Networking: A Broad Overview

Linux Session 12

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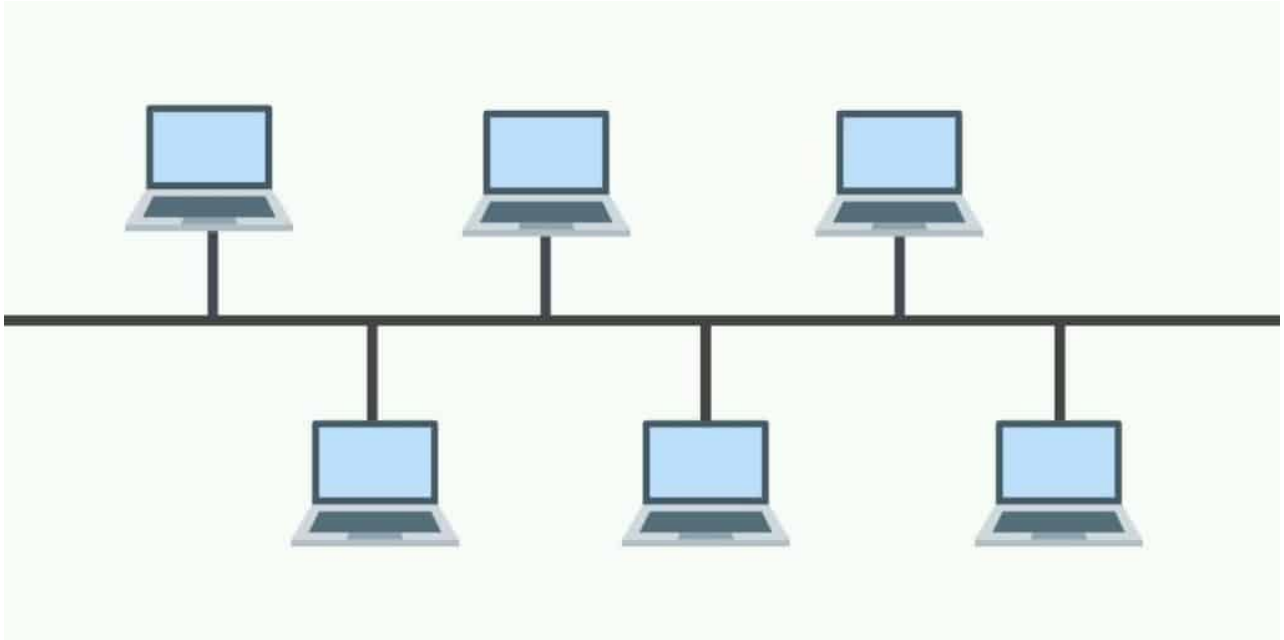
01

What even is Networking?

