



Networking: A Broad Overview

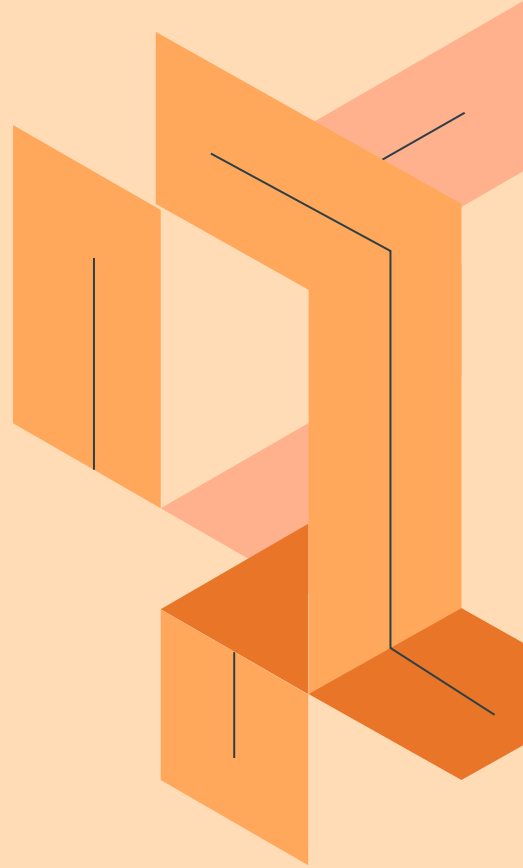
Linux Session 12

Mohannad Mahmoud

01

What even is Networking?

