

# OSI LAYERS

## Computer Networks

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# Outline

## 1 OSI Model

- The Physical Layer
- The Data Link Layer
- The Network Layer
- The Transport Layer
- The Application Layer



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# OSI Layers & Protocols

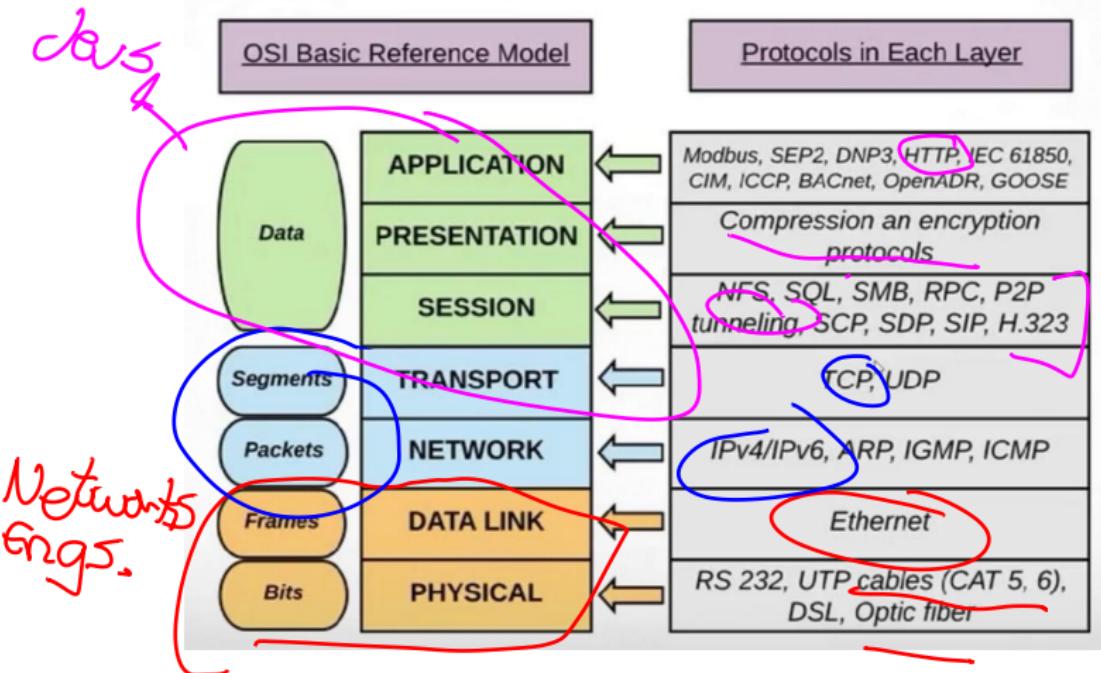


Figure: ISO Layers



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# Moving Bits Across the Wire

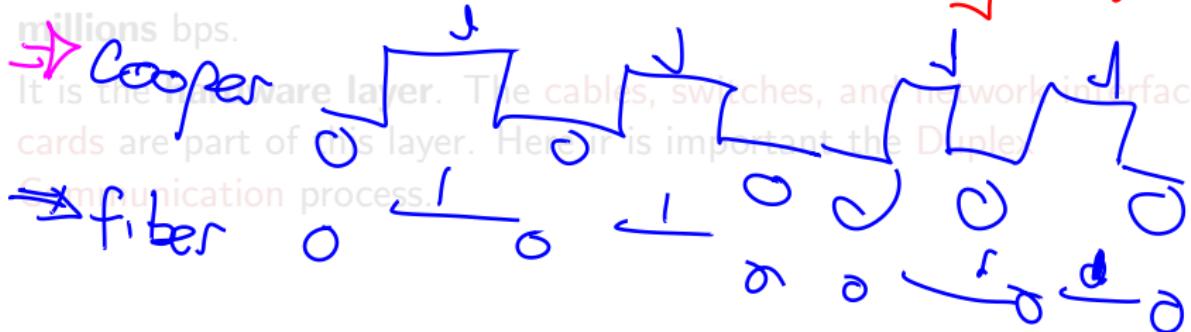
- **Physical Layer** is the **first layer** of the *OSI model*.
- It is responsible for moving **bits** across the wire.
- It defines the **electrical and physical specifications** of the data connection. Here **modulation** is pretty important, helps to move **10 millions bps**.
- It is the **hardware layer**. The **cables, switches, and network interface cards** are part of this layer. Here it is important the **Duplex Communication** process.