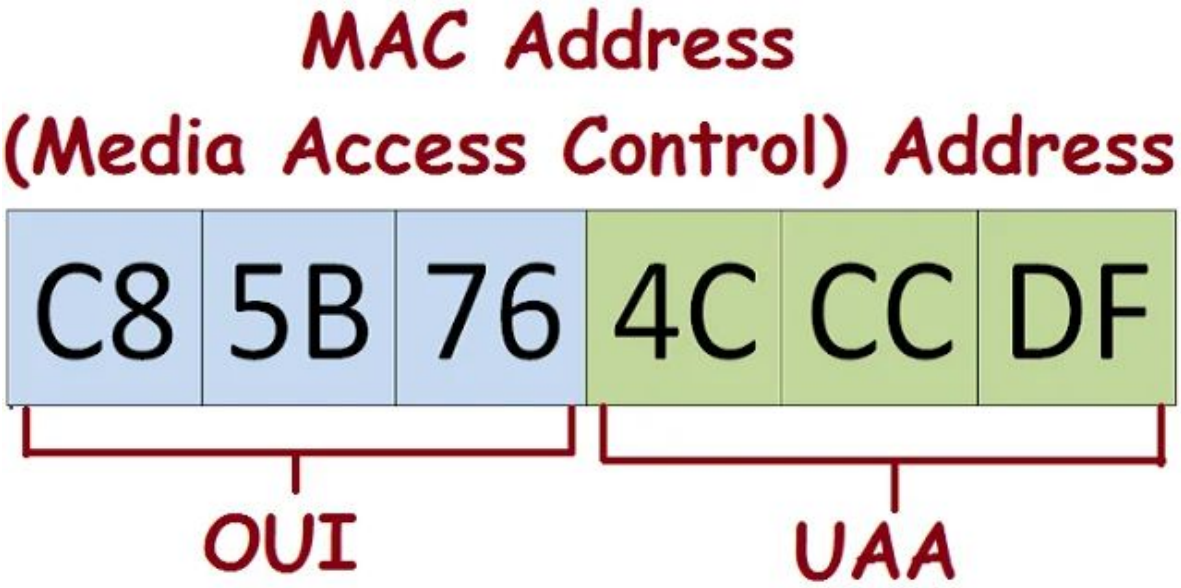
Introduction to networking basics

Point-to-Point Topology

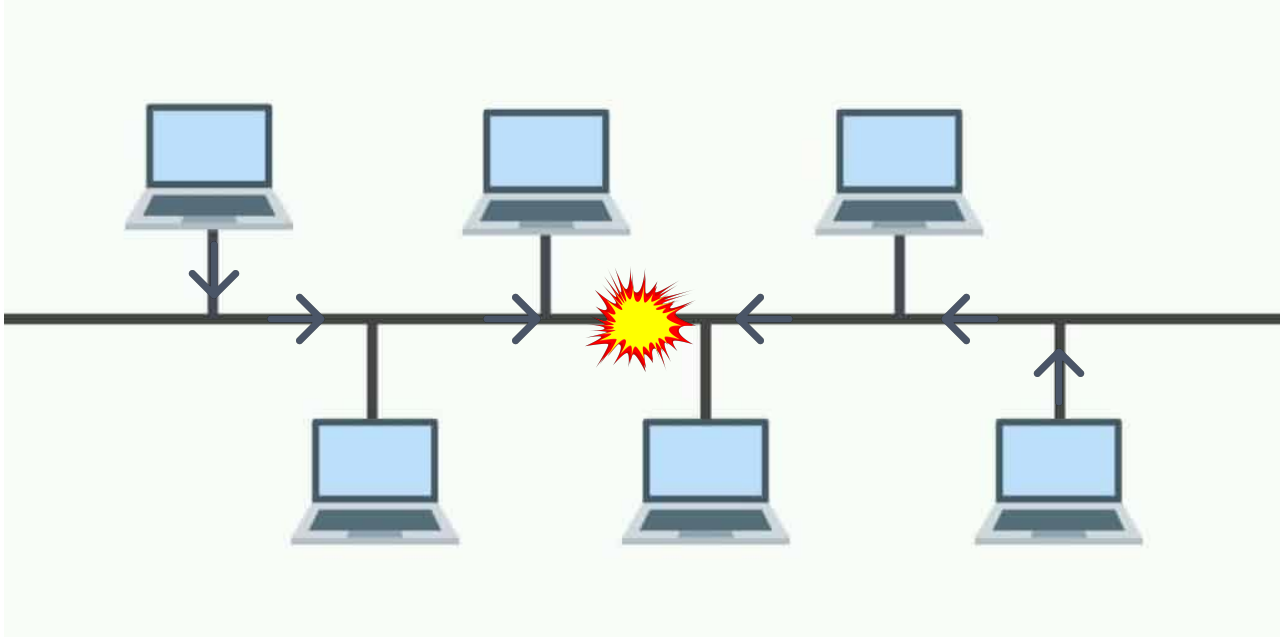
Broadcast Topology



MAC Address


MAC Address
(Media Access Control) Address
C8 5B 76 4C CC DF
OUI
UAA

Collision!



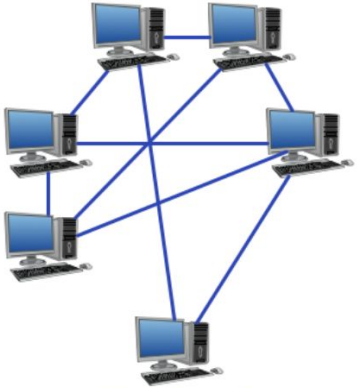
CSMA/CD

Carrier-**S**ense **M**ultiple **A**ccess with **C**ollision **D**etection

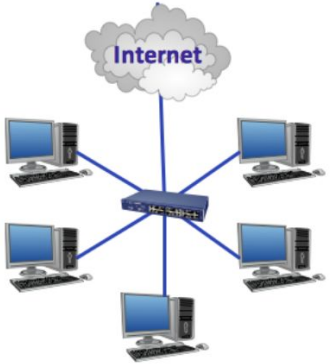
What is a Switch?