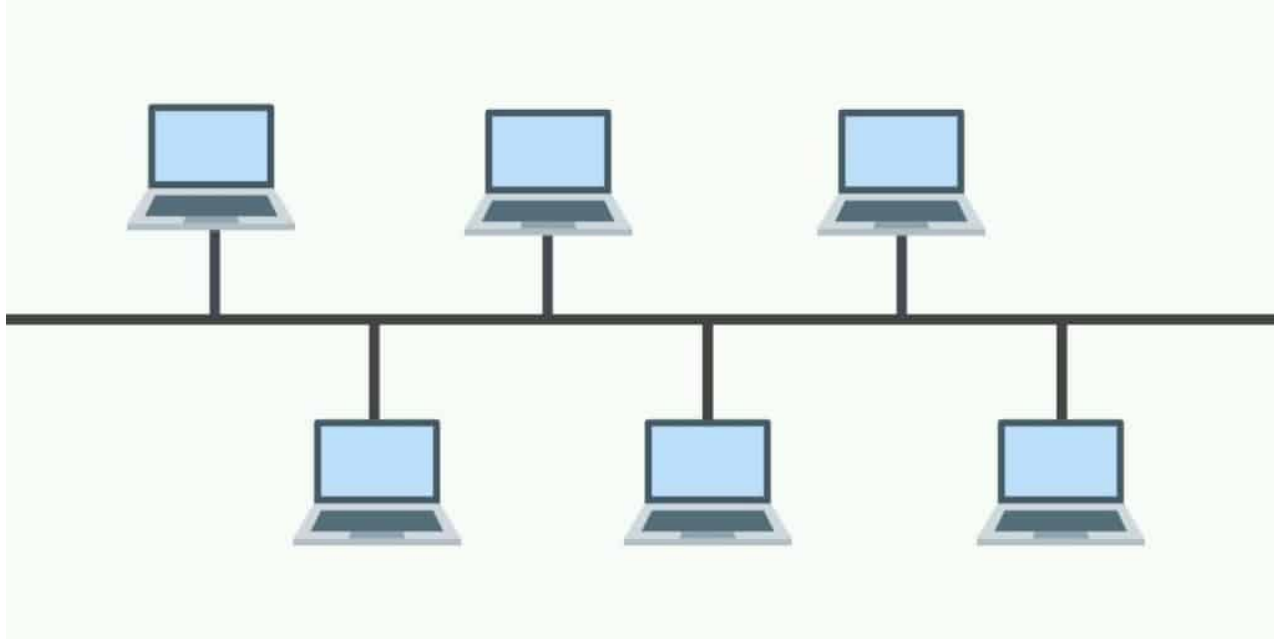
Introduction to networking basics



Point-to-Point Topology

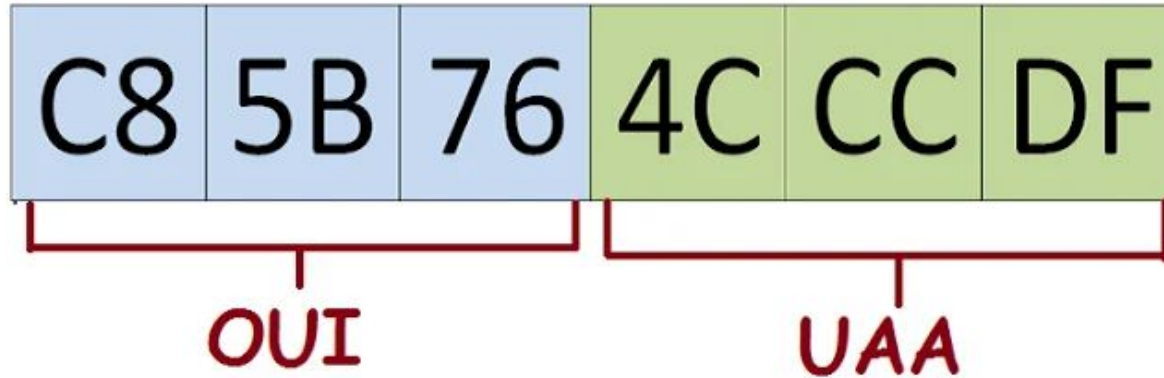


Broadcast Topology

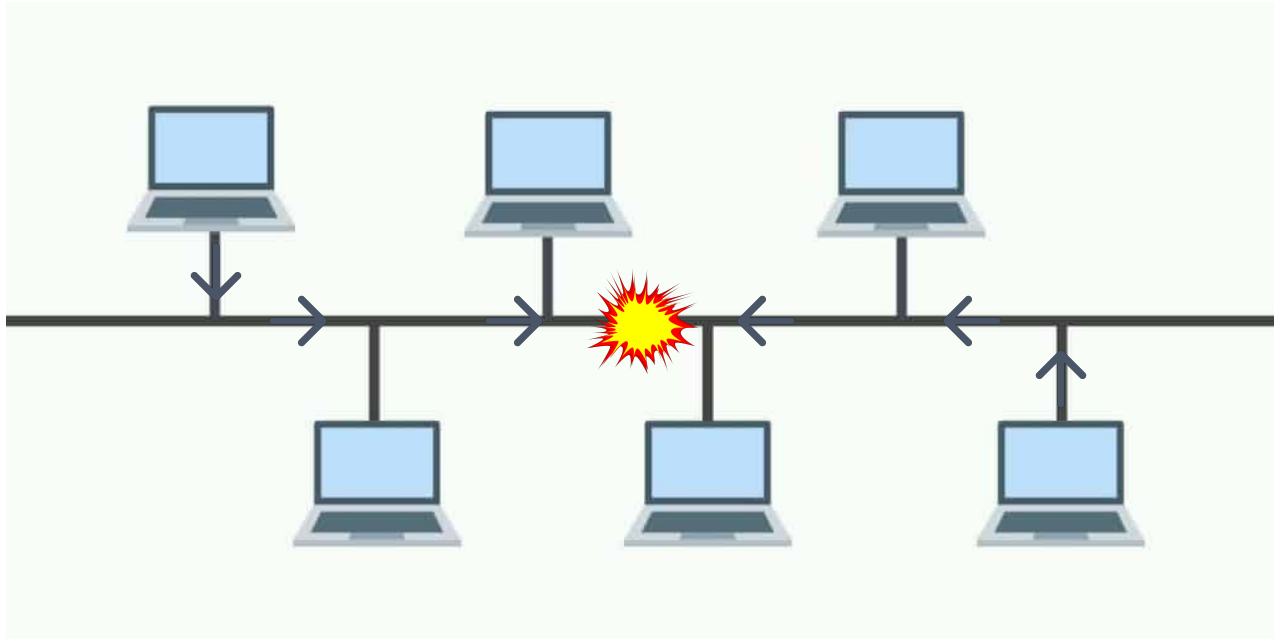


MAC Address

MAC Address
(Media Access Control) Address



Collision!



CSMA/CD

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



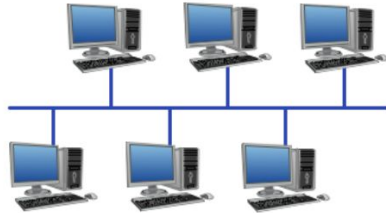
What is a Switch?



