How Networks Talk: A Deep Dive into TCP, ARP, and DHCP

Understanding the handshakes and conversations that power the internet.

Setting the Stage 🎬

TCP

For reliable connections between devices, ensuring data arrives intact and in order.

DHCP

For automatically getting an IP address when joining a network.

ARP

For finding physical devices on the local network using their IP addresses.

TCP/IP is the fundamental rulebook for internet communication. Before any data can be sent, devices must first introduce themselves and get the right address.

Guaranteed Delivery 📦

What is TCP?

TCP (Transmission Control Protocol) is a connection-oriented protocol. Its job is to ensure data arrives in order and without errors.

It's like sending a registered letter. You get confirmation that it was sent, and the recipient confirms they received it.

The Digital Handshake 🤝

SYN

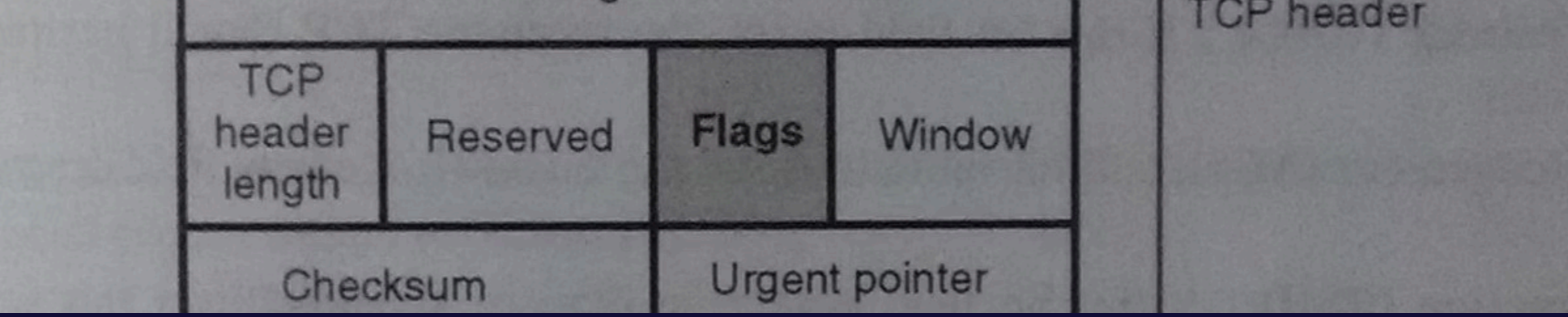
The client says, "Hello, I'd like to connect." (Synchronize)

SYN-ACK

The server replies, "Hello! I acknowledge your request and am ready." (Synchronize-Acknowledge)

ACK

The client says, "Great! I acknowledge your reply. Let's talk." (Acknowledge)



The Anatomy of a TCP Segment

Source & Destination Port

The "door numbers" for the applications talking.

Sequence Number

Keeps track of the data order.

Acknowledgement Number

Confirms which data has been received.