Network Topologies

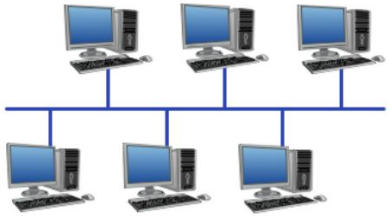
Fully Connected Network Topology



Mesh Network Topology



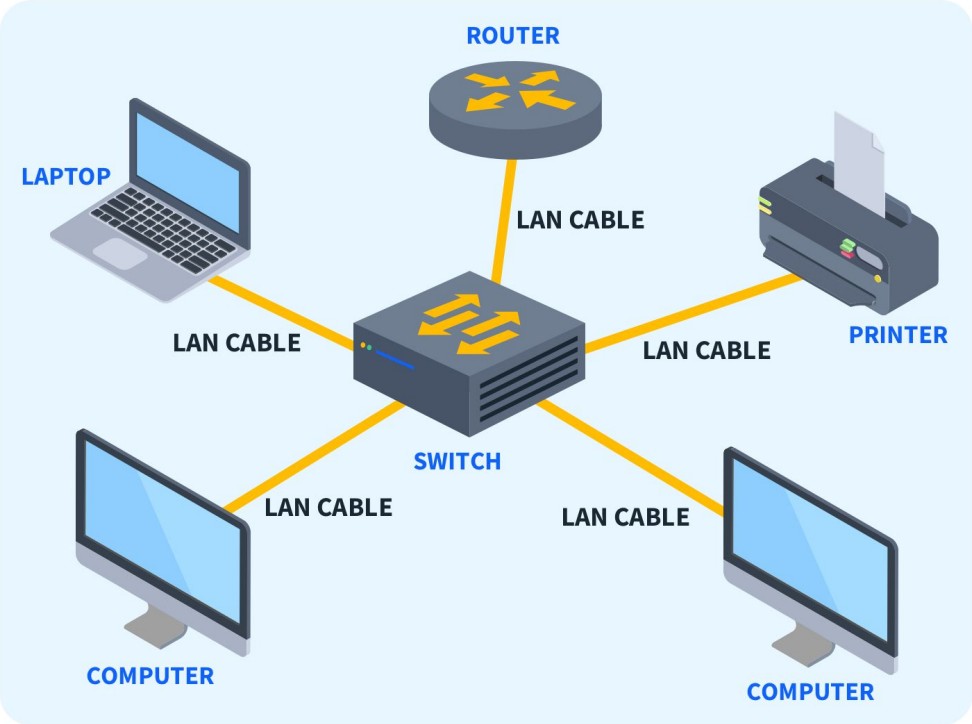
Star Network Topology



Common Bus Topology

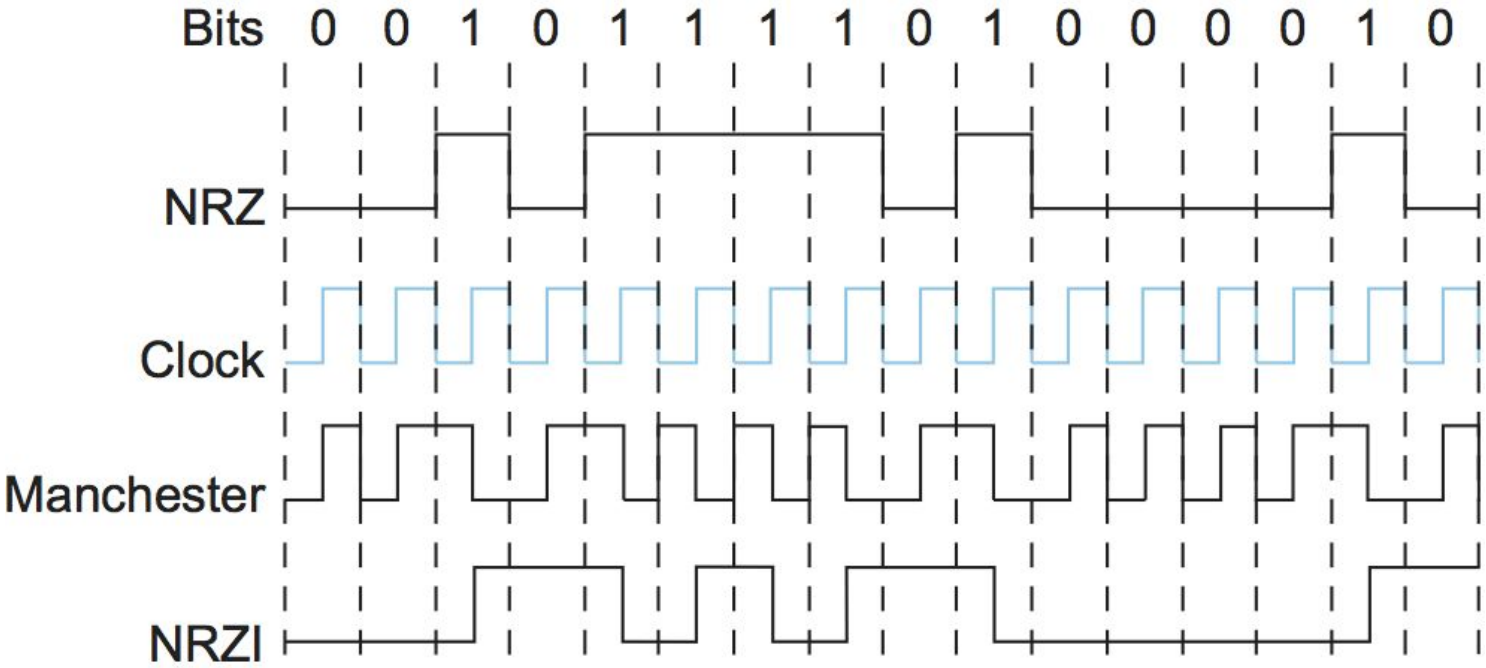
Ring Network Topology

LAN (Local Area Network)



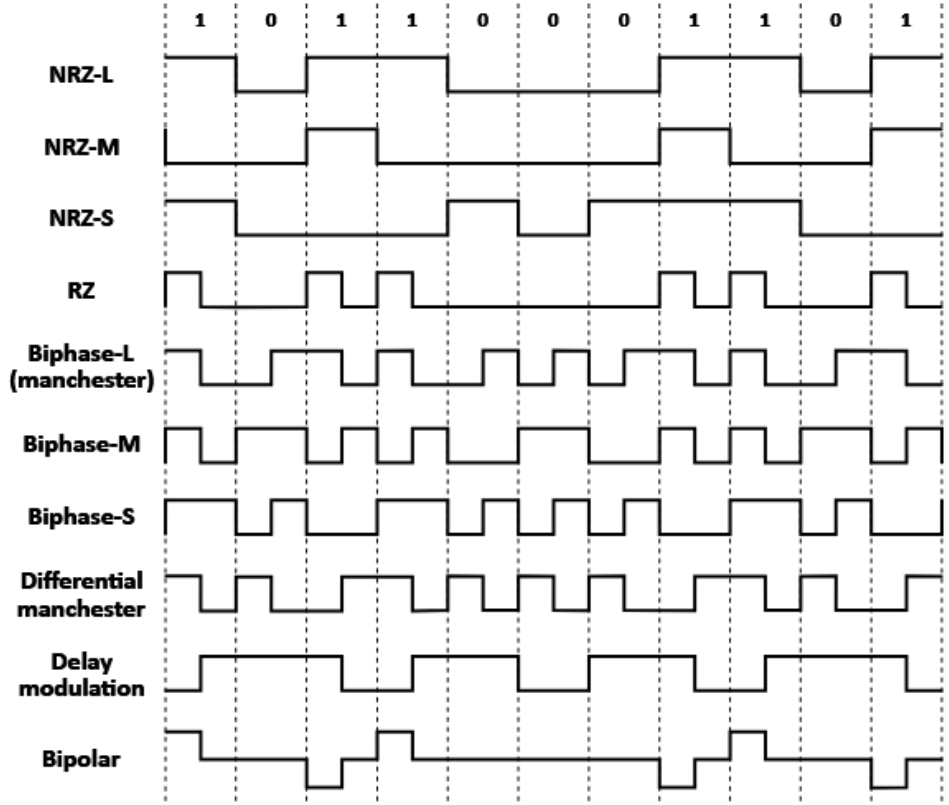
How do we know from electricity if the coming bit is a 0 or a 1?

Data Encoding Techniques



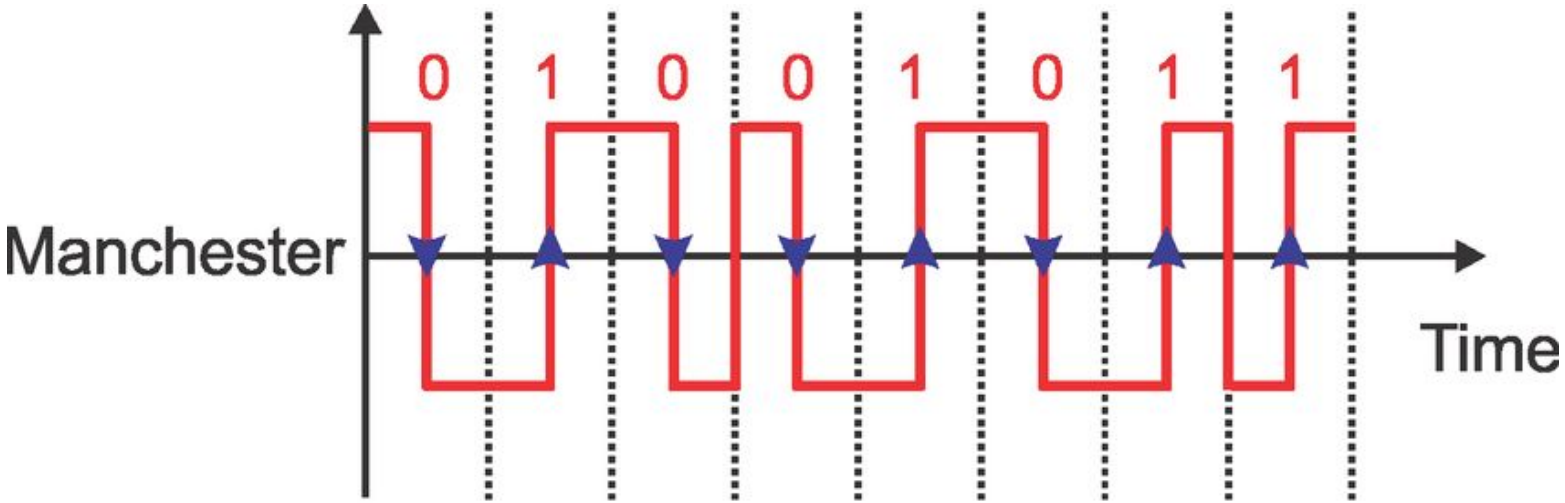
Encoding	Key idea	Where used
NRZ	High/low voltage per bit	Early serial comms
NRZI	Flip voltage on 1	USB 1.0, older Ethernet
Manchester	Transition in middle of bit	10BASE-T Ethernet
4B/5B	Map 4 bits to 5 bits	100BASE-TX Ethernet
8B/10B	Map 8 bits to 10 bits	Gigabit Ethernet, Fibre Channel
PAM	Multi-level voltage signaling	100G Ethernet, 400G Ethernet
QAM	Amplitude + Phase modulation	Wi-Fi, cable internet

