Networking for DevOps

What is a Network?

When two or more computers and computing devices connected together with each other through communication channels, such as cables or wireless media and sharing some files, then it is called a **Network**.

A network is used to:

Allow the connected devices to communicate with each other.

Enable multiple users to share devices over the network, such as music and video servers, printers and scanners.

The Internet is the largest network in the world and can be called "the network of networks".

Types of Networks

There are different types of networks. But the main two are LAN and WAN

1. **LAN** (Local Area Network) - interconnects computer within a limited area, such as residences, schools. e.g.: Wi-Fi, Ethernet
2. **MAN** (Metropolitan area network) - used in metropolitan area (cities).
3. **WAN** (Wide Area Network) - extends LAN over a large geographic area.
   e.g:- optical fiber cable
4. **SONET** (Synchronous Optical Network) - used in submarine.

Network Components:

1. Switch:

> It is a device which connects two or more computers.

2. Router:

> It is a device which is actually used to connect one network with another.

3. Modem:

> It is also a device used for modulation and Demodulation.

4. Hub:

> It is just a power extension dummy device that just broadcast the signals to its connected computers.

5. NIC:

> It is known as Network Interface Card which is used to connect your computer with the internet. It is wireless card preinstalled on motherboard now-a-days. It has a MAC (Media Access Control) address.

6. Bridge:

> It is also a networking device that connects multiple LANs (local area networks) together to form a larger LAN. It reduces the broadcasting part, and it store the MAC address of the computer but now this device is also obsoleted and replaced by switch.

What is Protocol?

A network protocol is a set of rules which is set up by people that determine how a particular data is transmitted between different devices in the same network. e.g.: HTTP, TCP, IP, FTP, SMTP etc.

IP Address and its Types and Classes:

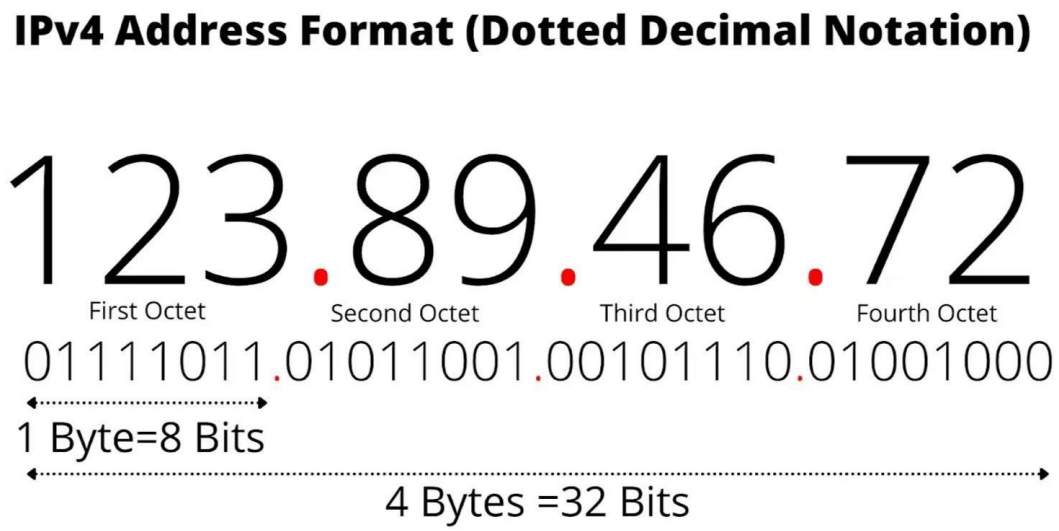
IP Address: An IP (Internet Protocol) address is a unique number assigned to each device on a network, allowing them to communicate with each other. It's like a device's "address" on the internet or local network.

Types of IP Addresses

1. **IPv4**:

   32-bit address, written as four numbers separated by dots (e.g., `123.89.46.7`).

This is a 32-bit IP address, means it contains a combo of 32 (1 and 0's). In this version of IP address there are 4 groups or **Octets** (8 bits), and each octet is represented by a decimal value in the address. It is easy to remember.

