
Src Port #
Dest Port #
Message
Frame
1
Physical Layer

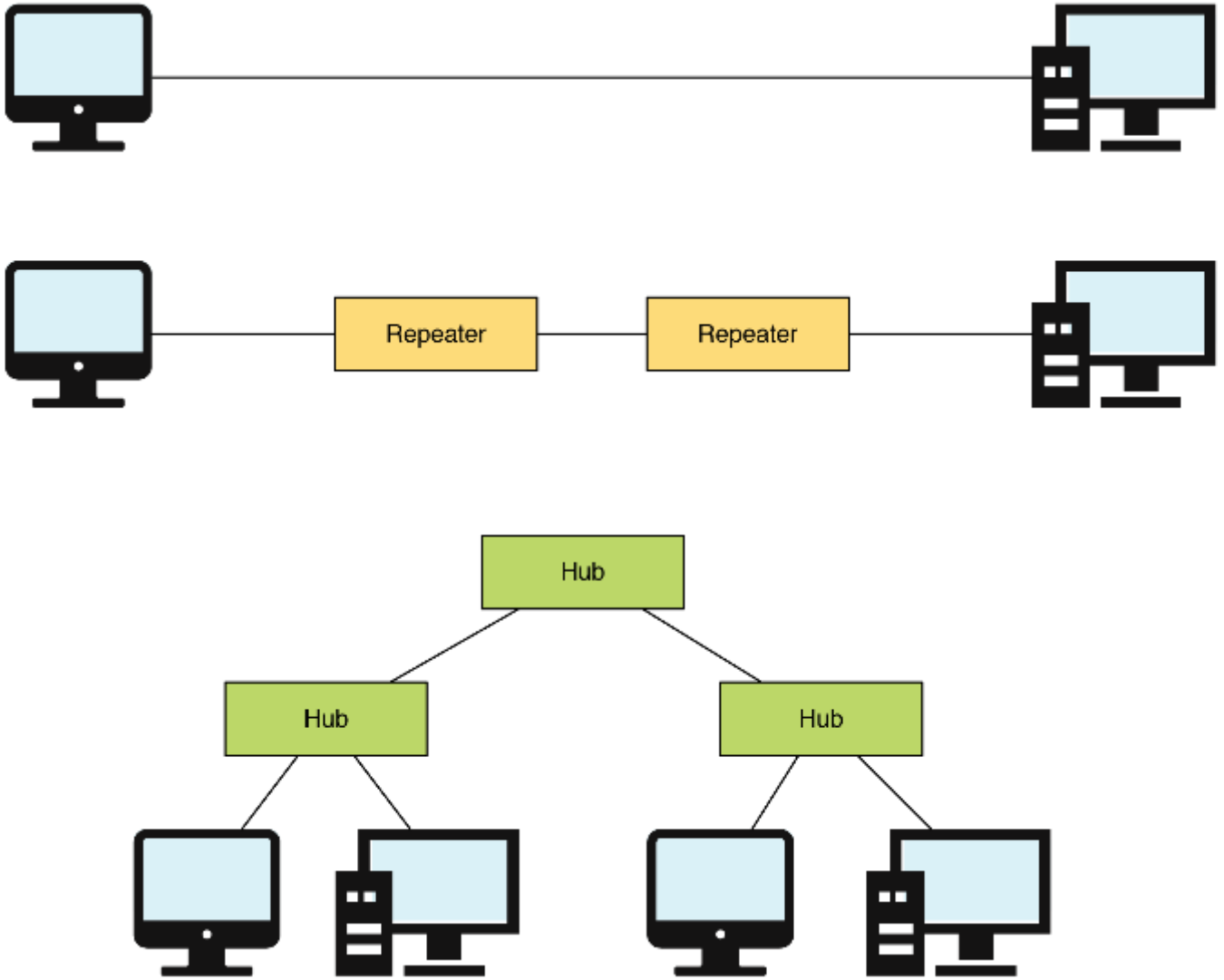
Frame, Datagram, Segment, Packet

- Different names for packets at different layers
  - Link Layer = Ethernet Frame
  - Network Layer = IP Packet
  - Transport Layer = TCP Segment
- Terminology is not strictly followed
  - We often just use the term “packet” at any layer

OSI Seven Layer Model



Building Networks at Layer 1



Layer 2 Example: Ethernet

- MAC addresses
- Protocol: 2 bytes
  - e.g. 0800 = IPv4, 0806 = ARP, 86DD = IPv6
- Preamble: Carrier Sense, Collision Detection