Data Encoding Techniques



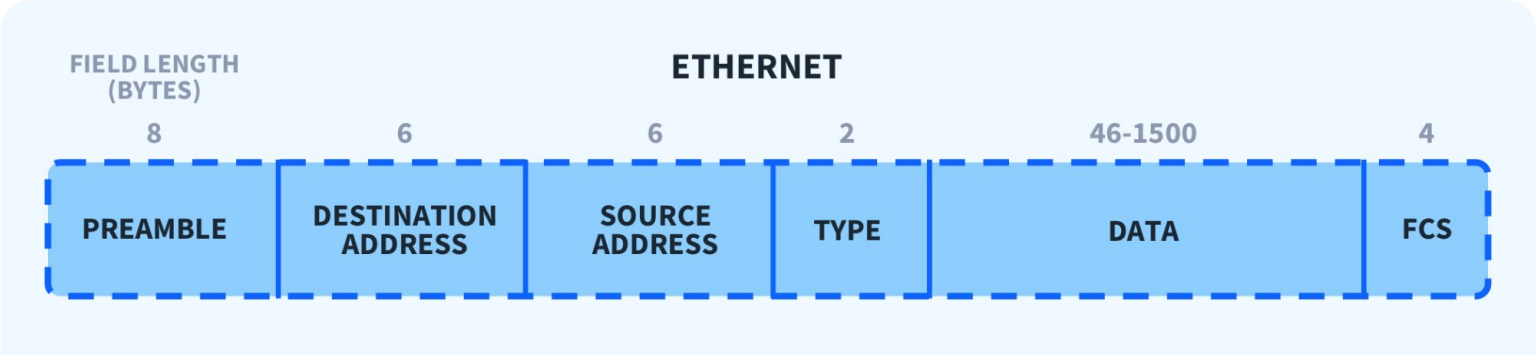
Ethernet

Ethernet Encoding



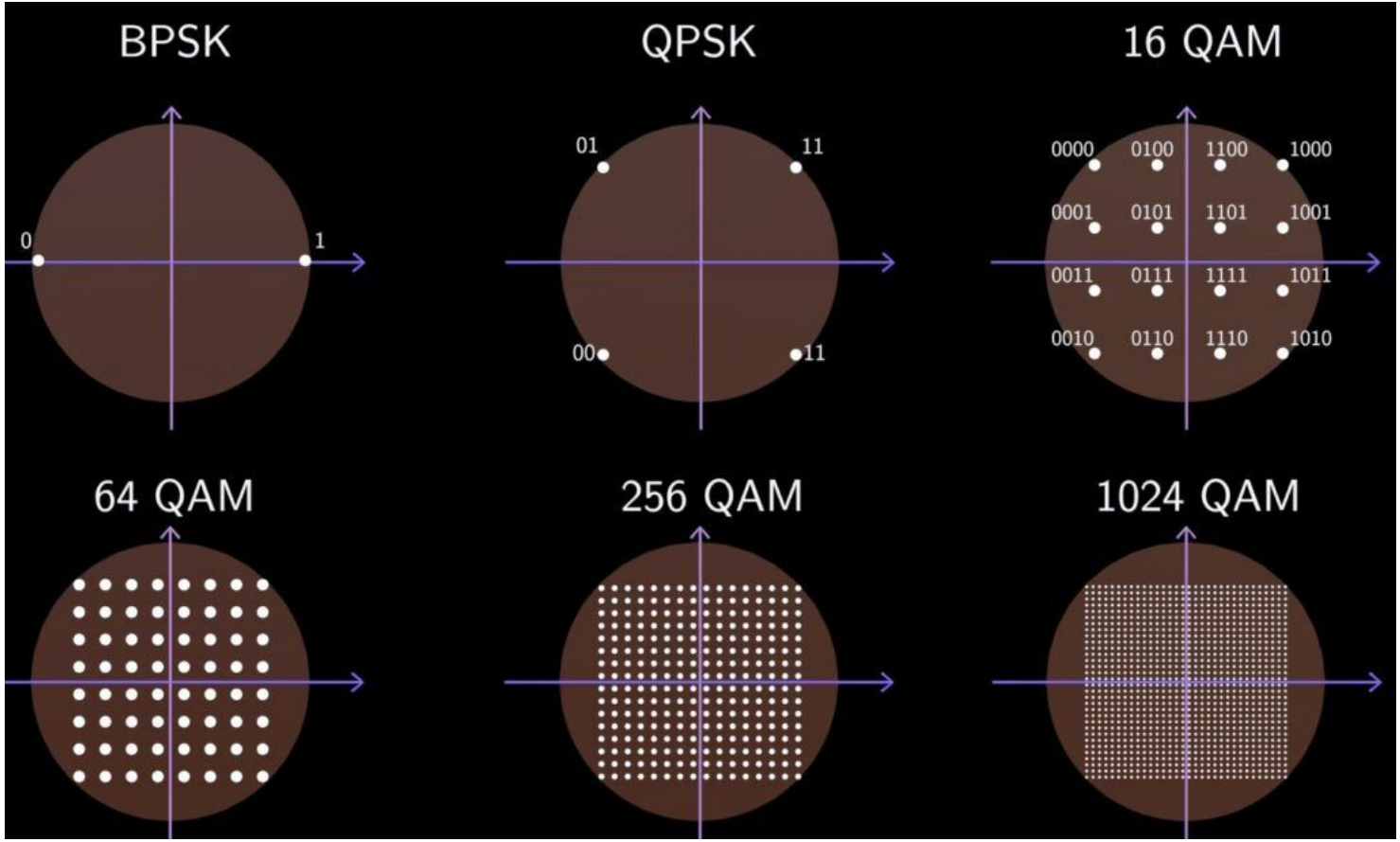
But what does those 1s and 0s really mean? They’re just 1s and 0s in the end..