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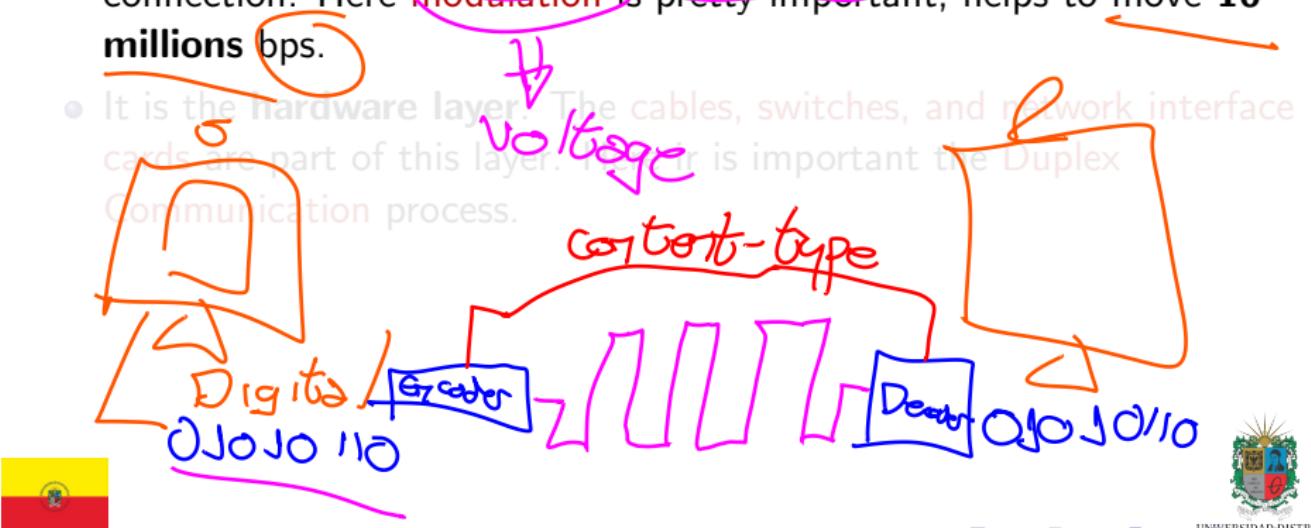
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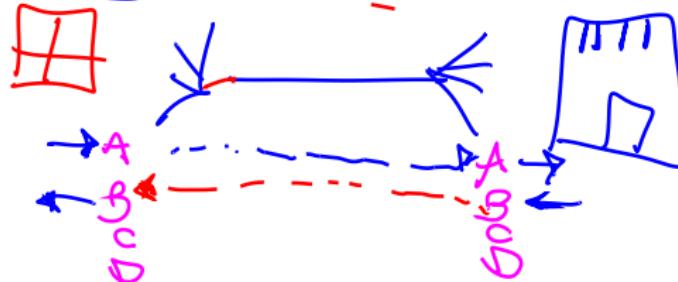


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# Networks Ports and Patch Panels

Box 17  
Cable - ISP Port

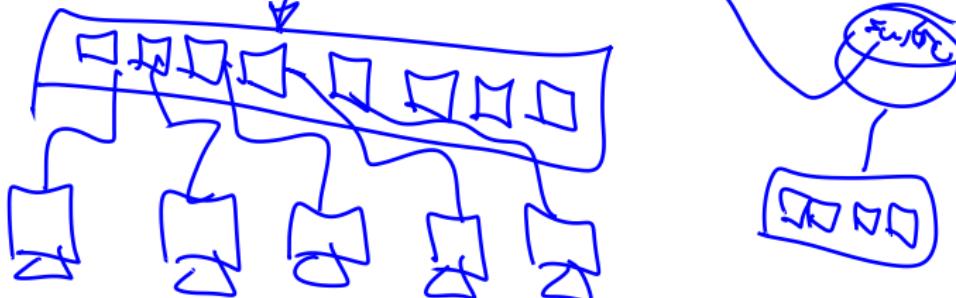
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# Networks Ports and Patch Panels

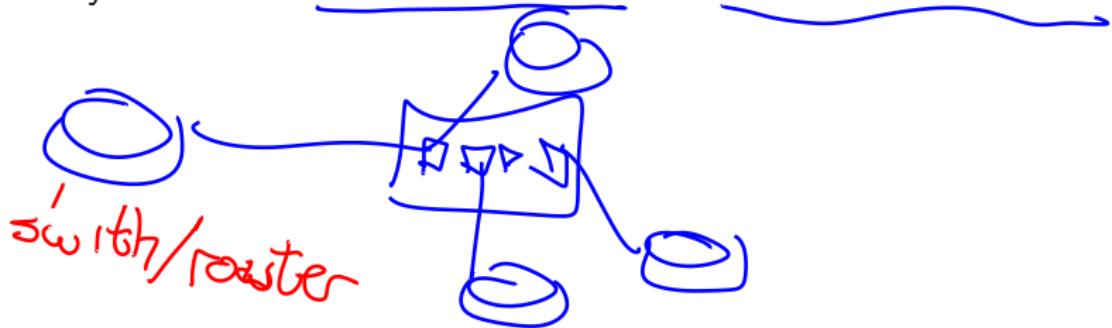


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# Cabling Tools

- Crimping Tool is used to attach ~~connectors to the end of a cable.~~

- Cable Tester is used to verify that the cable is properly connected.

- Tone Generator is used to trace cables. It sends a signal through the cable.



- Punch Down Tool is used to terminate cables on patch panels.

- Loopback Plug is used to test network ports. It sends a signal back to the device.



- Network Analyzer is used to monitor network traffic. It captures and analyzes packets.

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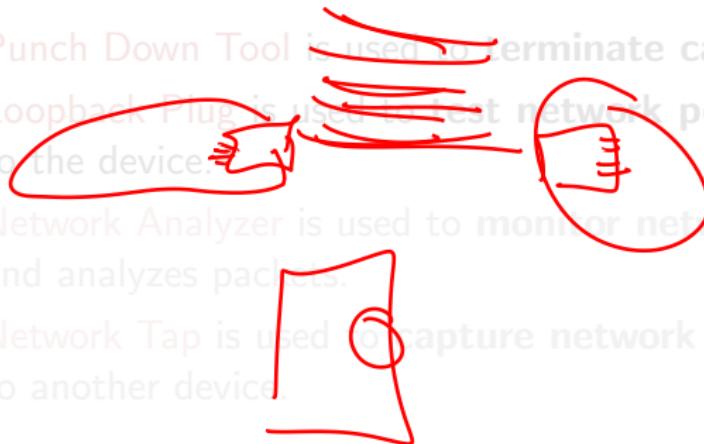
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- Note: Quality, speed*



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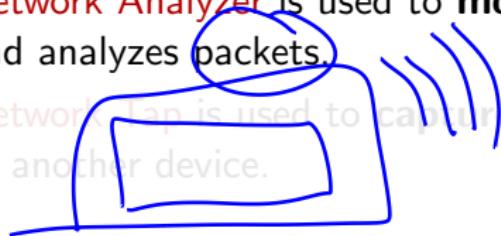
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# Ethernet and MAC Addresses

- **Data Link Layer** is the **second layer** of the *OSI model*.