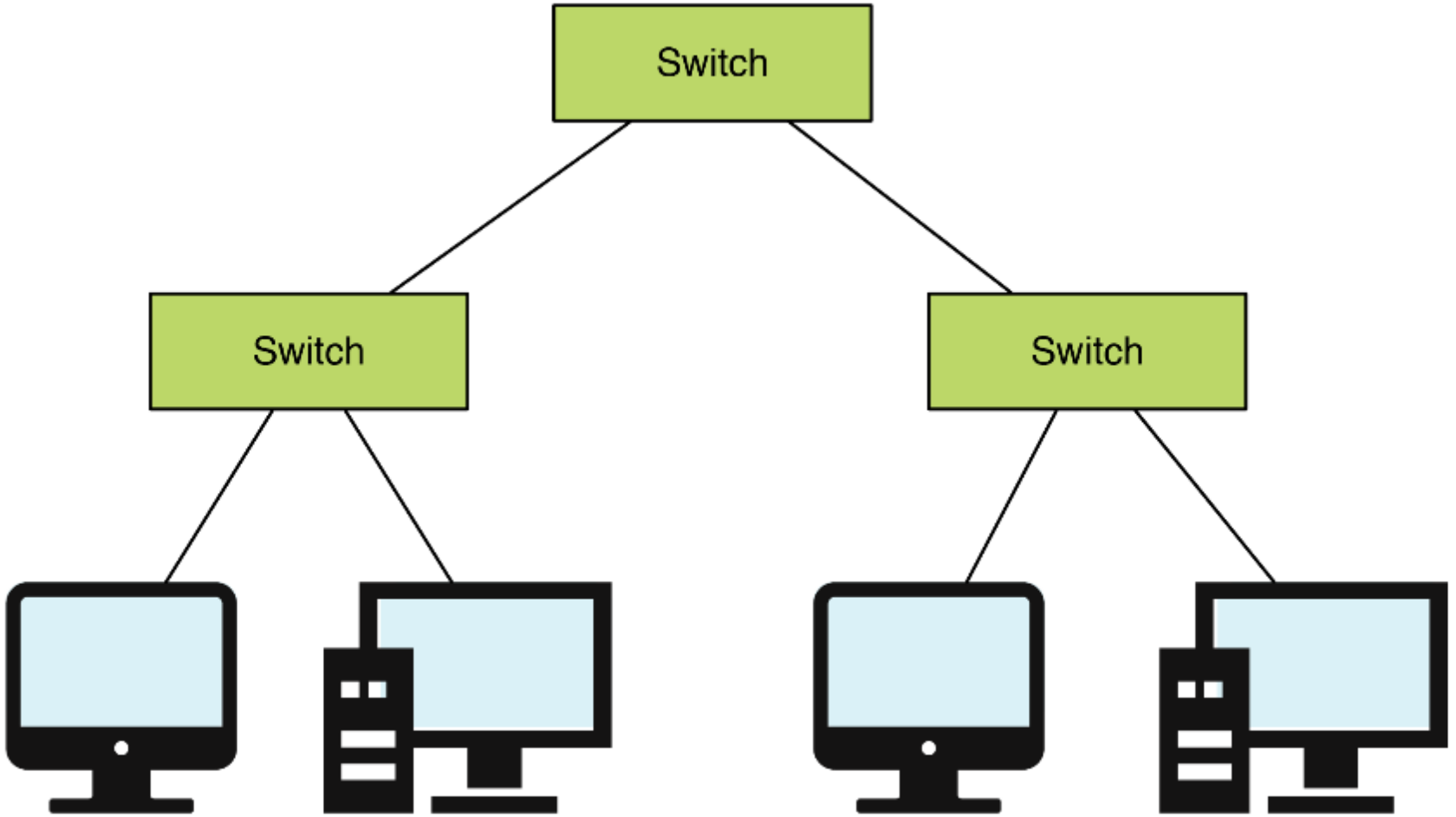
Layer 2: Data Link Layer

- **The network interface card address, called the hardware address, is protocol-independent and is usually assigned at the factory. This address is technically called the media access control address (MAC) because it is found on the MAC sub layer of the Data Link layer.**