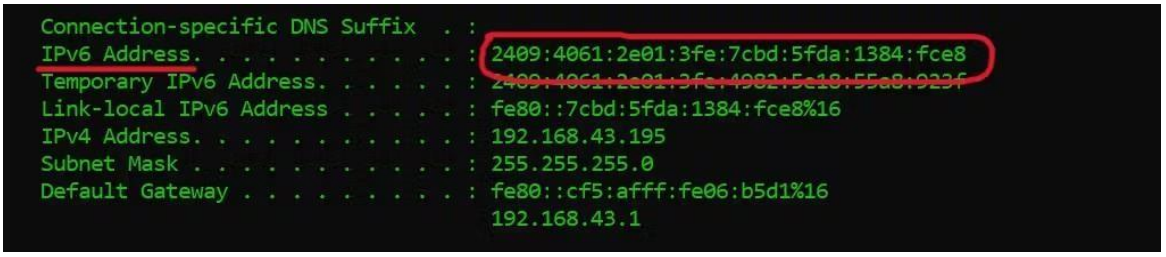


Commonly used, but limited number of addresses (about 4.3 billion).

2. **IPv6**:

   128-bit address, written in eight groups of hexadecimal numbers (e.g., `2001:0db8:85a3:0000:0000:8a2e:0370:7334`).

   Provides a vastly larger pool of addresses, designed to replace IPv4 as it runs out.



3. **Public IP**:

   Used to identify devices on the internet.

   Assigned by ISPs and accessible globally.

4. **Private IP**:

   Used within private networks (like home or office networks).

   Not accessible from the internet; usually in ranges like `192.168.x.x` ,

`10.x.x.x` , or `172.16.x.x` - `172.31.x.x` .

5. **Static IP**:

   Manually assigned, doesn't change.

   Often used for servers and devices that need a consistent address.

6. **Dynamic IP**:

   Automatically assigned by a DHCP (Dynamic Host Configuration Protocol) server.

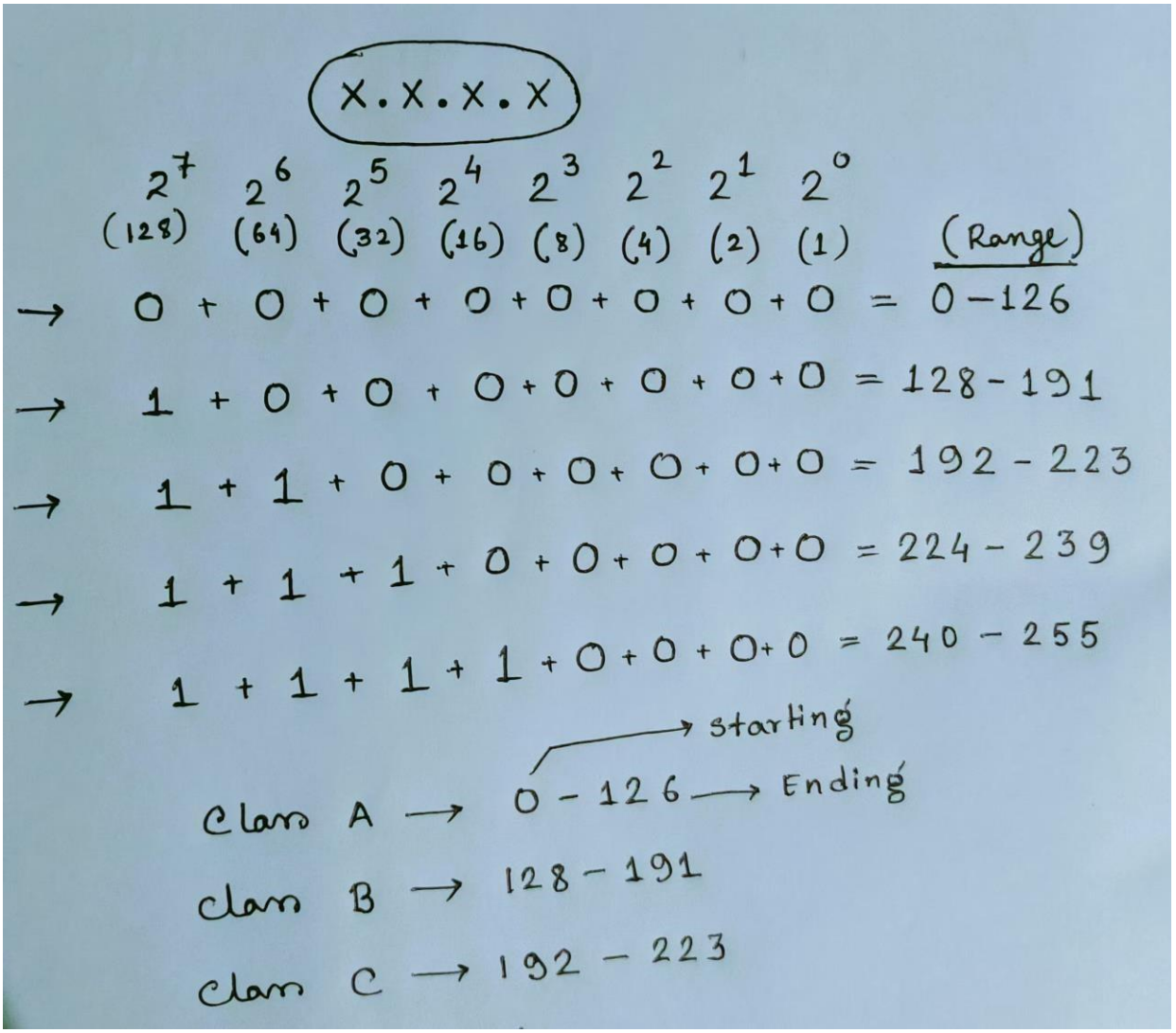
   Changes periodically; commonly used for home devices.