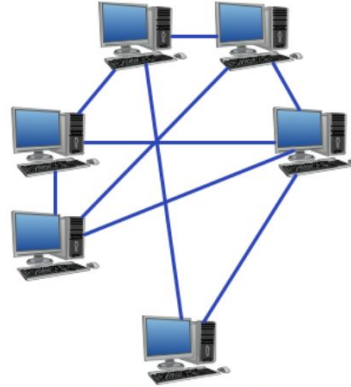
Network Topologies



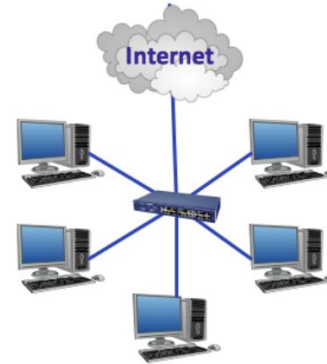
Fully Connected Network
Topology



Common Bus
Topology



Mesh Network
Topology

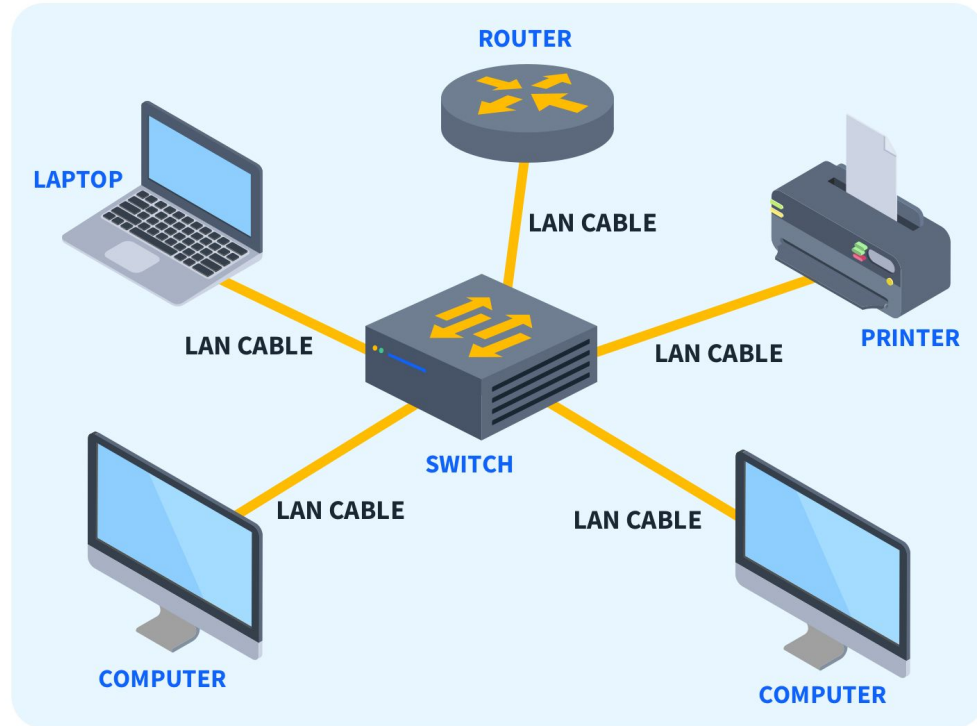


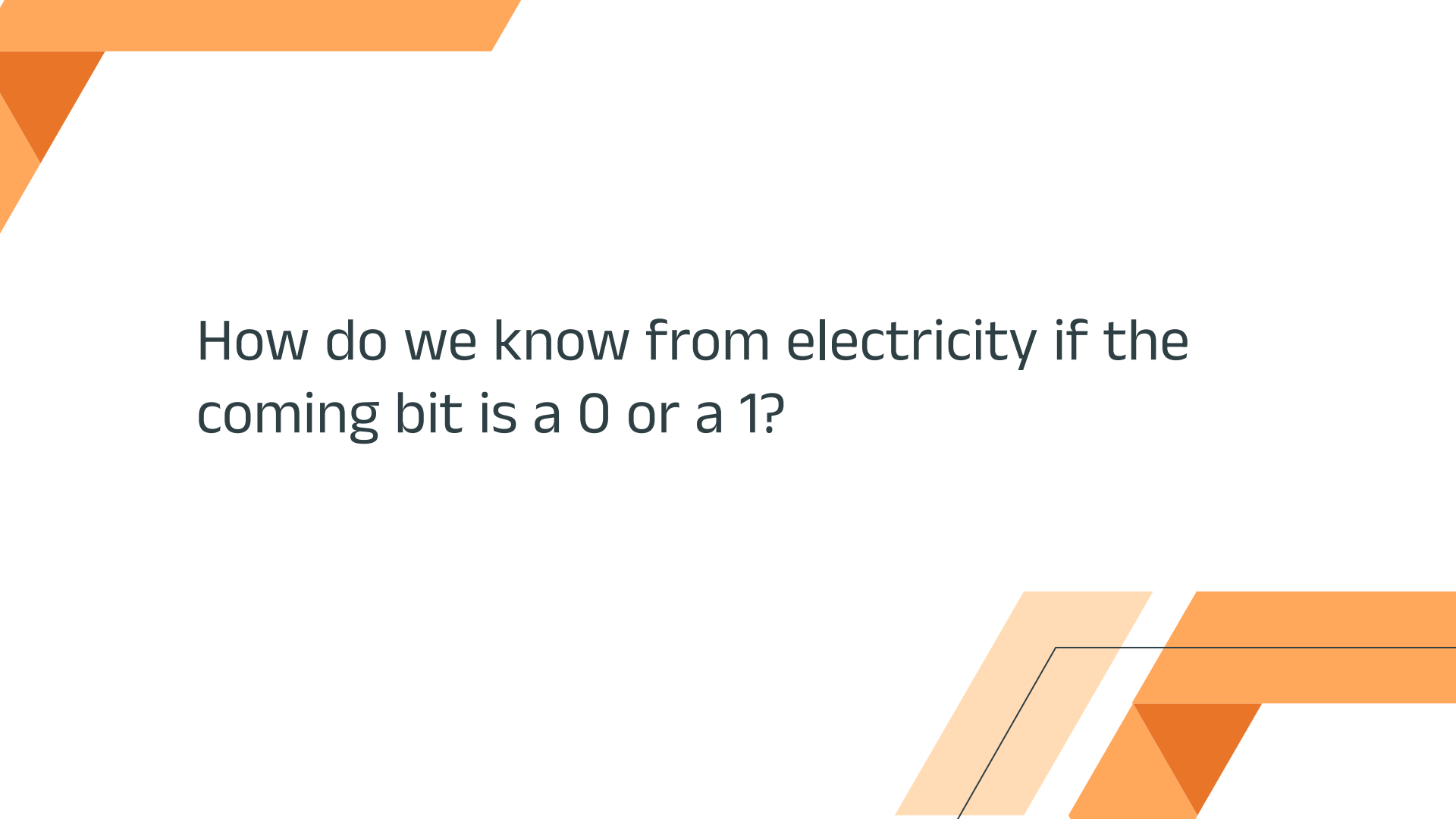
Star Network
Topology



Ring Network
Topology

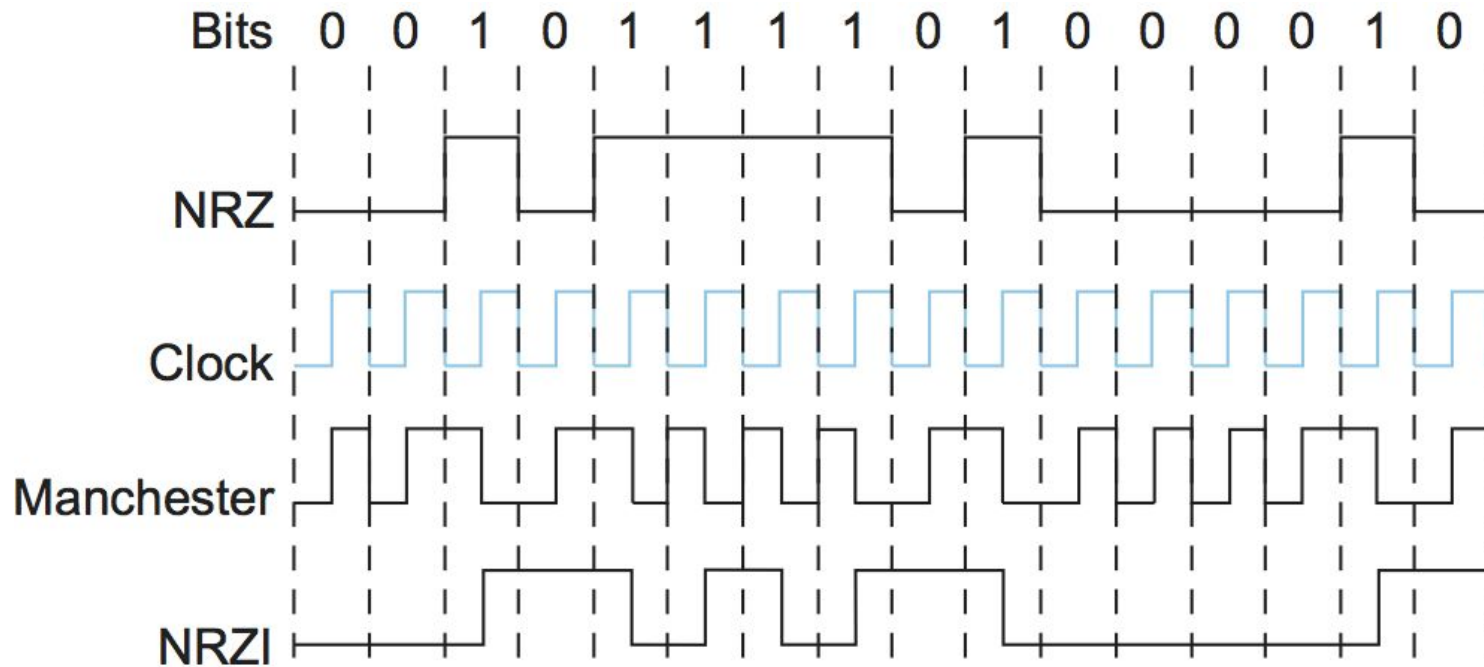
LAN (Local Area Network)