- It is responsible for framing and error detection.
- It defines the logical link control and media access control.
- It is a **software layer**. The Ethernet protocol (1908s) is part of this layer.
- **MAC Addresses** are **unique identifiers** assigned to network interfaces. It is a **48-bit** (six groups of two hexadecimal) number.
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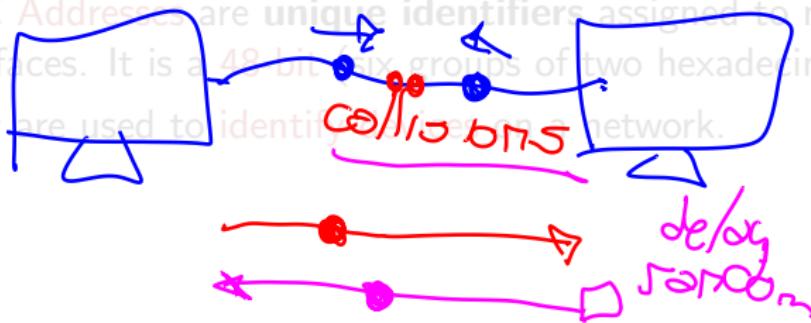
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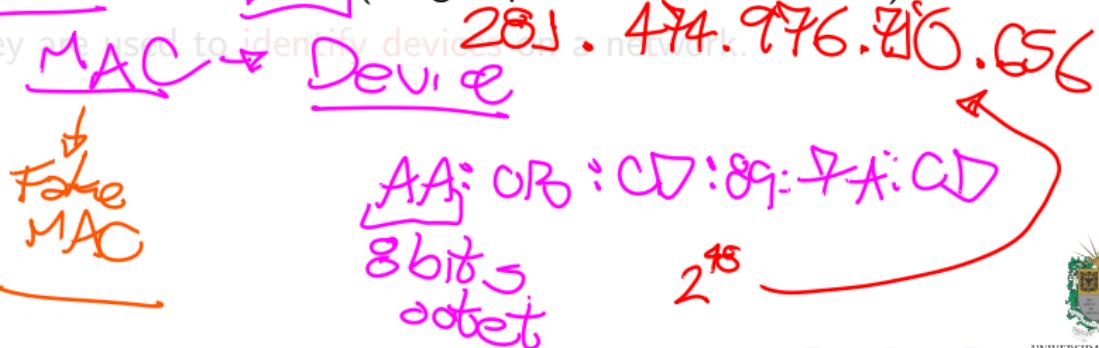
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# MAC Address Structure



Figure: MAC Address Structure

OSIAADF ~ 000000  
000001  
000002



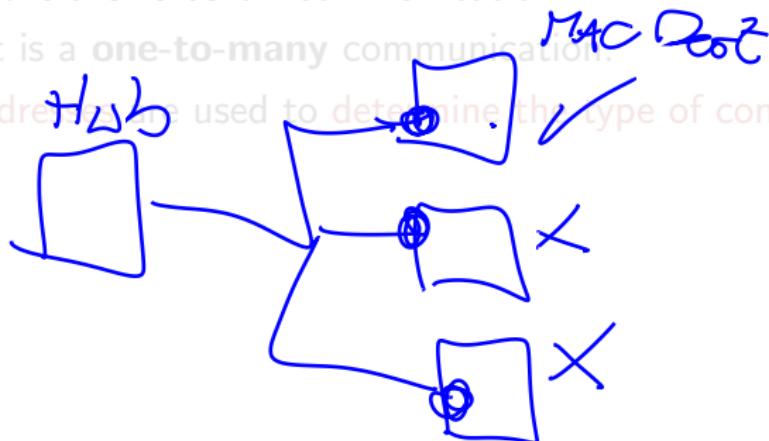
# Unicast, Broadcast, and Multicast

- Unicast is a **one-to-one** communication.
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- Multicast is a **one-to-many** communication.
- MAC Addresses are used to determine the type of communication.



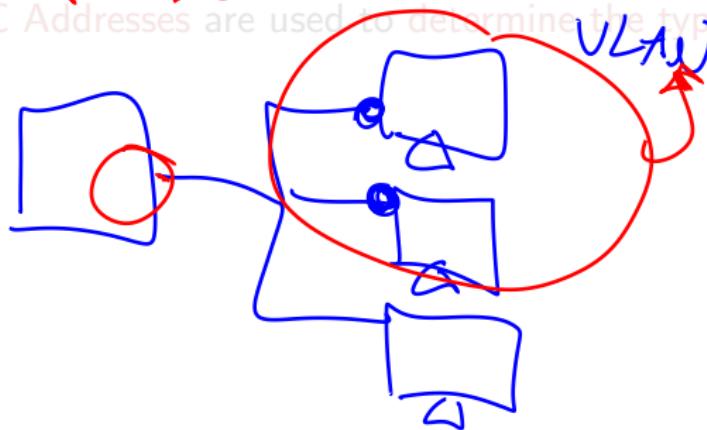
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## Ethernet Frames