Ethernet Frame



Wireless communication

Using QAM

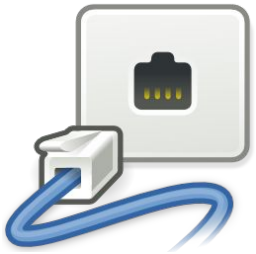

BPSK
0
1
QPSK
01
11
00
11
16 QAM
0000
0100
1100
1000
0001
0101
1101
1001
0011
0111
1111
1011
0010
0110
1110
1010
64 QAM
256 QAM
1024 QAM

02

Expanding Our Network

Models, Routers and the Internet

Access Network Types



Wired

DSL
Ethernet
Fiber (FTTH)

Wireless

Wi-Fi
Cellular

When trying to scale our network, we run into two main problems...

Problem 1: No Standards

Imagine everyone doing their own LAN, using their own protocols and data transmission media standards.

Then imagine trying to connect them together.

Problem 1: No Standards

Solution:

Agree on a universal standard to allow communication on a bigger scale.

These standards is what enables you to connect to Wi-Fi or cellular anywhere with ease.

Problem 2: Circuit Switching Is Inefficient

Our current setup, which uses a dedicated line for every connection, is inefficient at a large scale.

Networking Models

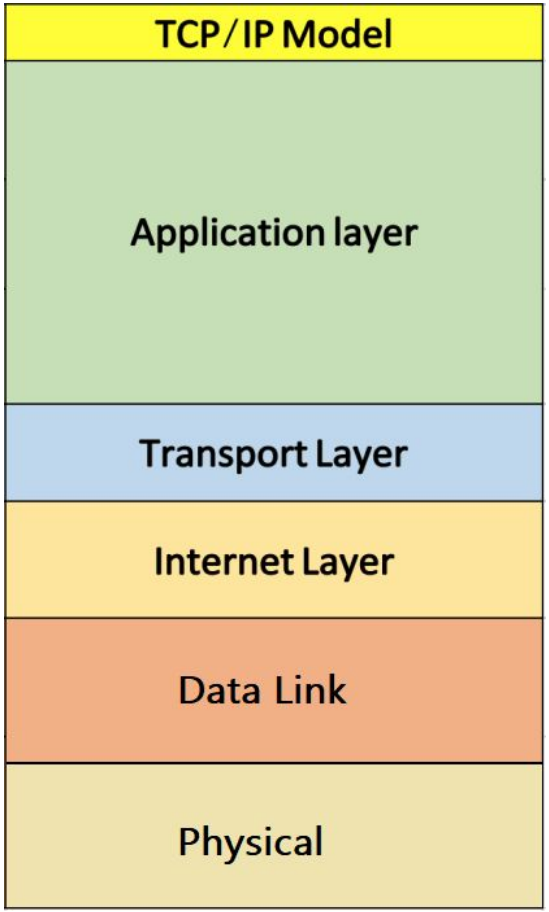
TCP/IP vs OSI

Why do we have two different models?

How are they related, and how are they different?

TCP/IP Model

The model is based on what was practically needed and built.



TCP/IP vs OSI

<table>
<tr><th>OSI Model</th><th>TCP/IP Model</th></tr>
<tr><td>Application Layer</td><td rowspan="3">Application layer</td></tr>
<tr><td>Presentation Layer</td></tr>
<tr><td>Session Layer</td></tr>
<tr><td>Transport Layer</td><td>Transport Layer</td></tr>
<tr><td>Network Layer</td><td>Internet Layer</td></tr>
<tr><td>Data link layer</td><td rowspan="2">Network Access</td></tr>
<tr><td>Physical layer</td></tr>
</table>

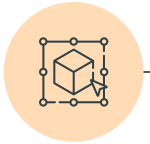
TCP/IP Model

Layer	Some Protocols
Application Layer	DNS, HTTP, FTP, SMTP, DHCP
Transport Layer	TCP, UDP
Internet Layer	IP, ICPM, ARP
Network Access Layer	Ethernet

For a WAN, switches are no longer enough.
We need other devices called **Routers**.

What is a Router?

Switching Techniques



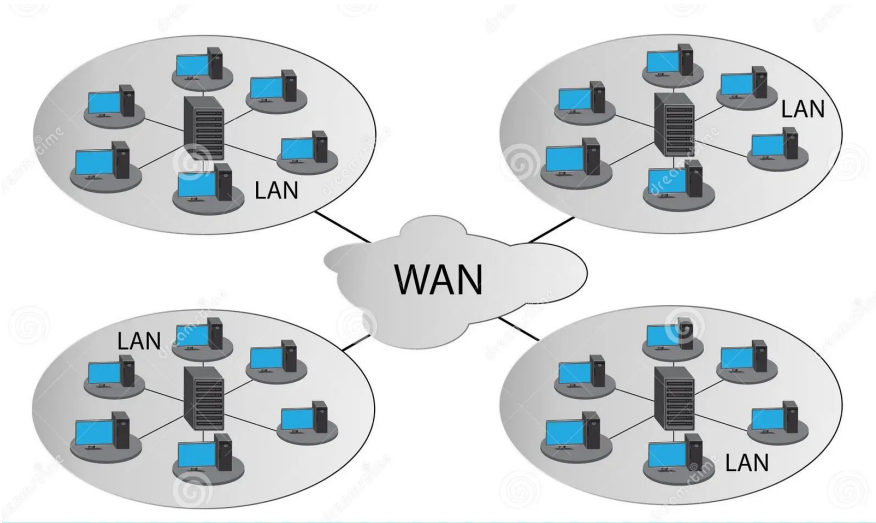
Circuit Switching

Message Switching

Packet Switching

WAN (Wide Area Networks)