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

Data Encoding Techniques



Encoding

NRZ

NRZI

Manchester

4B/5B

8B/10B

PAM

QAM

Key idea

High/low voltage per bit

Flip voltage on 1

Transition in middle of bit

Map 4 bits to 5 bits

Map 8 bits to 10 bits

Multi-level voltage signaling

Amplitude + Phase modulation

Where used

Early serial comms

USB 1.0, older Ethernet

10BASE-T Ethernet

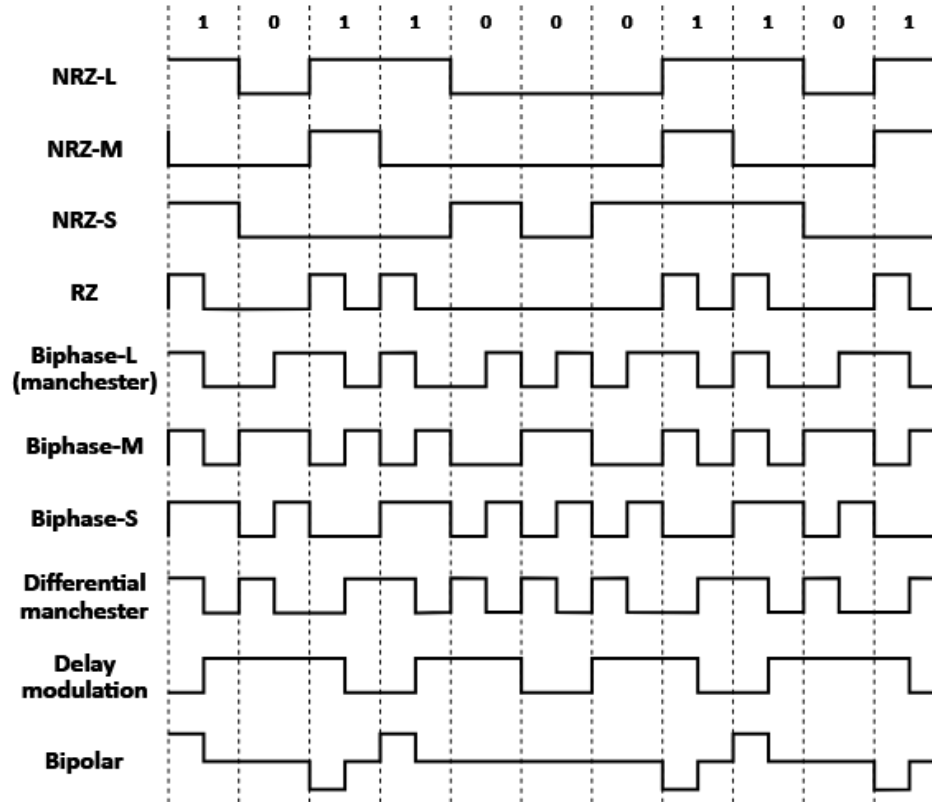
100BASE-TX Ethernet

Gigabit Ethernet, Fibre Channel

100G Ethernet, 400G Ethernet

Wi-Fi, cable internet

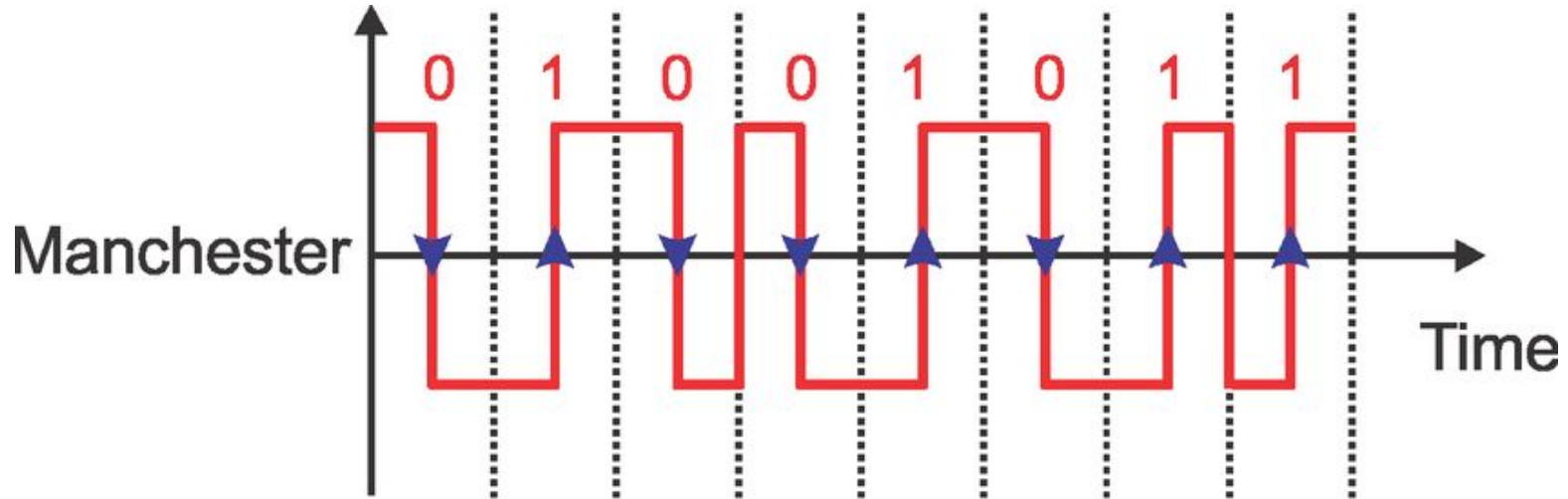
Data Encoding Techniques




The background features abstract, three-dimensional orange geometric shapes, possibly representing folded paper or architectural elements, located in the top-left and bottom-right corners. These shapes are composed of various rectangular and trapezoidal forms in different shades of orange, creating a sense of depth and perspective.


Ethernet

Ethernet Encoding

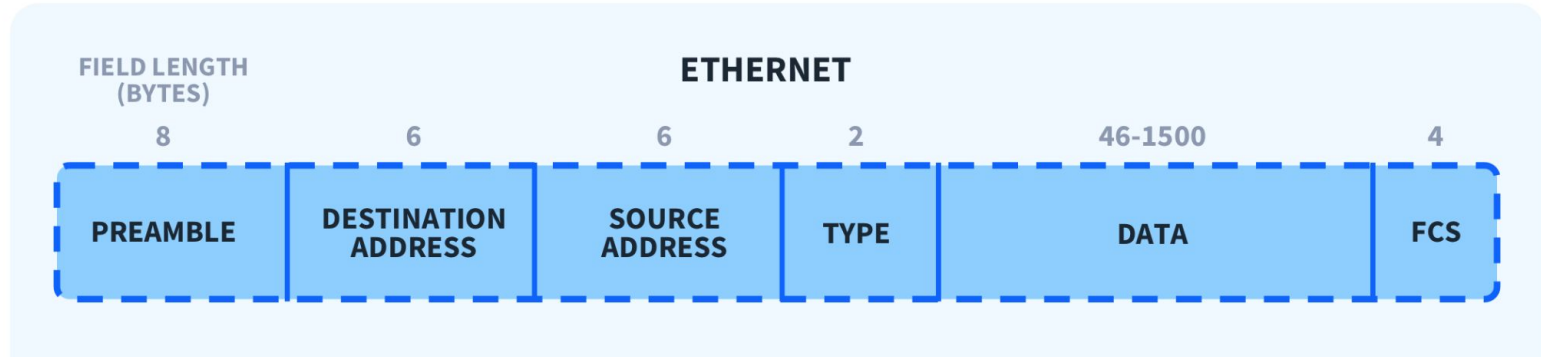




But what does those 1s and 0s really mean? They're just 1s and 0s in the end..