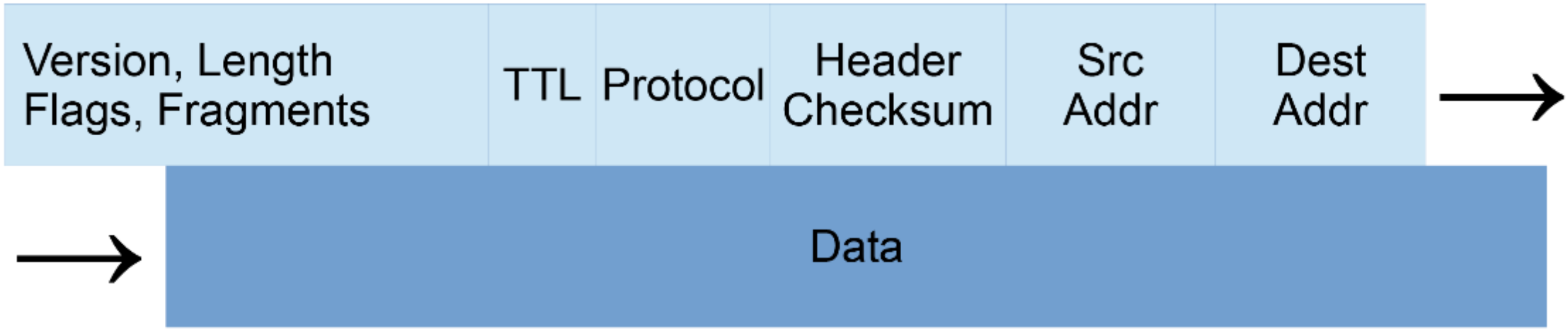
00-0C-F1-5E-BE-F2

MAC Address = Hardware Address

Building Networks at Layer 2



Layer 3 Example: IPv4 Datagram



- Source, Destination: IPv4 addresses
- Protocol: 1 byte
  - e.g. 6 = TCP, 17 = UDP