- **Ethernet Frames** are the **data packets** used in **Ethernet** networks.
  - They contain the **source and destination MAC addresses**.
  - They also contain the **type of data** and the **data payload**.
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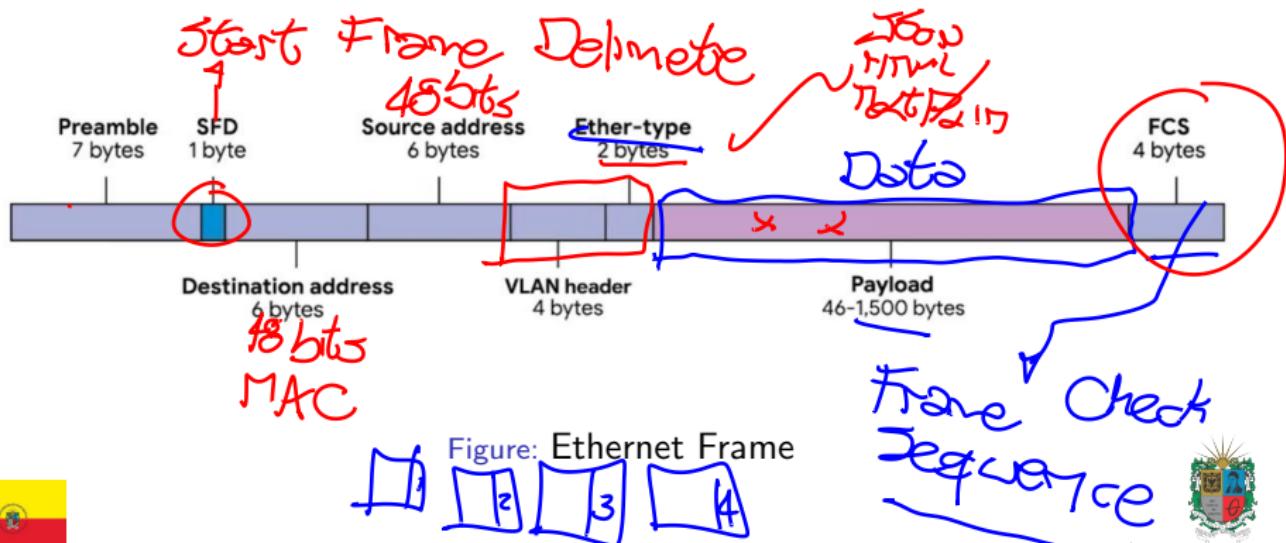


Figure: Ethernet Frame



# Avoiding Data Corruption

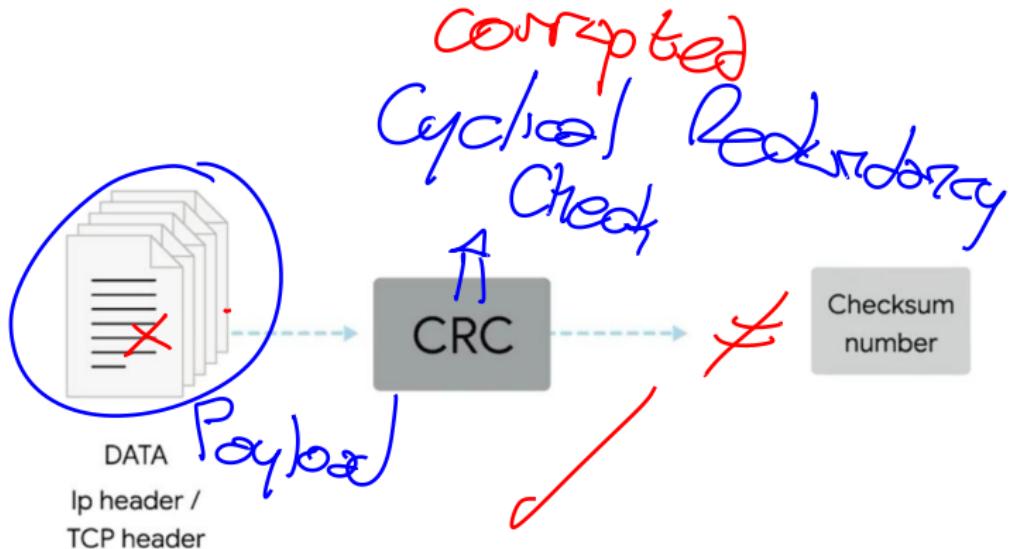


Figure: Checksum Validation



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# IPv4 Addresses and Addresses Classes

- Network Layer is the **third layer** of the *OSI model*.
- It is responsible for **routing** and addressing.
- It defines the **logical addressing** and **path determination**.
- It is a **software layer**. The IP protocol is part of this layer.
- IPv4 Addresses are **32-bit numbers** used to identify devices on a network.
- They are divided into **classes** based on the **network size**.