Ethernet Frame

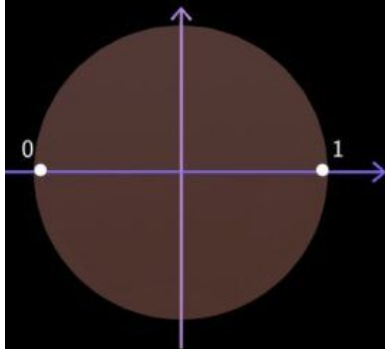


Wireless communication

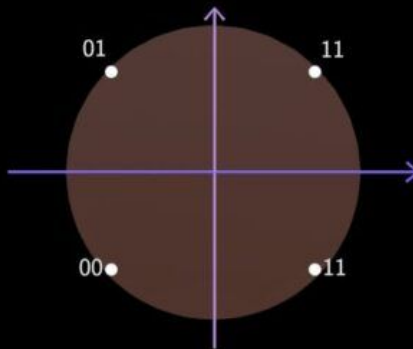
Using QAM



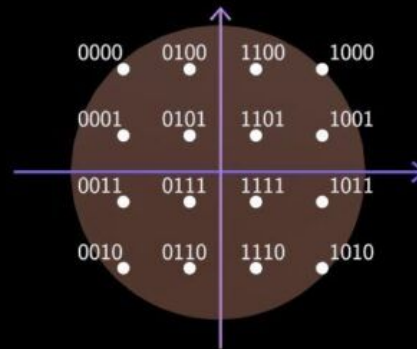
BPSK



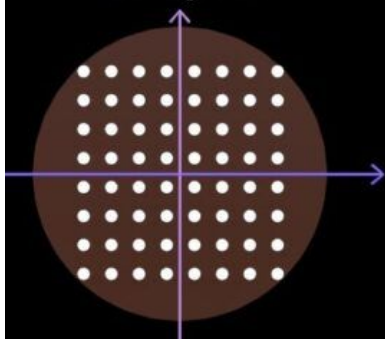
QPSK



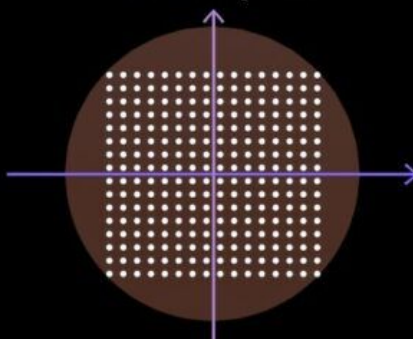
16 QAM



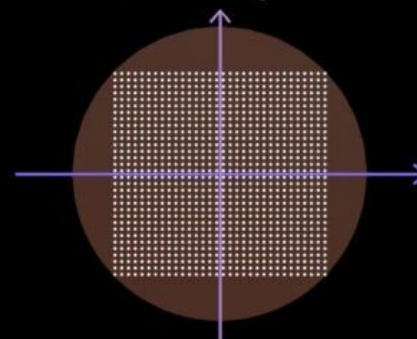
64 QAM



256 QAM



1024 QAM



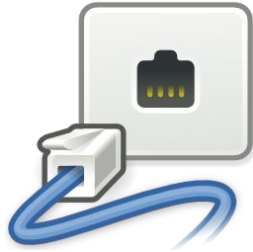
02

Expanding Our Network

Models, Routers and the Internet



Access Network Types



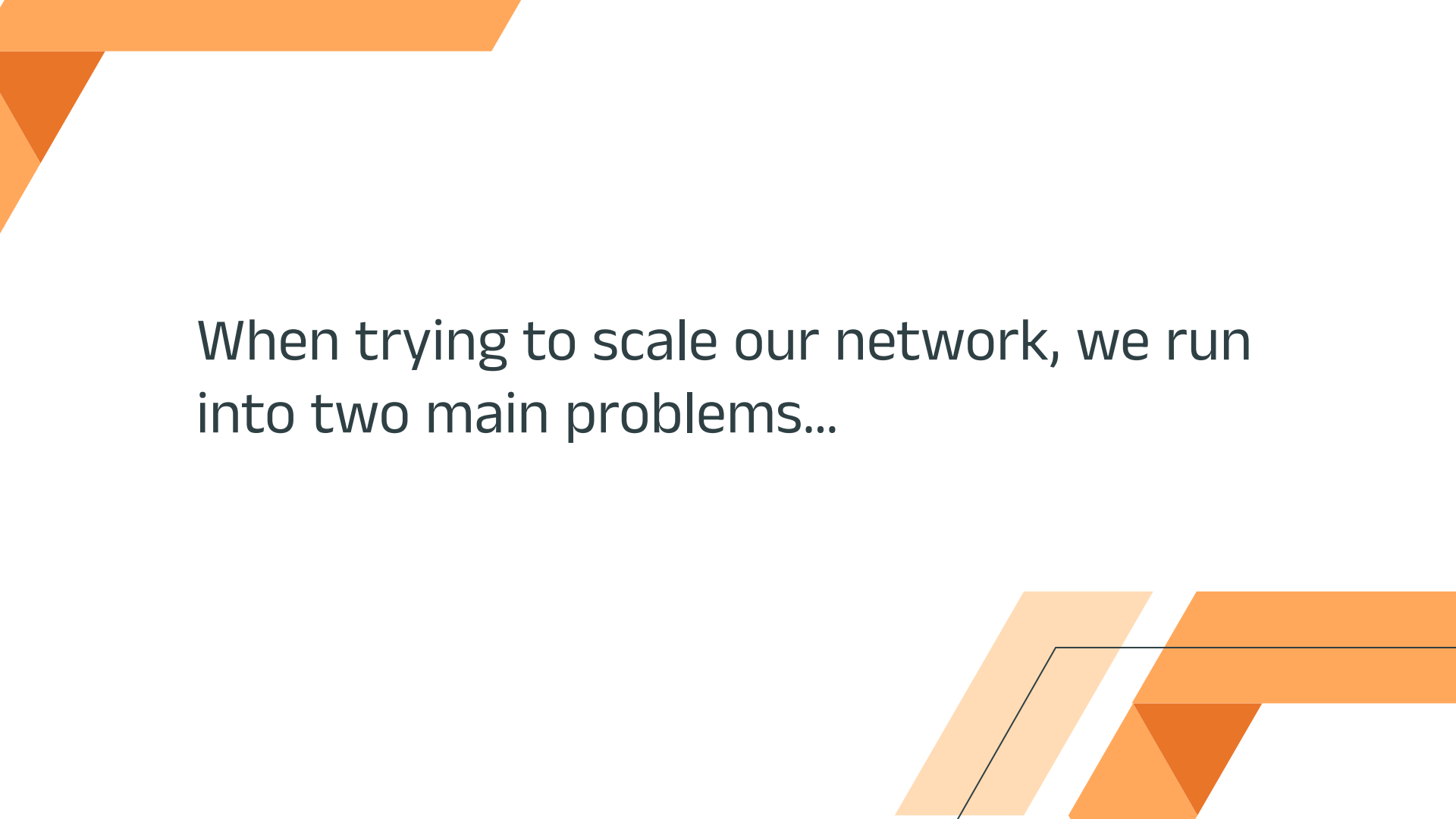
Wired

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.