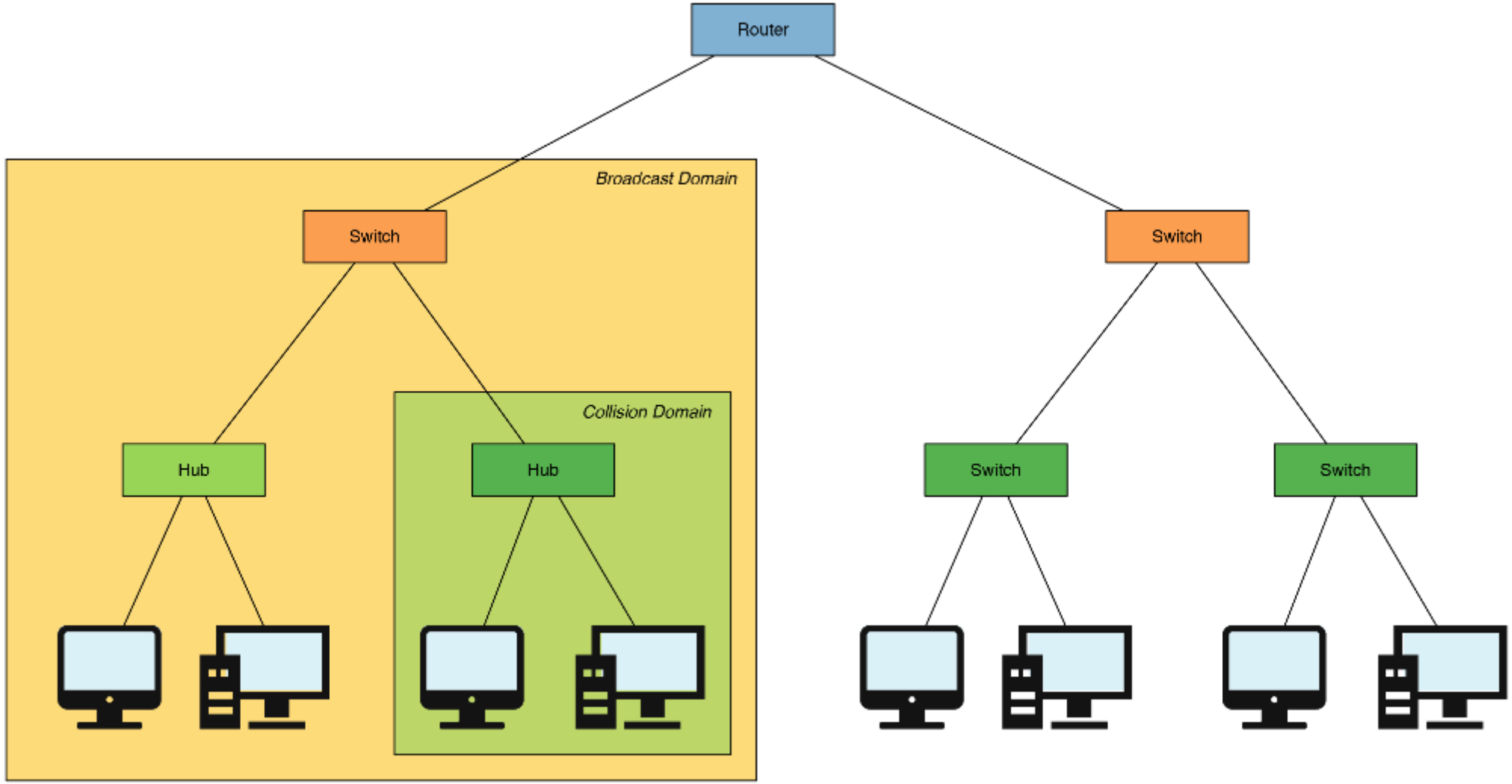
Layer 3: Network Layer

- **IP is a standard that defines the manner in which the network layers of two hosts interact. IP addresses are 32 bit long, hierarchical addressing scheme.**

192.168.6.17

IP Address = Logical Address

Building Networks At Layer 3



Layer 4: User Datagram Protocol

- System (Well-Known) Ports < 1024
  - 53, 69, 161, 162
- User (Registered) Ports 1024 - 49151
- Dynamic (Ephemeral) Ports
  - IANA Recommends ≥ 49152, Linux uses ≥ 32768
  - Typically used for temporary, one session only
  - Other end of a conversation with a well-known port

Layers 5+6: Session & Presentation

- Session Layer: long-lived sessions
  - Re-establish transport connection if it fails
  - Multiplex data across multiple connections
- Presentation Layer: data reformatting
  - Character set translation
- Neither exist in the TCP/IP suite
  - Application is responsible for these functions