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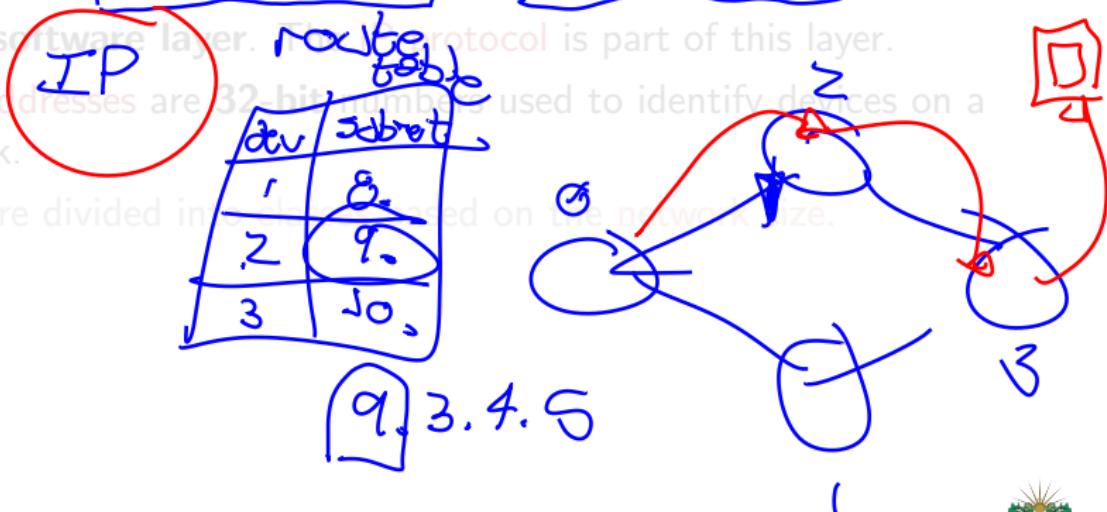
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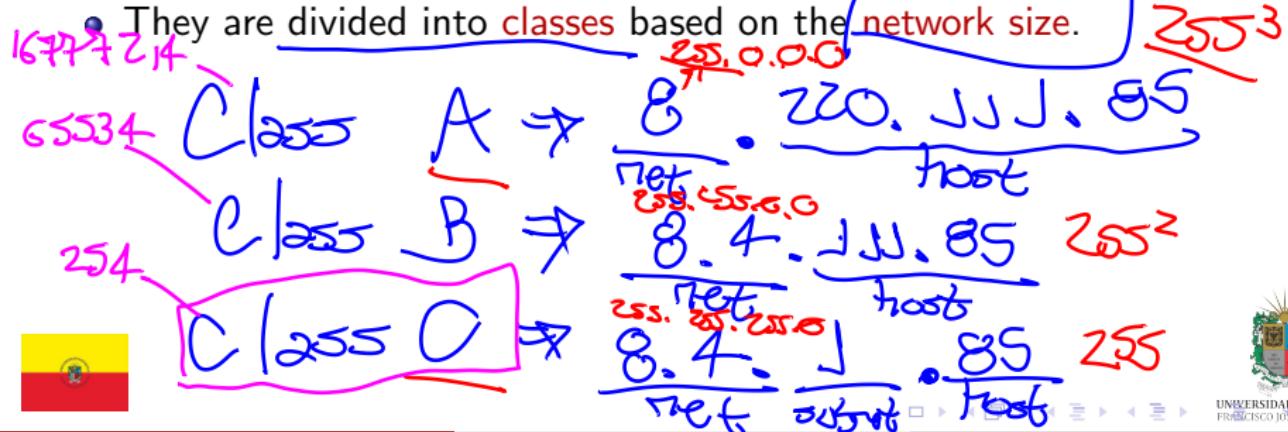
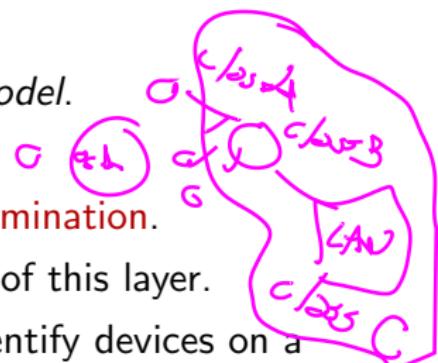
2<sup>32</sup>  
8 bits. E.g. 8.8.8.8

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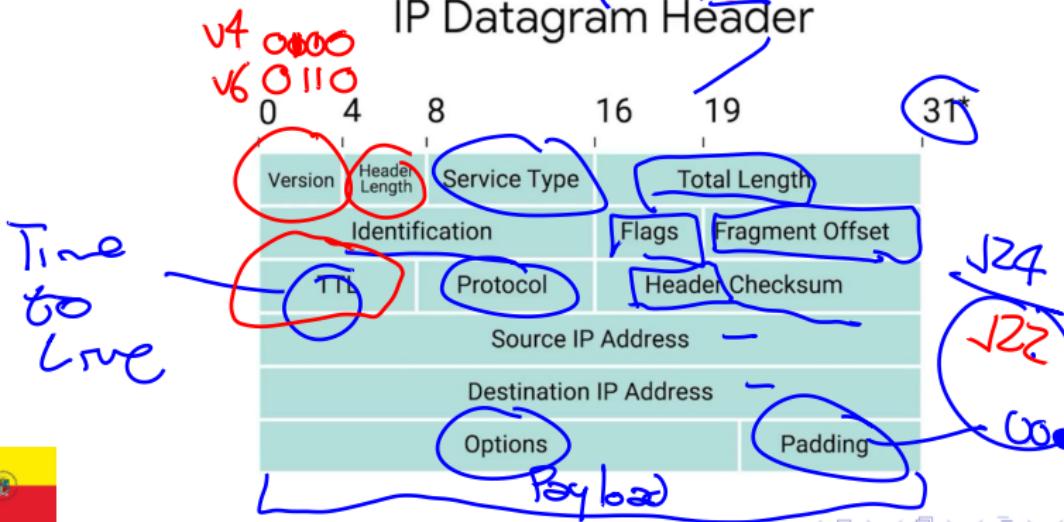