The background features abstract, 3D-style orange geometric shapes. On the left, there are several L-shaped blocks in different shades of orange, some with thin black outlines. On the right, there are more vertical and horizontal blocks, also in various shades of orange, creating a sense of depth and structure.

Networking Models

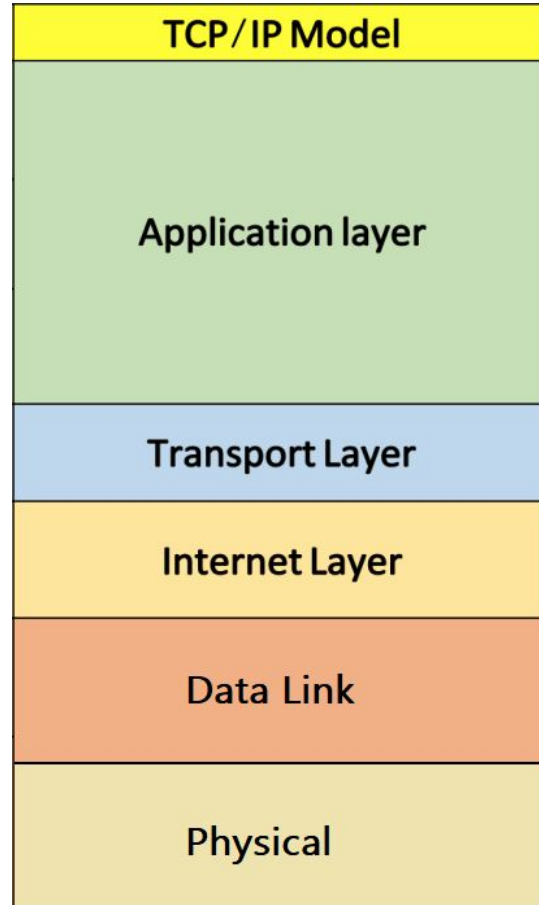
TCP/IP vs OSI

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

OSI Model	TCP/IP Model
Application Layer	Application layer
Presentation Layer	
Session Layer	
Transport Layer	Transport Layer
Network Layer	Internet Layer
Data link layer	Network Access
Physical layer	

TCP/IP Model

Layer	Some Protocols
Application Layer	DNS, HTTP, FTP, SMTP, DHCP
Transport Layer	TCP, UDP
Internet Layer	IP, ICMP, 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



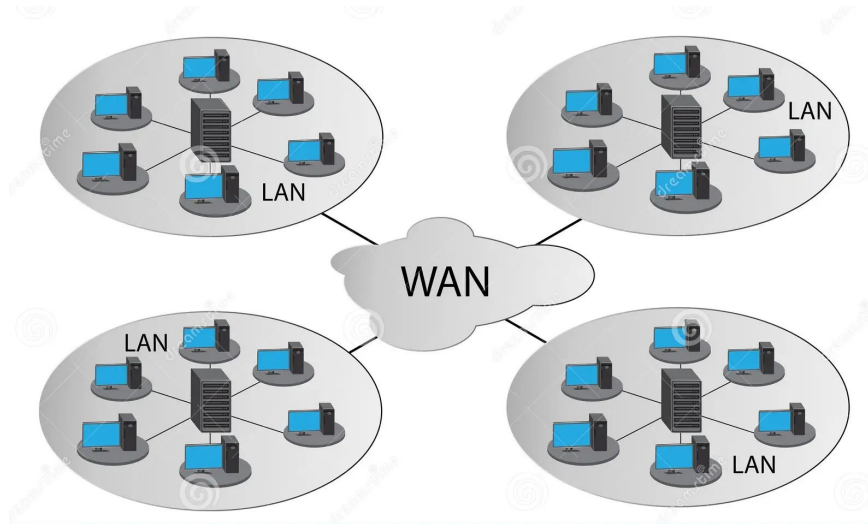
— Message Switching



— Packet Switching

WAN (Wide Area Networks)