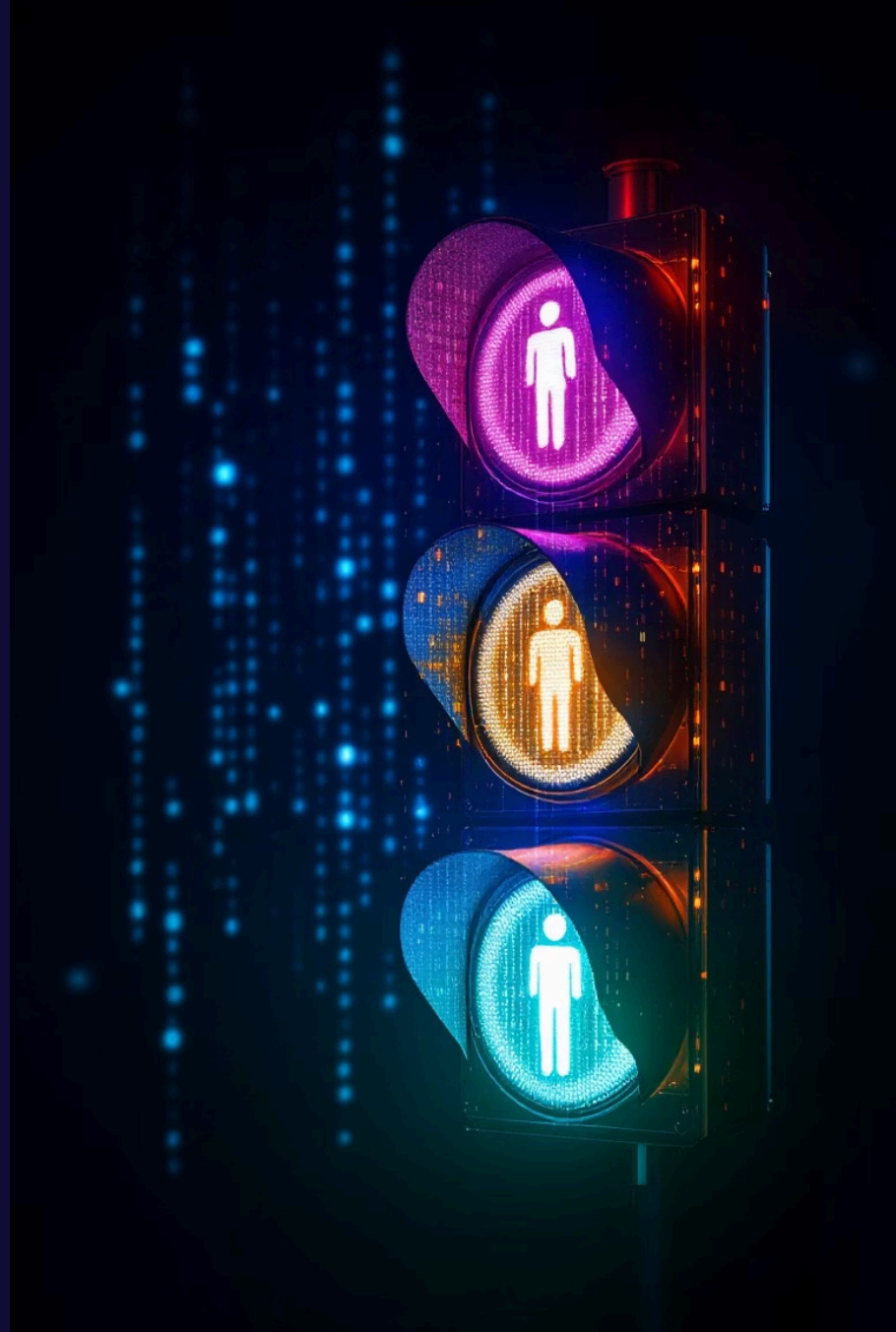
Flags

The control bits that manage the connection state.

The Control Signals 🚦

TCP flags are one-bit fields that act as signals:

SYN	Initiates a connection.
ACK	Acknowledges received data.
FIN	Gracefully closes a connection.
RST	Abruptly resets a connection.
PSH	Tells the system to process this data immediately.



From IP Address to Physical Device

The Problem:

Computers on a local network find each other with a physical **MAC Address**, but they communicate using a logical **IP Address**.

How do you link the two?

The Solution:

Two key protocols manage this translation:

- **ARP**: Links IP addresses to MAC addresses
- **DHCP**: Assigns IP addresses to devices

Finding Your Neighbor 🕵️

Broadcast

A computer broadcasts: "Who has IP address 192.168.1.100?"

Reply

The device replies directly: "I do! My MAC address is 00:1A:2B:3C:4D:5E."

Cache

The first computer saves this mapping in its ARP cache.

ARP (Address Resolution Protocol) translates an IP address into a MAC address on local networks.

Getting Your Network ID 💼

DHCP (Dynamic Host Configuration Protocol) automatically assigns IP addresses and other network settings to devices when they join a network.

01

Discover

A device shouts, "Is there a DHCP server here?"

02

Offer

The server replies, "Yes, you can have this IP address."

03

Request

The device says, "Okay, I'll take that IP address."

04

Acknowledge

The server confirms, "It's yours!"

Putting It All Together

1

Step 1: Get an Address

A laptop connects to a network and uses **DHCP** to get an IP address.

2

Step 2: Initiate Connection

The user tries to visit a website, initiating a **TCP Three-Way Handshake**.

3

Step 3: Find the Router

To send the SYN packet to the local router, the laptop uses **ARP** to find the router's MAC address.

4

Step 4: Data Flows!

The connection is established, and communication begins.