## IPv4 Datagram

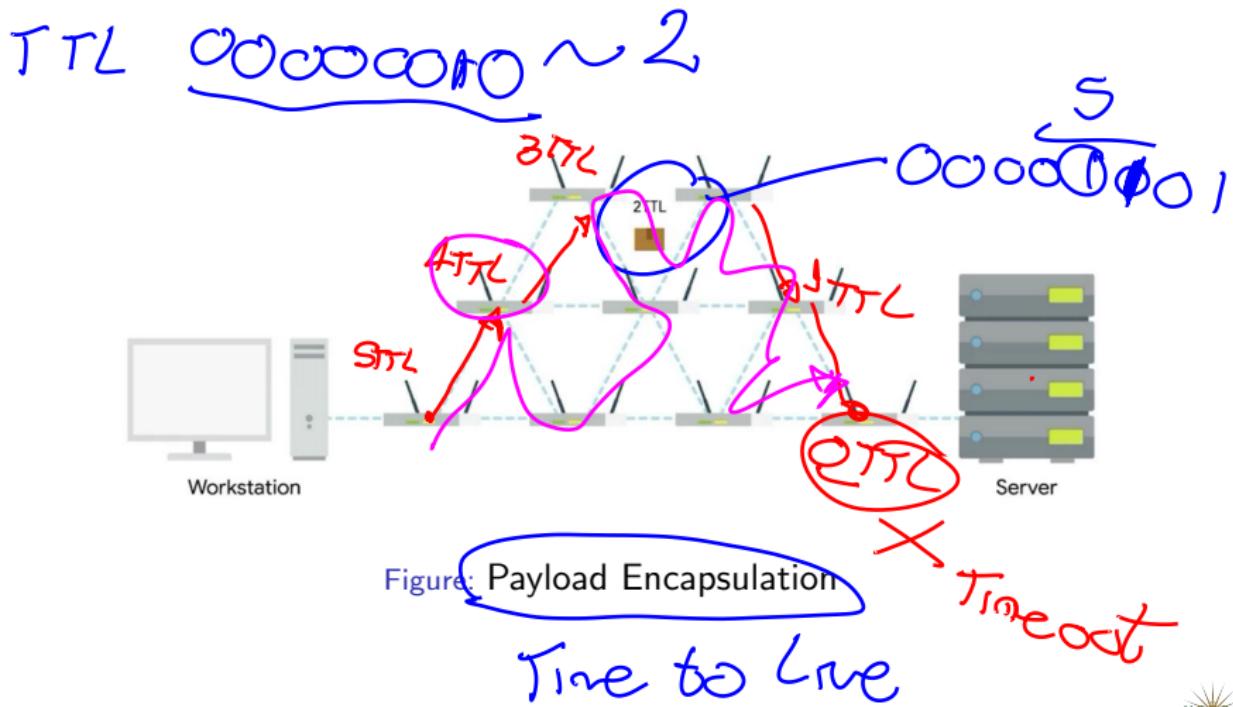
- **IPv4 Datagram** is the **data packet** used in **IP** networks.
  - It contains the source and destination IP addresses.
  - It also contains the **type of data** and the **data payload**.
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IP  
Ethernet

## IP Datagram Header



## Time To Live



# Encapsulation

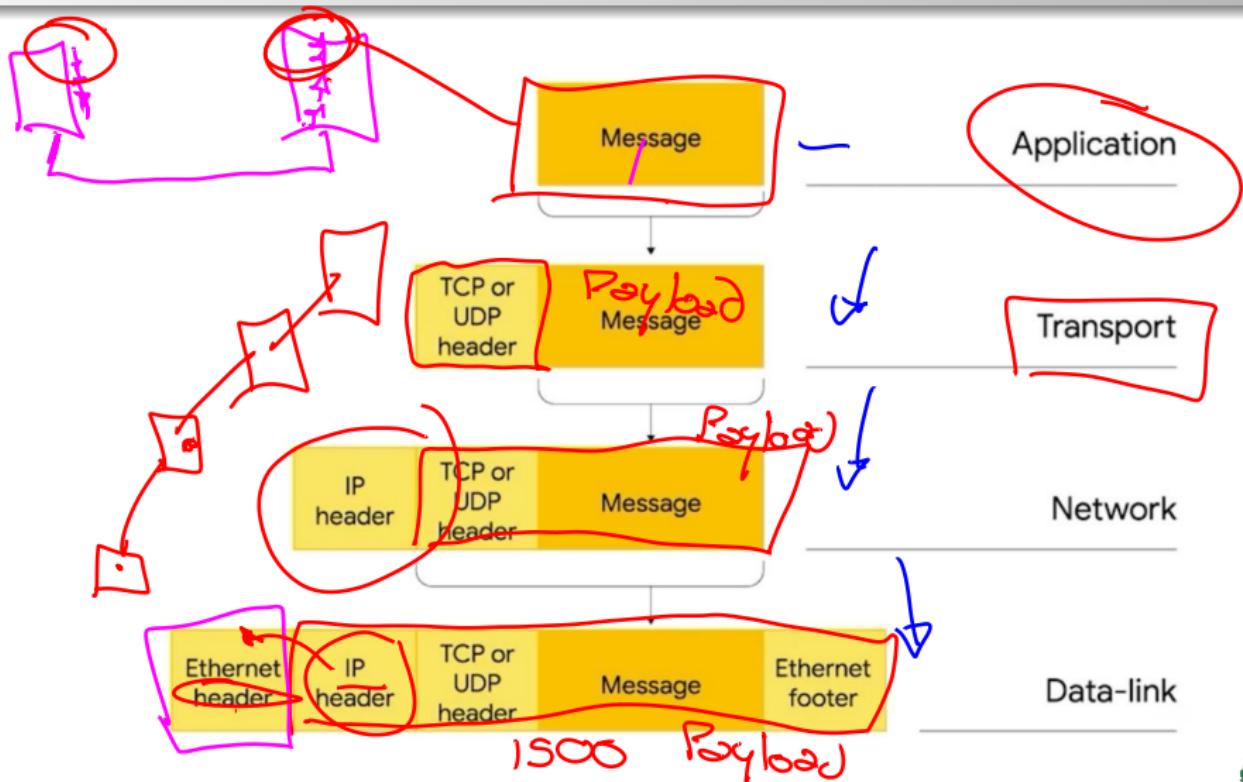
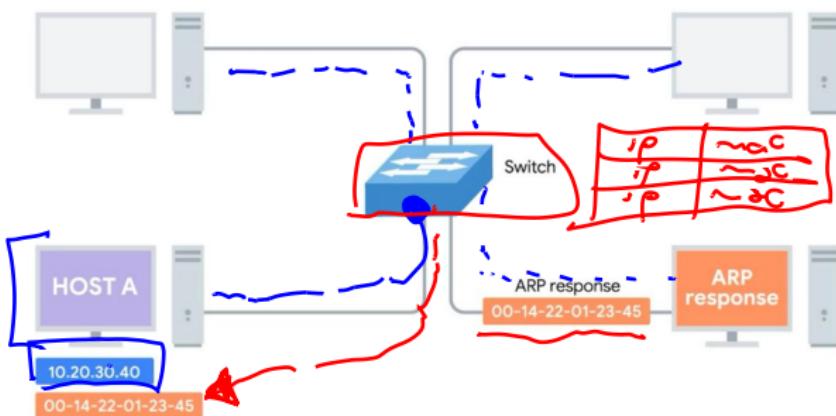