IP Address Classes (IPv4 Only)

There is an organization called **IANA** (Internet Assigned Numbers Authority) who divides the IP address into different classes. You have to know about binary to decimal conversion to understand this.

IPv4 addresses are divided into **five classes** based on the starting number, which determines their usage in networks.

Class	Range	Purpose
A	1.0.0.0 - 126.0.0.0	Large networks, like big organizations.
B	128.0.0.0 - 191.255.0.0	Medium-sized networks.
C	192.0.0.0 - 223.255.255.0	Small networks, like home or business LANs.
D	224.0.0.0 - 239.255.255.255	Reserved for multicasting.
E	240.0.0.0 - 255.255.255.255	Experimental, used for research.



Note:

Class A addresses in IPv4 officially start from **1.0.0.0** and go up to **126.0.0.0**. The address **0.0.0.0** is not part of the Class A range and has a special purpose in networking.

- **0.0.0.0** is a special address, not part of the usable IP address range in Class A.

The **127.0.0.0** to **127.255.255.255** range, especially **127.0.0.1**, is reserved for **loopback addresses** in IPv4.

What is Loopback?

Loopback address allows a device to communicate with itself.

It's often used for testing network software on the local machine.

Key Points:

- **127.0.0.1** is commonly known as "localhost."

  Any IP address in the **127.x.x.x** range will loop back to the same device.

  Useful for **testing** networking applications without needing an external network.

IP address - Network ID and Host ID:

There are two parts to an IP address - Network ID and Host ID (Any device which gets the IP address is called a Host).

The **Network ID** portion differs depending on the IP class:

- **Class A**: 1st octet is the Network ID.
- **Class B**: 1st and 2nd octets are the Network ID.
- **Class C**: 1st, 2nd, and 3rd octets are the Network ID.

Direct Connection: Devices with the same Network ID can connect without a router.

Router Requirement: Devices with different Network IDs need a router to connect.

We will try to break it with text based structural diagram for a better understanding:

```
IP Address Structure and Device Connection

+---------------------+---------------------+-----------------
|   IP Address Class  |   Network ID        |   Host ID
+---------------------+---------------------+-----------------
|   Class A           |   1st Octet         |   2nd, 3rd, 4th
|                     |  Example: 17.0.0.1  |   (0.0.1)
+---------------------+---------------------+-----------------
|   Class B           |   1st & 2nd Octets  |   3rd, 4th
|                     |  Example: 172.16.0.1|   (0.1)
+---------------------+---------------------+-----------------
 | Class C             | 1st, 2nd & 3rd      | 4th Octet
|                      | Example: 192.168.1.1|     (1)
+---------------------+---------------------+-----------------

Device Connection Scenario:
```

```
1. Device A IP Address: 17.0.0.1 (Class A)
2. Device B IP Address: 17.0.4.2 (Class A)

   Network ID for Class A: 17 (1st Octet)

   Since both devices have the same Network ID (17), they
   are in the same network and can connect directly.

Connection Summary:

+----------------------+---------------------------+---------
 | Device A IP          | Device B IP                 | Connec
+----------------------+---------------------------+---------
 | 17.0.0.1             | 17.0.4.2                    | Direct
+----------------------+---------------------------+---------
 | 17.0.0.1             | 192.168.1.5                 | Requir
+----------------------+---------------------------+---------

Explanation:
- If Device A and Device B are in the same network (same Netwo
- If they are on different networks (different Network IDs), a

  Router Usage:

+----------------------+---------------------------+---------
   | Different Networks | Example:                    | Connec
+----------------------+---------------------------+---------

   | Device A Network ID | 17 (Class A)             |
   | Device B Network ID | 192.168 (Class C)        |
 | Router Needed        | Yes                         | Requir
+----------------------+---------------------------+---------
```

Subnetting:

Divides a network into smaller, more manageable segments.