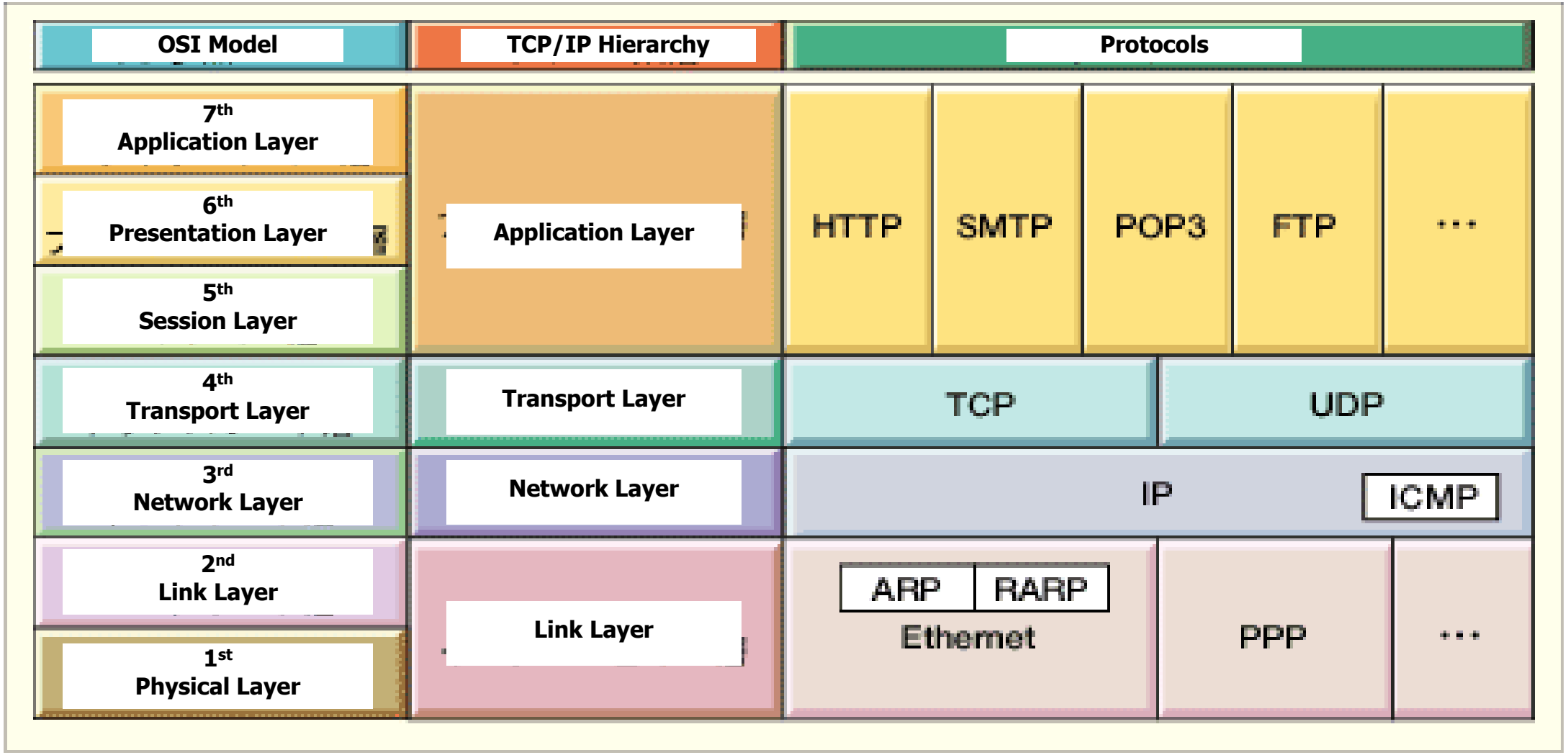
Layer 7: Application Layer

- The actual work you want to do
- Protocols specific to each application

TCP/IP networking

TCP/IP Network Model

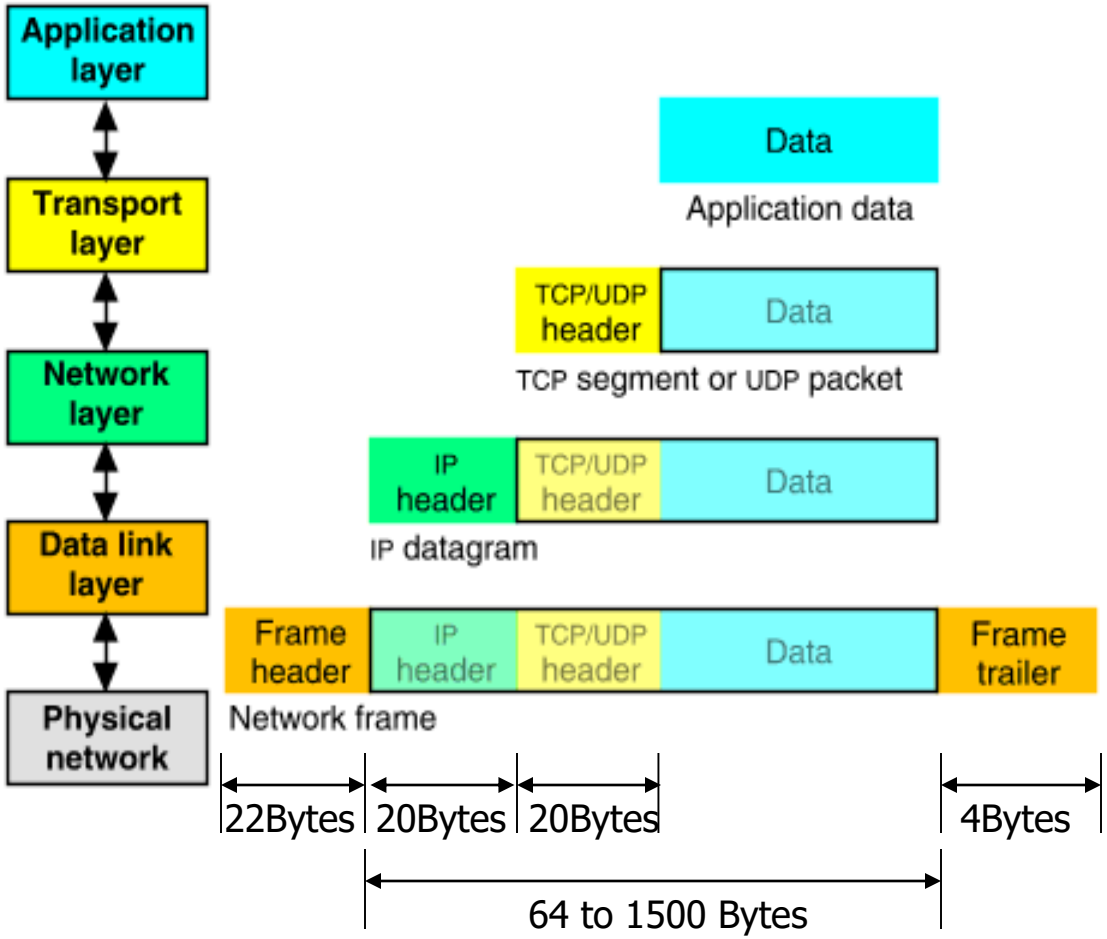
- Different view – 4 layers
  - Layer 1 : Link
  - Layer 2 : Network
  - Layer 3 : Transport
  - Layer 4 : Application