Figure: Time To Live Counter



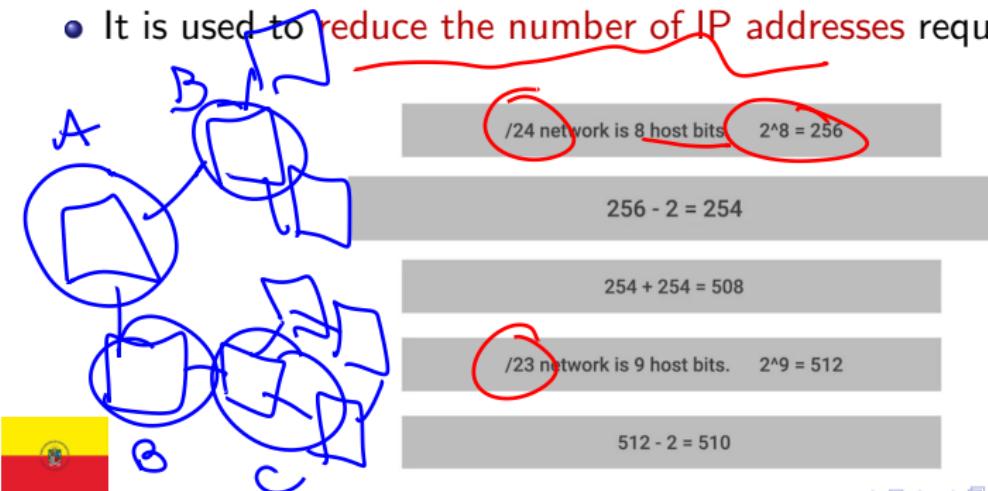
# Address Resolution Protocol (ARP)

- Address Resolution Protocol (ARP) is used to map IP addresses to MAC addresses.
- It is used to resolve IP addresses to physical addresses, using ARP table or ARP cache.



# Subnetting and CIDR

- Subnetting is the process of dividing a network into smaller subnets.  $IP_A \Rightarrow IP_B \Rightarrow IP_C$
- It is used to reduce network congestion and improve network performance.
- CIDR (stands for ClassLess InterDomain Routing) is a subnetting technique that uses a prefix length to define the subnet.
- It is used to reduce the number of IP addresses required for a network.



# Routing and Routers

- **Routing** is the process of **determining the best path** for data to travel on a network.
- It is used to forward data packets between devices on a network.
- Routers are devices that are used to route data between networks.
- They are used to connect different networks together.



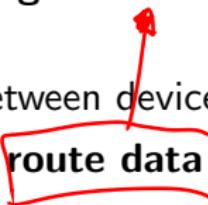
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# TCP Segment

Physical → cables + devices  
DataLink → MAC MAC source | MAC dest  
Network → IP IP dest | IP source

- Transport Layer is the fourth layer of the OSI model.
- It is responsible for end-to-end communication and error recovery.
- It defines the connection-oriented and reliable data transfer.
- It is a software layer. The TCP protocol is part of this layer.
- TCP Segment is the data packet used in TCP networks.
- It contains the source and destination port numbers.
- It also contains the sequence number and the data payload.
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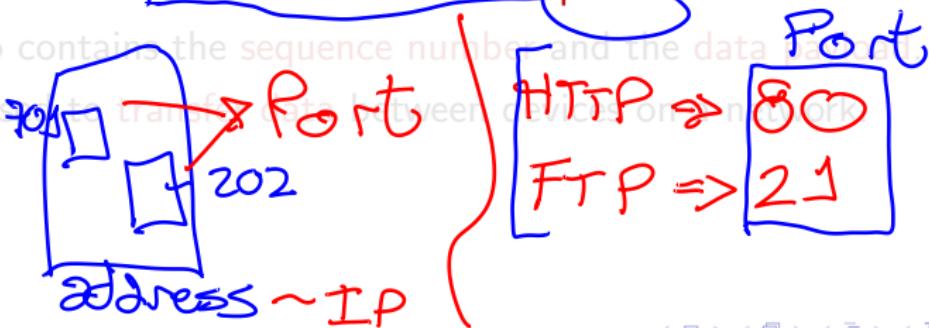
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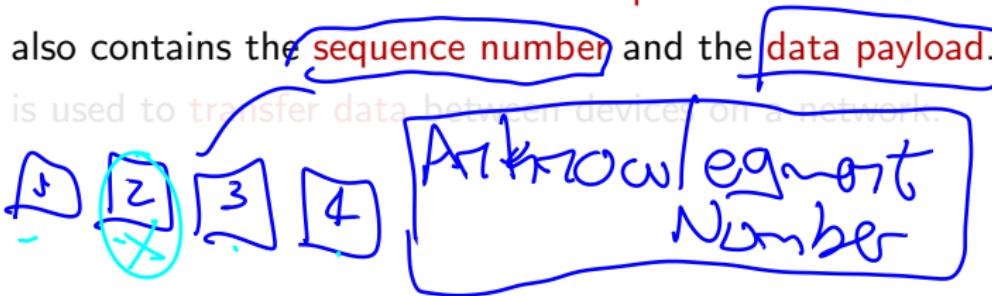
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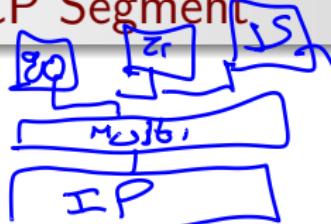
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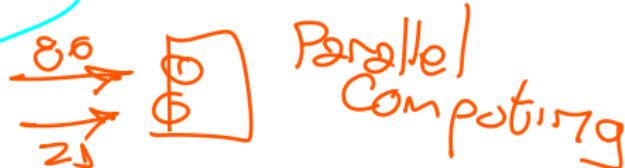