Example: A network with IP address 192.168.1.0/24 can be divided into subnets like 192.168.1.0/25 and 192.168.1.128/25.

Example of Subnetting:

Given network: **192.168.1.0/24**

192.168.1.0/24 is a Class C network.

/24 indicates a subnet mask of **255.255.255.0**, meaning there are **8 bits for hosts** (32 total bits in IPv4 - 24 bits for the network portion › 8 bits for hosts).

192.168.1.0/24 provides **256 IP addresses** (from 192.168.1.0 to 192.168.1.255).

Dividing into Smaller Subnets:

To divide this into two equal subnets, we can use **/25** subnet masks, which allocate **7 bits for hosts** (32 - 25 › 7 bits for hosts).

1. **Subnet 1: 192.168.1.0/25**

   Range: 192.168.1.0 to 192.168.1.127

   Subnet Mask: 255.255.255.128

   Total IPs: 128 addresses (126 usable for hosts, as the first address is the network address and the last is the broadcast address).

2. **Subnet 2: 192.168.1.128/25**

   Range: 192.168.1.128 to 192.168.1.255

   Subnet Mask: 255.255.255.128

   Total IPs: 128 addresses (126 usable for hosts).

Summary Table

Subnet	Range	Subnet Mask	Total IPs	Usable Host IPs
192.168.1.0/25	192.168.1.0 - 192.168.1.127	255.255.255.128	128	126
192.168.1.128/25	192.168.1.128 - 192.168.1.255	255.255.255.128	128	126

Explanation:

By using a **/25 mask** instead of **/24**, we split the network into two subnets with 128 IP addresses each.

This creates smaller segments within the original network, making it easier to manage specific groups of hosts separately.

Benefits of Subnetting:

1. **Improves Network Performance**: Reduces broadcast domains, limiting broadcast traffic to specific subnets.
2. **Enhances Security**: Allows segregation of different departments or functions within an organization.
3. **Efficient IP Usage**: Prevents wasting IP addresses by only allocating what is necessary for each subnet.

CIDR (Classless Inter-Domain Routing):

CIDR (Classless Inter-Domain Routing) is a method for allocating IP addresses and IP routing that replaces the older **classful network** system. It was introduced to improve IP address utilization and simplify routing.

The table below outlines the most common combination of addresses and netmasks and important details about them.

Prefix	Netmask	Number of addresses	Relation to class	Comment
/32	255.255.255.255	1	Class C/256	Single host in a network
/25	255.255.255.128	128	Class C/2	
/24	255.255.255.0	256	Class C	
/23	255.255.254.0	512	Class C*2	
/16	255.255.0.0	65,536	Class C*256 › Class B	
/15	255.254.0.0	131,072	Class B*2	
/8	255.0.0.0	16,777,216	Class B*256 › Class A	
/0	0.0.0.0	4,294,967,296	Class A*256	0.0.0.0/0 means entire internet. Often used in public firewall rules

Network Models

There are mainly two types of network model -

1. OSI Reference Model
2. TCP/IP Model

1. OSI Reference Model:

The **OSI (Open Systems Interconnection)** Model is a set of rules that explains how different computer systems communicate over a network. OSI Model was developed by the **International Organization for Standardization (ISO)**. The OSI Model consists of 7 layers and each layer has specific functions and responsibilities.