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

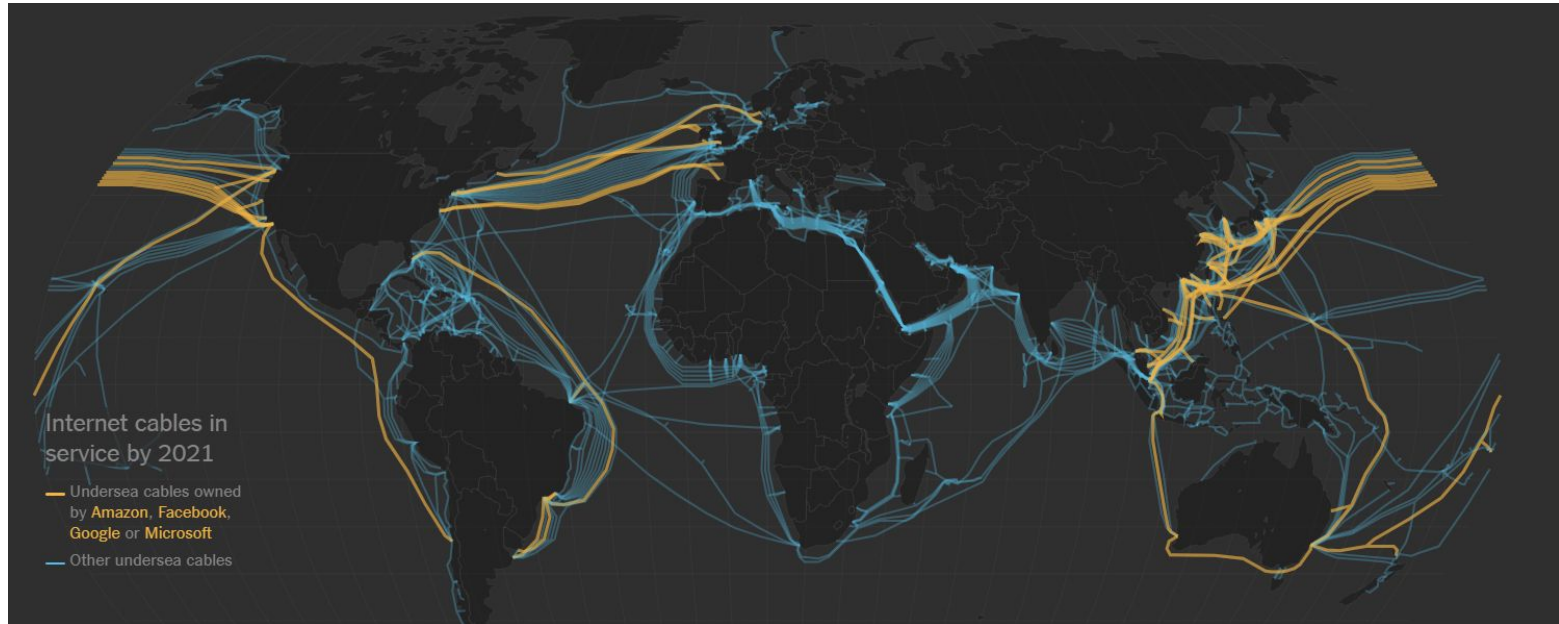




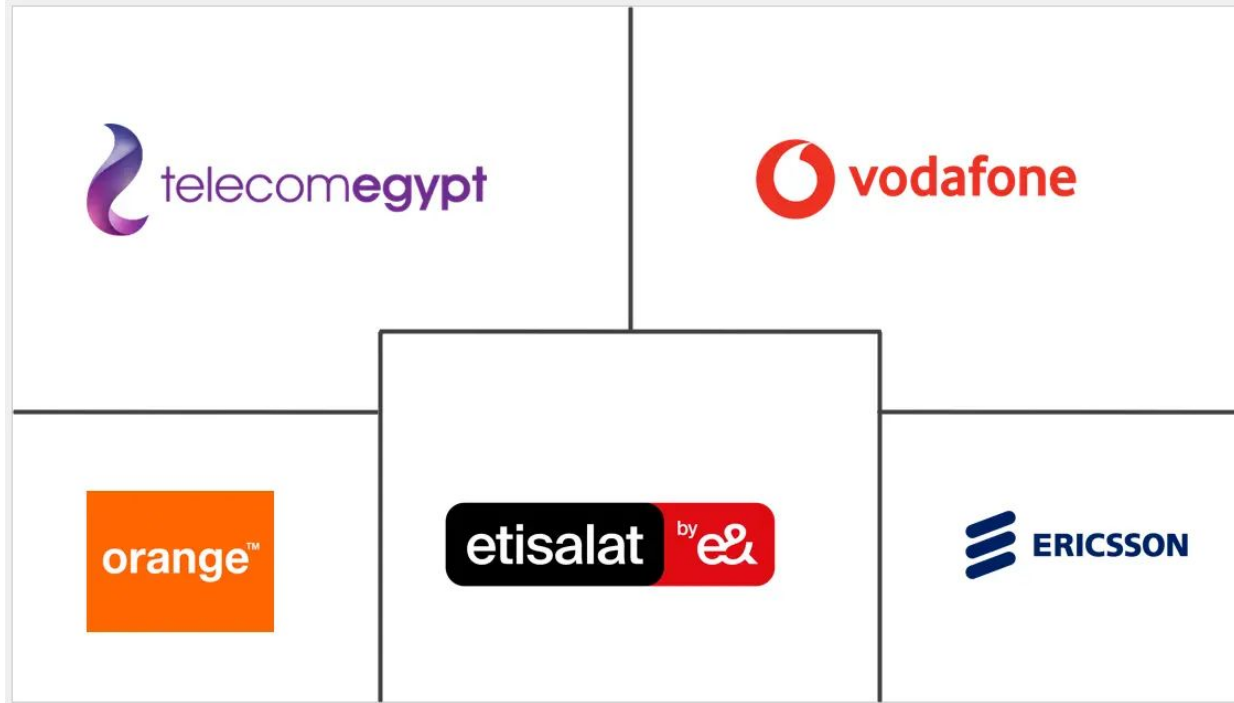
The Internet

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

0	4	8	16	19	31
Version	Header Length	Service Type	Total Length		
Identification			Flags	Fragment Offset	
TTL		Protocol	Header Checksum		
Source IP Addr					
Destination IP Addr					
Options				Padding	

IP vs MAC Addresses

A helpful analogy:



MAC: Your SSN



IP = your home address


ARP

Address Resolution
Protocol

Maps IP to Mac address

Hardware Type		Protocol Type
Hardware Length	Protocol Length	Operation Request 1, Reply 2
Sender Hardware Address		
Sender Protocol Address		
Target Hardware Address		
Target Protocol Address		

ARP Packet Format



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

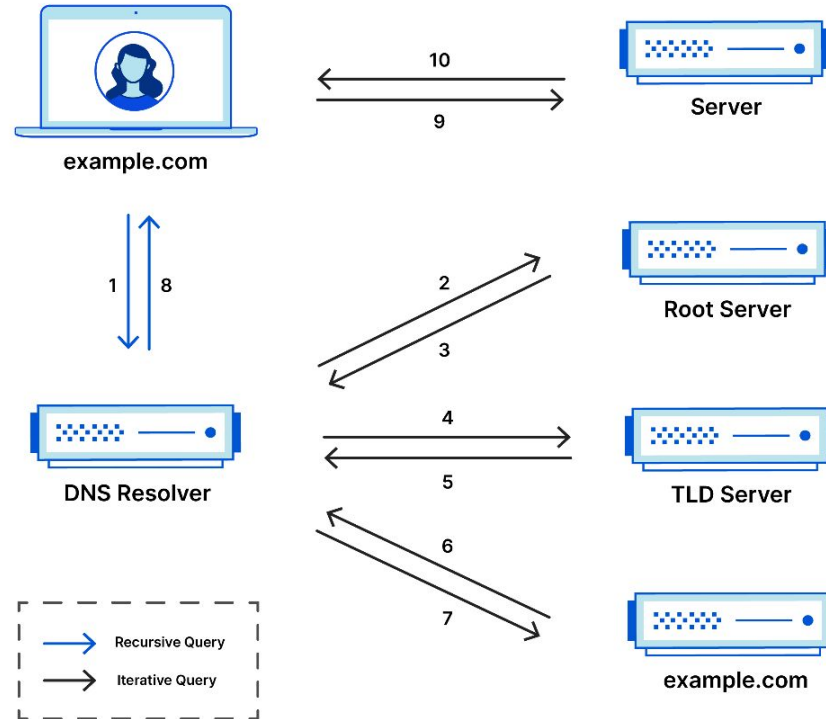
This is why we often use **domain names** instead.