# TCP Segment



*socket => IP:Port*  
↳ *listen*  
↳ *software*

- **Transport Layer** is the **fourth layer** of the **OSI model**.
- It is responsible for **end-to-end communication** and **error recovery**.
- It defines the **connection-oriented** and **reliable** data transfer.
- It is a **software layer**. The **TCP protocol** is part of this layer.
- **TCP Segment** is the **data packet** used in TCP networks.
- It contains the **source and destination port numbers**.
- It also contains the **sequence number** and the **data payload**.
- It is used to **transfer data between devices on a network**.



# TCP Control Flags

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 $\nwarrow$  F

- TCP Control Flags are used to control the flow of data in a TCP connection.
- They are used to establish and terminate connections.
- They are used to acknowledge data and control the flow of data.

check  
points



# TCP Control Flags

Connection refused

404

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Troubleshooting



# TCP & UDP Packets

TCP/IP

- **TCP** (Transmission Control Protocol) is a **connection-oriented** protocol.
  - It is used to establish a **connection** between devices.
  - It is used to guarantee the **delivery** of data.
  - UDP (User Datagram Protocol) is a **connectionless** protocol.
  - It is used to send data without establishing a connection.
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# TCP Socket States



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# Firewalls and NAT



- **Firewalls** are used to **protect networks** from unauthorized access.
- They are used to filter traffic based on rules and policies.
- NAT (Network Address Translation) is used to map private IP addresses to public IP addresses.
- It is used to hide internal network addresses from the public Internet.



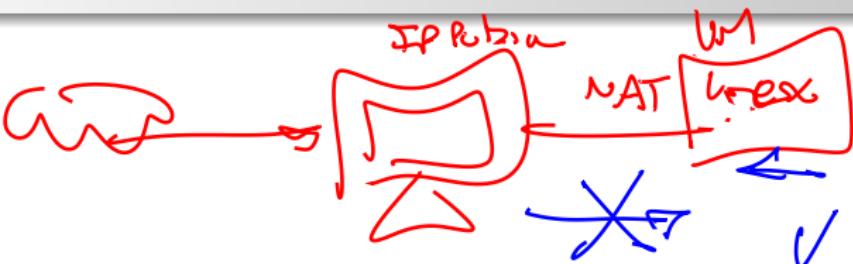
# Firewalls and NAT

the one  
www.\*\*.udistrital.edu.co

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# Outline

## 1 OSI Model

- The Physical Layer
- The Data Link Layer
- The Network Layer
- The Transport Layer
- The Application Layer



# Application Layer Protocols

- Application Layer is the **fifth layer** of the *OSI model*.
- It is responsible for user interfaces and application services.
- It defines the protocols used by applications to communicate over the network.
- It is the software layer. The HTTP protocol is part of this layer.



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*seventh*

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# All the Layers Together

Q1

routing

switch → server

#	Layer Name	Protocol	Protocol Data Unit	Addressing
5	Application	HTTP, SMTP, etc...	Messages	n/a
4	Transport	TCP/UDP	Segment	Port #'s
3	Network	IP	Packet / Datagram	IP Address
2	Data Link	Ethernet, Wi-Fi	Frames	MAC Address
1	Physical	n/a	Bits	binary codification

Annotations:

- Handwritten arrows point from the layers down to the PDU levels: Application to Messages, Transport to Segment, Network to Packet / Datagram, Data Link to Frames, and Physical to Bits.
- The word "routing" is written above the Network layer.
- The word "switch" is written above the Data Link layer.
- The word "server" is written above the Physical layer.
- Red circles highlight "n/a" under Protocol for the Physical layer and under Addressing for the Application layer.
- Red boxes highlight "TCP/UDP" under Protocol for the Transport layer and "IP" under Protocol for the Network layer.
- Blue boxes highlight "Ethernet, Wi-Fi" under Protocol for the Data Link layer.
- Handwritten text "text format" is associated with the IP Address.
- Handwritten text "Grid 60 60" is associated with MAC Address.
- Handwritten text "bits" is associated with Bits.
- Handwritten text "binary codification" is associated with Bits.
- Handwritten text "Q1" is in the top left corner.

5



Figure: All the Layers working in Unison



# Outline

## 1 OSI Model

- The Physical Layer
- The Data Link Layer
- The Network Layer
- The Transport Layer
- The Application Layer



# Thanks!

## Questions?



Repo:

 [github.com/engandres/ud-public/main/tree/computer-networks](https://github.com/engandres/ud-public/main/tree/computer-networks)



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