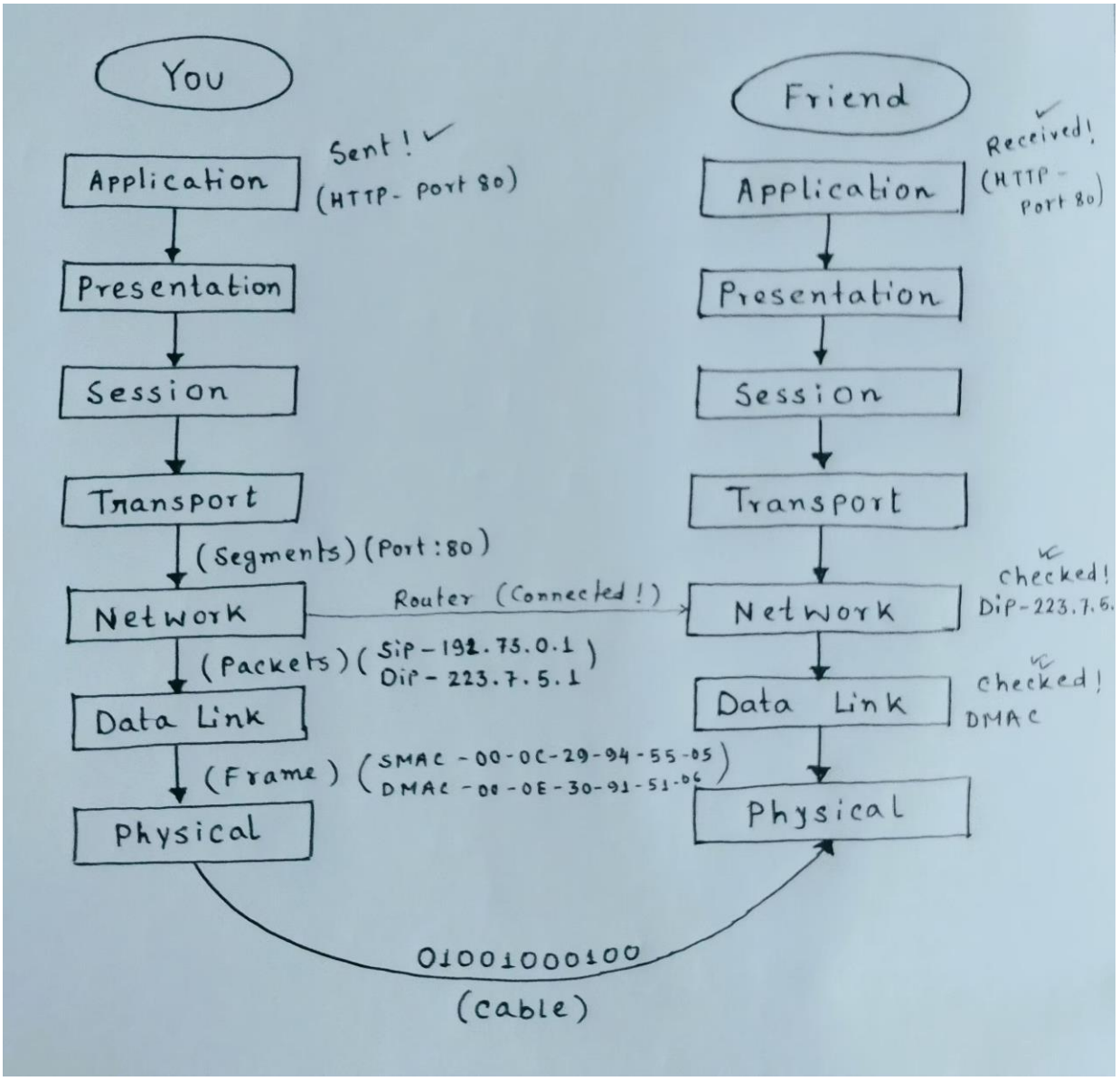
1. **Physical Layer**: Handles the physical connection between devices, transmitting raw data as bits over cables, radio signals, etc.
2. **Data Link Layer**: Manages data transfer between directly connected nodes.
   It handles error detection and flow control. Examples: Ethernet, Wi-Fi.
3. **Network Layer**: Manages packet forwarding and routing through the network. Uses IP addressing. Example: IP (Internet Protocol).
4. **Transport Layer**: Ensures reliable data transfer with error correction and flow control. Examples: TCP, UDP.
5. **Session Layer**: Establishes, maintains, and manages communication sessions between applications.
6. **Presentation Layer**: Translates data formats to ensure compatibility between systems. Handles encryption and compression. Example: SSL/TLS.
7. **Application Layer**: Interfaces directly with the user and provides network services like HTTP, FTP, SMTP.