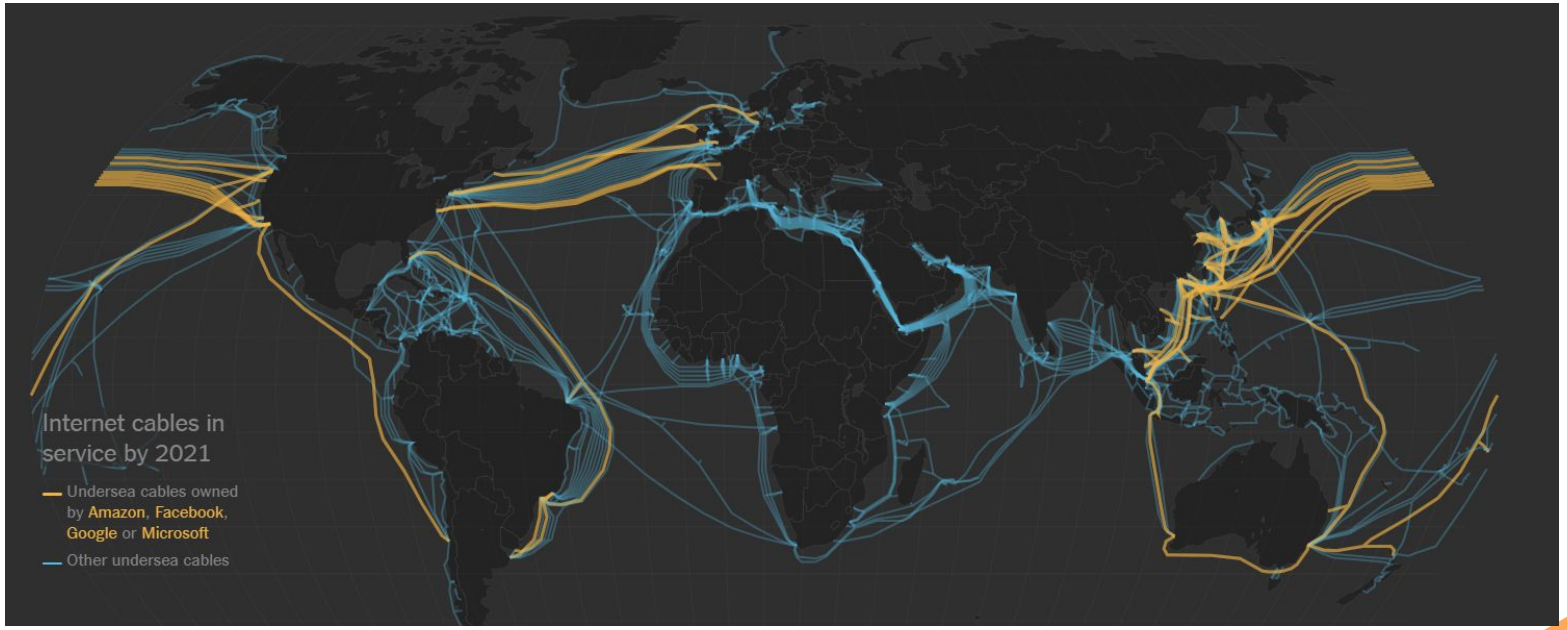
and here we go (this is the **internet**)



The Internet

A Network of Networks

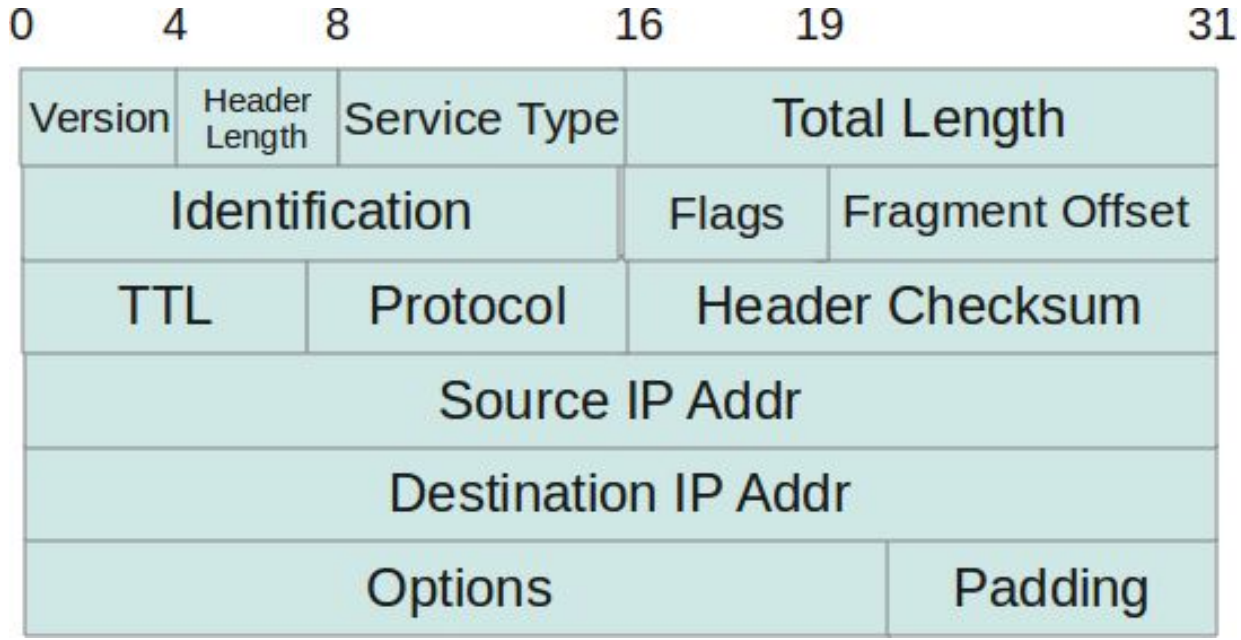
How could a packet get from one point to another through this whole network?!