URL Structure



DNS Lookup



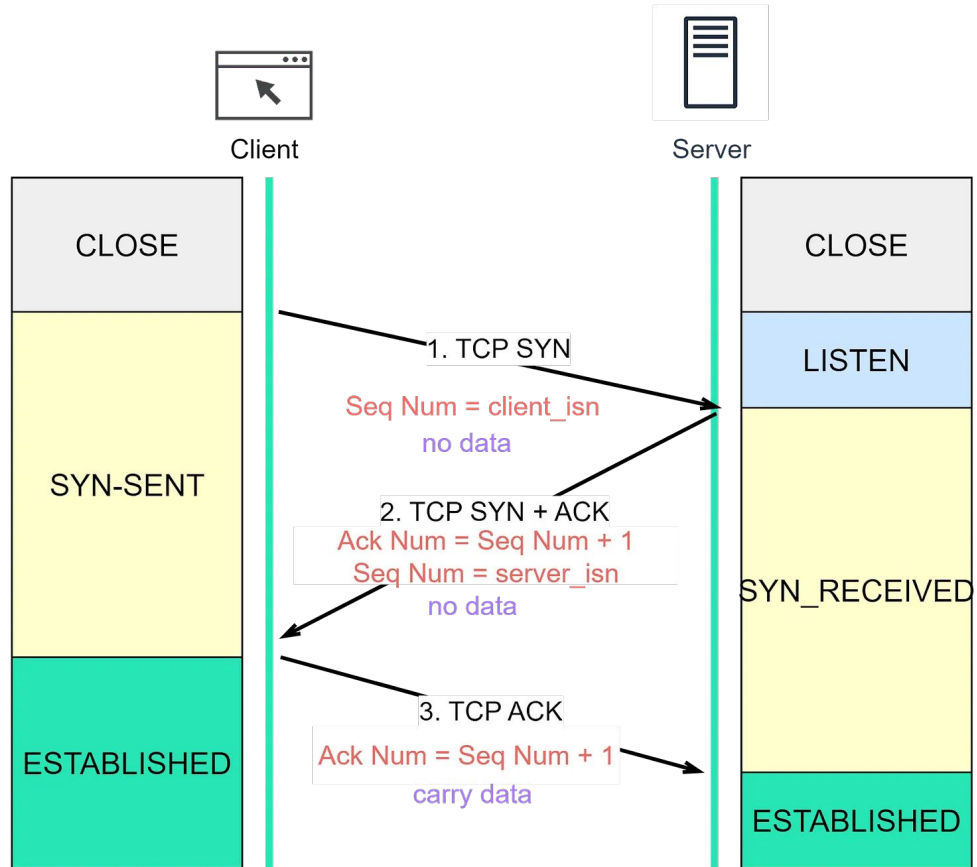
The background features abstract, 3D-style orange geometric shapes on the left and right sides, resembling folded paper or architectural elements. These shapes are in various shades of orange and are positioned to frame the central text.

Transport Layer Protocols

TCP

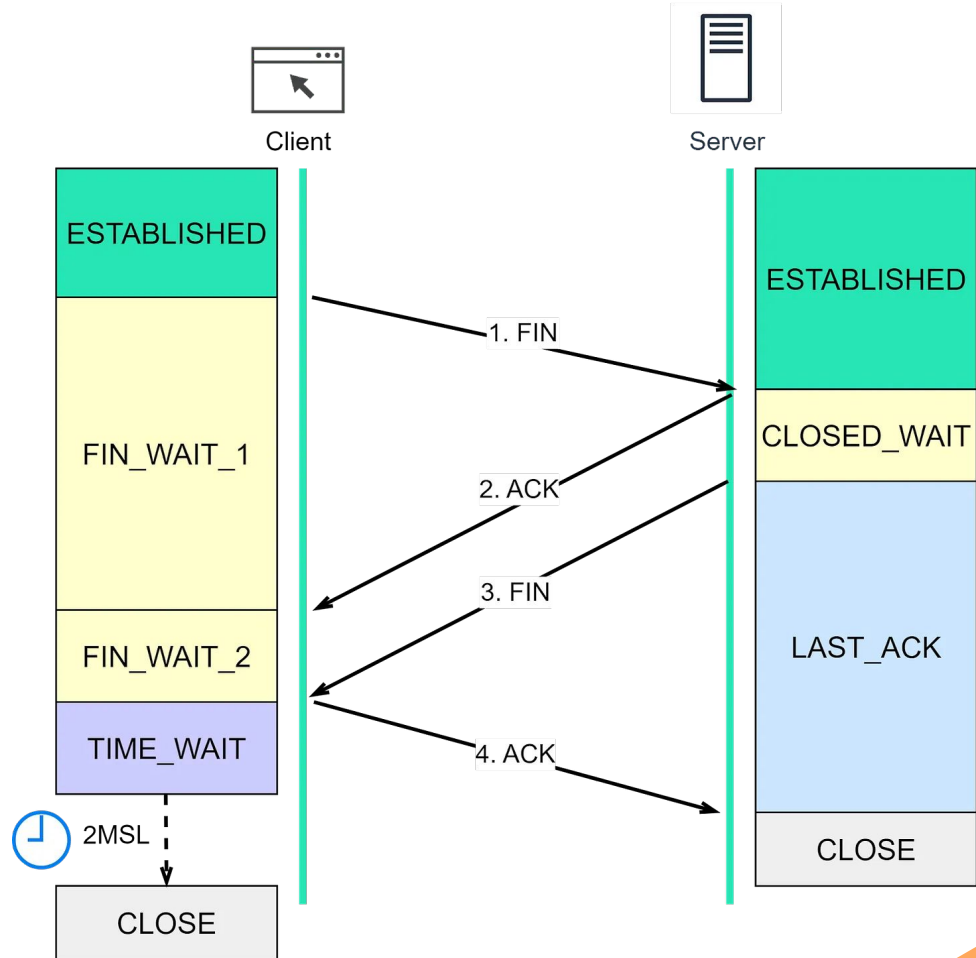
Transmission Control Protocol

Connection-oriented protocol



TCP

Closing TCP connection



UDP

Connectionless protocol

USER DATAGRAM PROTOCOL (UDP)



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



The image features abstract, 3D-style orange geometric shapes in the top-left and bottom-right corners. These shapes are composed of various rectangular blocks and lines, creating a modern, architectural feel. The central text is bold and dark blue, standing out against the light gray background.

Switch vs Router?

The background features abstract, 3D-style orange geometric shapes, primarily L-shaped blocks, arranged in a corner-like pattern on the left and right sides of the slide. The shapes are in various shades of orange and are oriented to create a sense of depth and perspective.

TCP/IP and OSI model

The image features abstract orange geometric shapes in the corners, resembling stylized architectural elements or frames. These shapes are composed of various shades of orange and are arranged in a way that suggests depth and perspective. The central text is a large, bold, dark blue question.

IP Protocol?

The background features abstract, 3D-style orange geometric shapes on the left and right sides, resembling folded paper or architectural elements. These shapes are in various shades of orange and are positioned to frame the central text.

MAC vs IP address?

The image features abstract, 3D-style geometric shapes in shades of orange and light orange, positioned in the top-left and bottom-right corners. These shapes resemble folded paper or architectural elements, creating a modern, minimalist frame around the central text.

ARP?

The background features abstract, 3D-style orange geometric shapes on the left and right sides, resembling stylized architectural elements or data structures. These shapes are composed of various rectangular and trapezoidal blocks in different shades of orange, creating a modern, tech-oriented aesthetic.

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!**