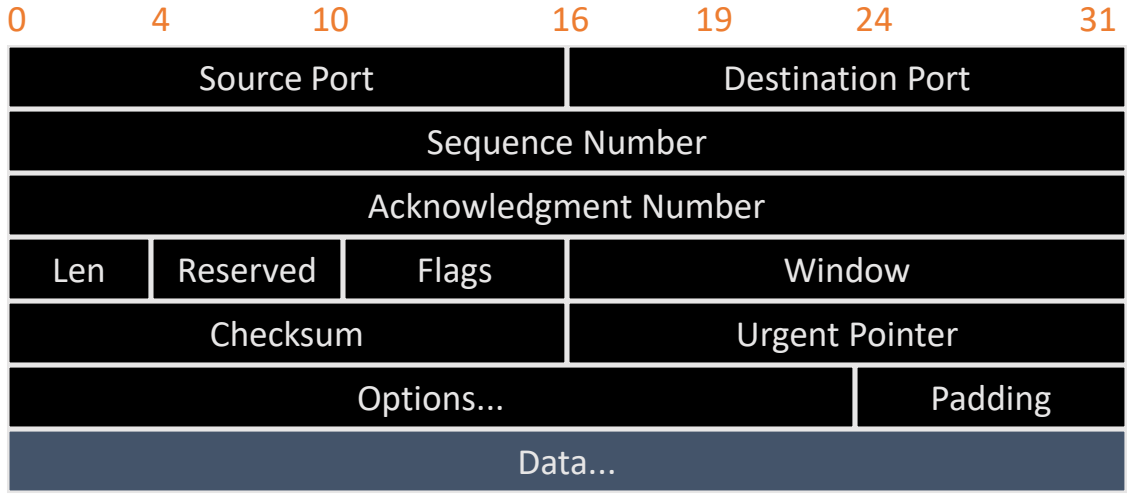
Link Layer : includes device driver and network interface card
Network Layer : handles the movement of packets, i.e. Routing
Transport Layer : provides a reliable flow of data between two hosts
Application Layer : handles the details of the particular application

Packet Encapsulation

- The data is sent down the protocol stack
- Each layer adds to the data by prepending headers