ISP (Internet Service Provider)

IP (Internet Protocol)

IP Header Format



IP vs MAC Addresses

A helpful analogy:

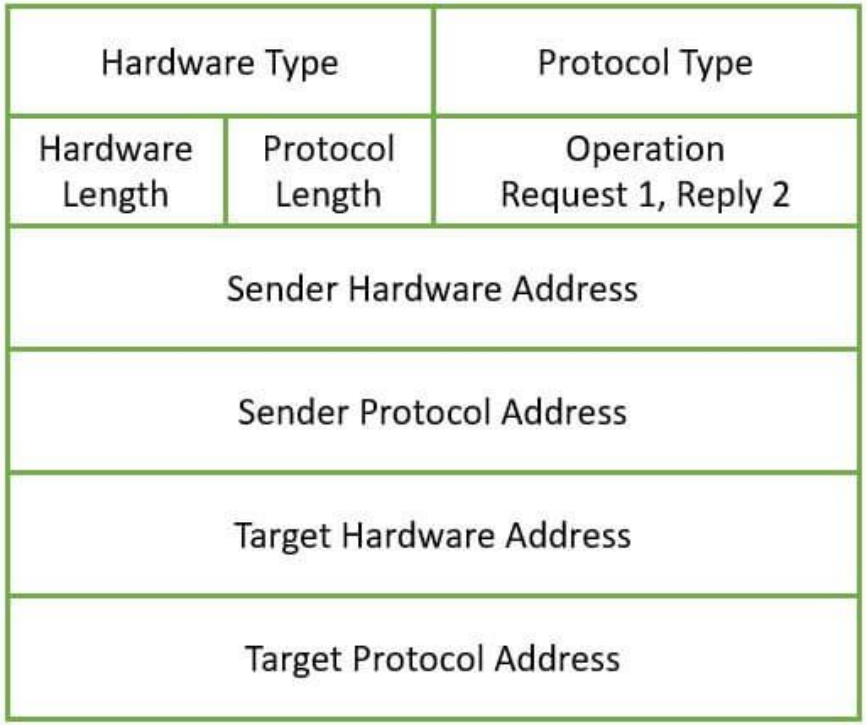
MAC: Your SSN

IP = your home address

ARP

Address Resolution Protocol

Maps IP to Mac address



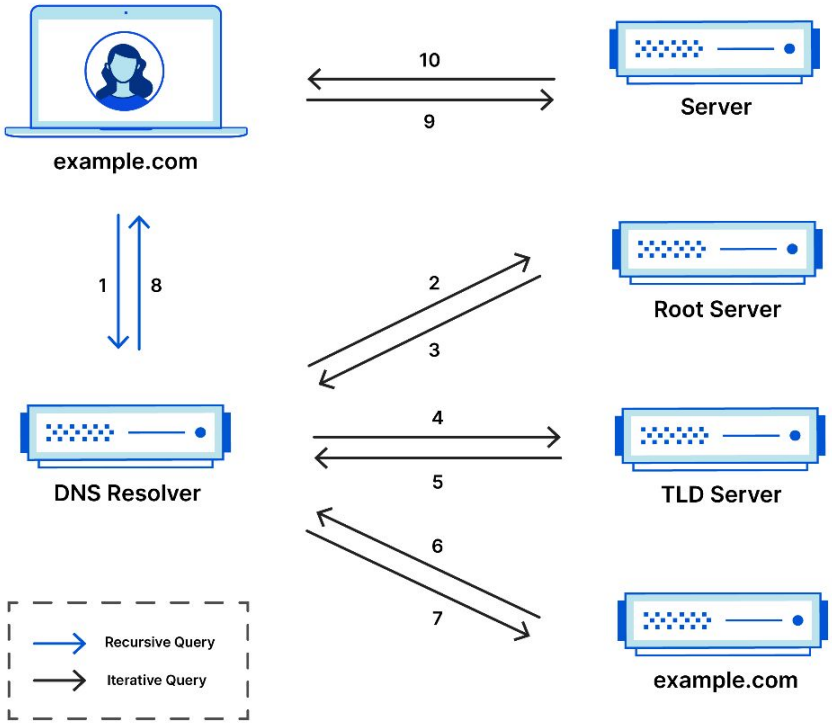
ARP Packet Format

IP addresses are difficult to remember, so using them to connect to servers is inconvenient.

This is why we often use **domain names** instead.

URL Structure

DNS Lookup

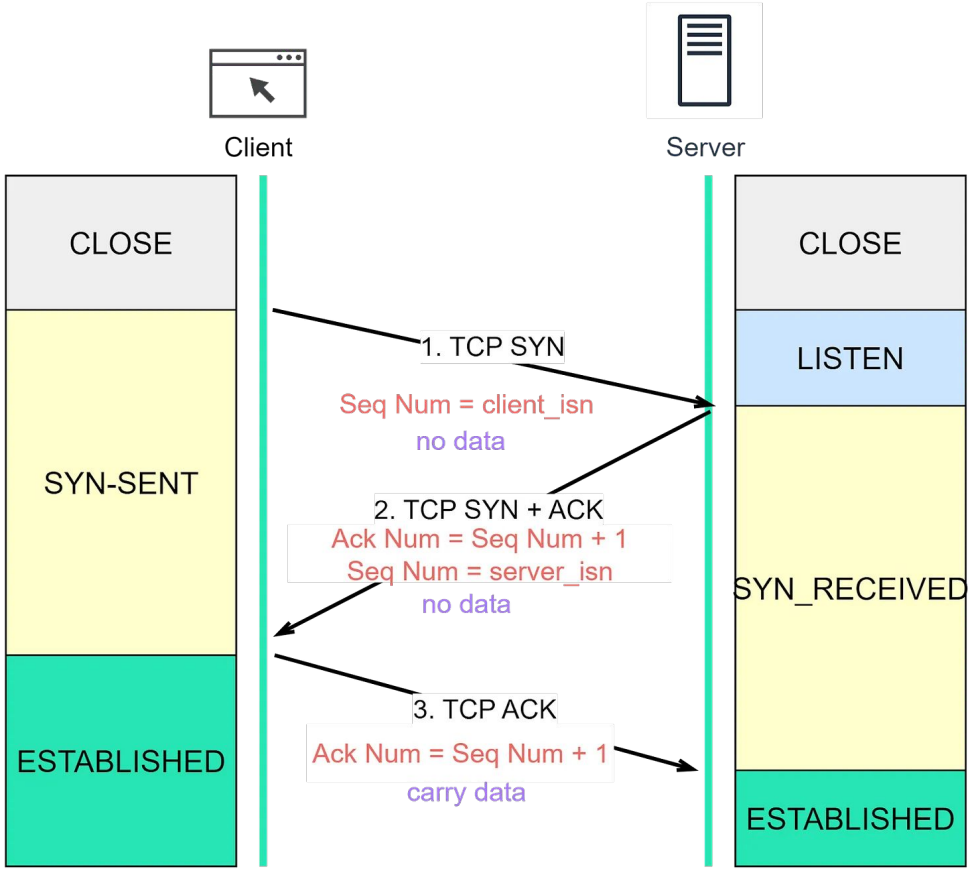

example.com
10
9
Server
1
8
2
3
Root Server
DNS Resolver
4
5
TLD Server
6
7
example.com
Recursive Query
Iterative Query

Transport Layer Protocols

TCP

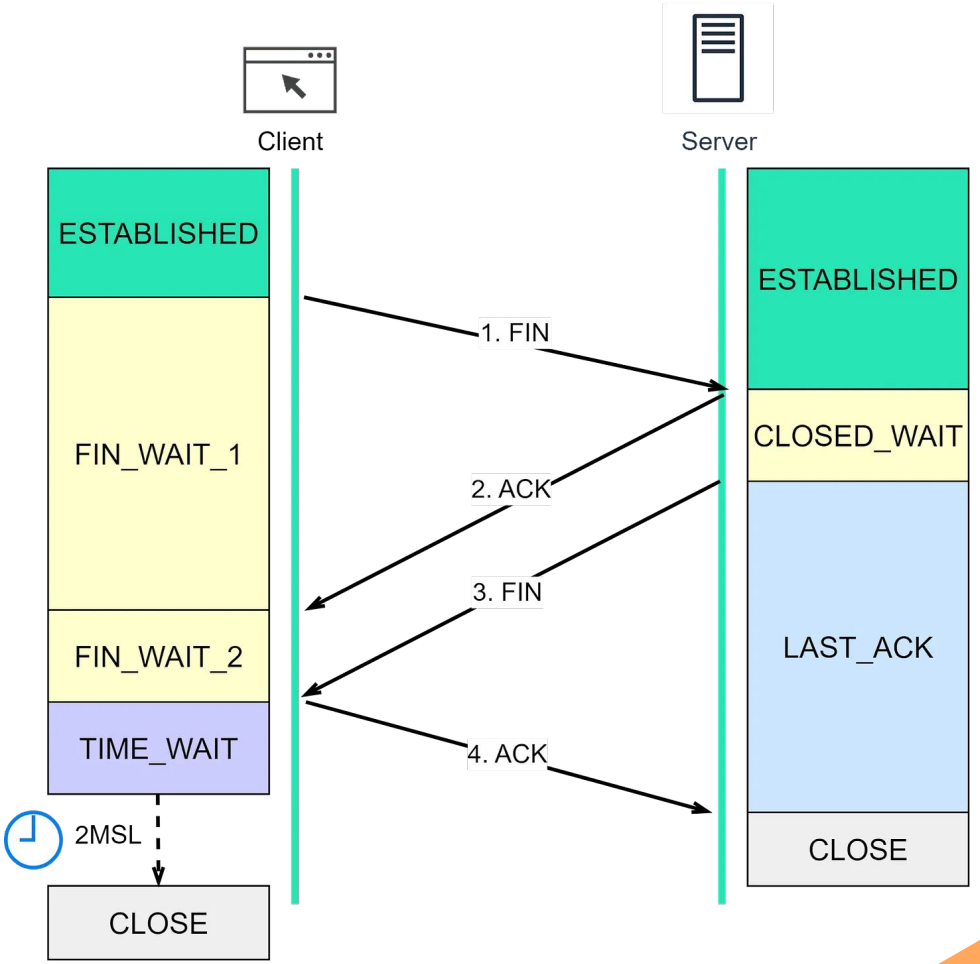
Transmission Control Protocol

Connection-oriented protocol



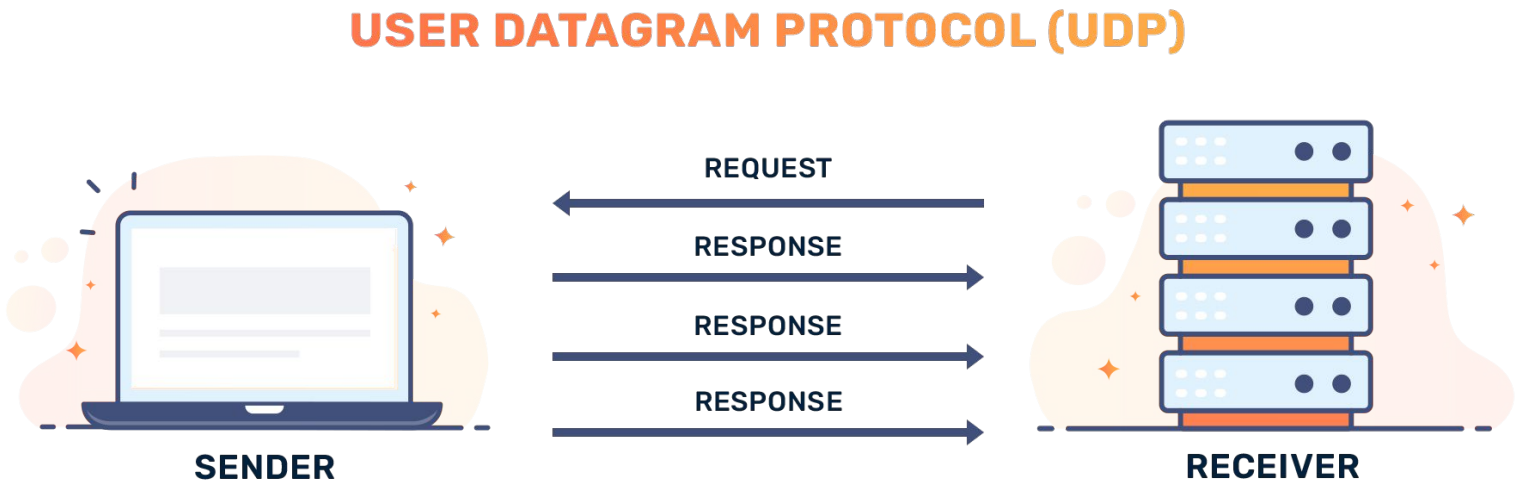
TCP

Closing TCP connection



UDP

Connectionless protocol



TCP vs UDP

Streaming a live sports game?	**UDP**
Downloading a document?	**TCP**
Having an online meeting?	**UDP**
Playing an online game?	**UDP**
Sending a message to a friend?	**TCP**

TCP vs UDP

Comparison maybe, table or bullet points

We could have a quiz about different applications and what protocol could be suited for each

Eg streaming a live sports game, uploading a file online, etc

Let’s Recap

Switch vs Router?

TCP/IP and OSI model

IP Protocol?

MAC vs IP address?

ARP?

TCP vs UDP?

DNS?

Congratulations

You now understand networking a little bit better, hopefully!

Session Task

Find the quiz link in the material repo.

Thank You!