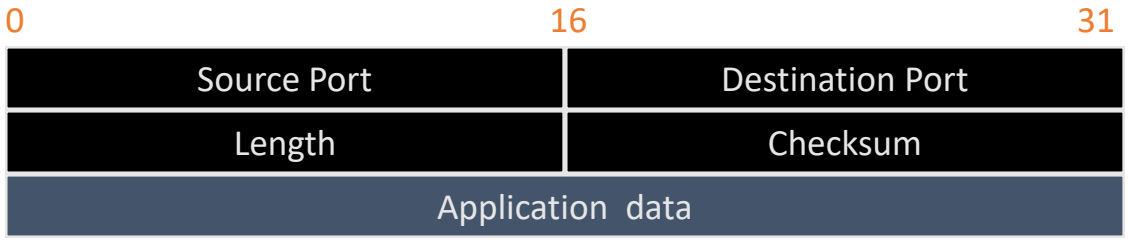


TCP Segment



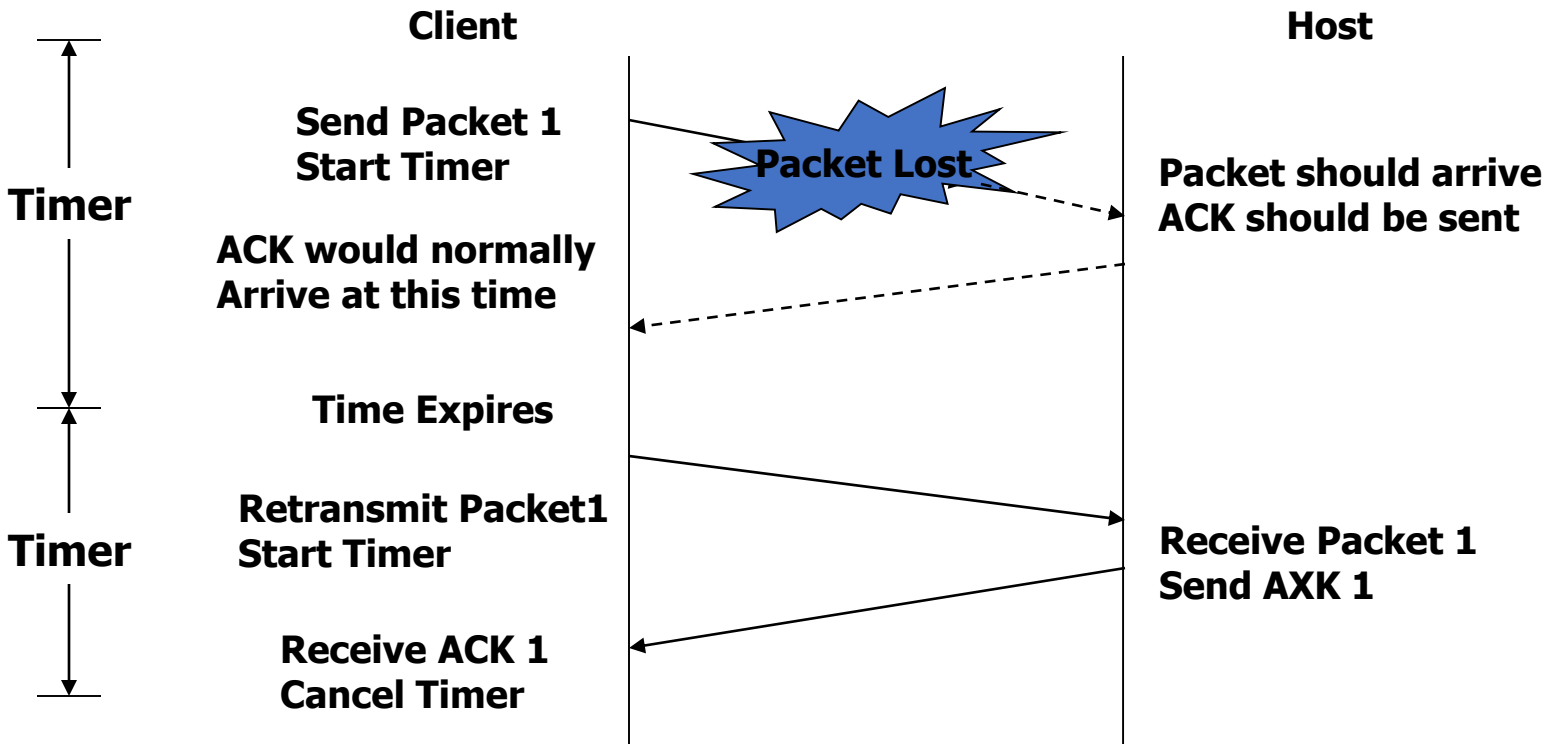
Field	Purpose
Source Port	Identifies originating application
Destination Port	Identifies destination application
Sequence Number	Sequence number of first octet in the segment
Acknowledgment #	Sequence number of the next expected octet (if ACK flag set)
Len	Length of TCP header in 4 octet units
Flags	TCP flags: SYN, FIN, RST, PSH, ACK, URG
Window	Number of octets from ACK that sender will accept
Checksum	Checksum of IP pseudo-header + TCP header + data
Urgent Pointer	Pointer to end of “urgent data”
Options	Special TCP options such as MSS and Window Scale

UDP datagram



Field	Purpose
Source Port	16-bit port number identifying originating application
Destination Port	16-bit port number identifying destination application
Length	Length of UDP datagram (UDP header + data)
Checksum	Checksum of IP pseudo header, UDP header, and data

TCP : Data transfer



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