Here's a
text-based structural diagram that shows the flow through the **OSI model** from **Person X to Person Y**:

```
START: Person X Sends a Message
|
├── Application Layer (Layer 7)
|   └── Prepare message using messaging app protocol (e.g., SM
|
├── Presentation Layer (Layer 6)
|   └── Encode/Encrypt the message into a suitable format.
|
├── Session Layer (Layer 5)
|   └── Establish a session with Person Y's device through the
|
├── Transport Layer (Layer 4)
|   └── Break the message into segments and add TCP/UDP header
|
├── Network Layer (Layer 3)
|   └── Add source and destination IP addresses for routing.
|
├── Data Link Layer (Layer 2)
|   └── Convert segments to frames and add MAC addresses for d
|
├── Physical Layer (Layer 1)
|   └── Convert frames into bits (0s and 1s) for transmission.
|
└── Transmit through Physical Medium (e.g., Ethernet/Wi-Fi) to
    |
    ├── Person Y Receives Message
    |
    ├── Physical Layer (Layer 1)
    |   └── Receive bits and reassemble into frames.
    |
    ├── Data Link Layer (Layer 2)
    |   └── Verify and process frames with MAC addresses.
    |
    ├── Network Layer (Layer 3)
```

```
      │    └── Extract IP addresses and verify routing informatio
      │
      ├── Transport Layer (Layer 4)
      │    └── Reassemble segments into data using TCP/UDP.
      │
      ├── Session Layer (Layer 5)
      │    └── Verify and maintain the communication session.
      │
      ├── Presentation Layer (Layer 6)
      │    └── Decode/Decrypt message into readable format.
      │
      └── Application Layer (Layer 7)
           └── Display the message to Person Y in the messaging a

END: Person Y Reads the Message
```



The infographic below summarizes the seven layers of the OSI reference model.

The 7-Layer OSI Model

No.	Layer	Function	Data unit	Hardware	Protocols
7	Application 	Human-computer interaction through applications that access network services	Message/data	Gateway	UPnP, DHCP, DNS, HTTP, HTTPS, NFS, NTP, POP3, SMTP, SNMP, FTP, Telnet, SSH, TFTP, IMAP
6	Presentation 	Data formatting and encryption/ decryption	Message/data	Gateway redirector	TLS, SSL, AFP
5	Session 	Inter-host communication	Message/data	Gateway	NetBIOS, RPC, SMB, Socks
4	Transport 	Data transmission	TCP: segment; UDP: datagram	Gateway	TCP, UDP, SCTP
3	Network 	Path determination and logical addressing	Packet, datagram	Router, Brouter	ARP, IP, NAT, ICMP, IPsec, ICMP (ping)
2	Data Link 	Physical addressing	Frame, cell	Switch, bridge, NIC	ARP, Ethernet, L2TP, LLDP, MAC, NDP, PPP, PPTP, VTP, VLAN
1	Physical 	Binary signal transmission over physical media	Bit, frame	Cables, modem, hub, repeater, NIC, multiplexer	Ethernet, IEEE802.11, ISDN, USB, Bluetooth

Below is the list of protocols in each layer of the **OSI model** along with their **port numbers** (where applicable):

1. Application Layer (Layer 7)

HTTP (Port **80**): Web browsing.

HTTPS (Port **443**): Secure web browsing.

SMTP (Port **25**): Sending email.

FTP (Ports **20**, **21**): File transfer.

DNS (Port **53**): Domain name resolution.

POP3 (Port **110**): Receiving email.

IMAP (Port **143**): Receiving email.

2. Presentation Layer (Layer 6)

SSL/TLS (Port **443** for HTTPS, also used in other protocols): Encryption for secure data transmission.

MIME: Used for formatting email attachments.

JPEG/PNG: Image formats used to encode multimedia files.

3. Session Layer (Layer 5)

PPTP (Port **1723**): Tunneling protocol for VPNs.

NetBIOS (Ports **137**, **138**, **139**): Establishes sessions for network communications.

4. Transport Layer (Layer 4)

TCP: Reliable data transmission with acknowledgment.

UDP: Fast, connectionless data transmission without acknowledgment.

SCTP: Used for applications that require multiple data streams.

5. Network Layer (Layer 3)

IP (IPv4/IPv6): Routing packets between source and destination.

ICMP: Error messaging and diagnostics (e.g., ping).

IGRP: Routing protocol used for sharing routing information.

6. Data Link Layer (Layer 2)

Ethernet: Defines physical addressing and channel access.

PPP: Used for point-to-point connections.

HDLC: For framing and error control on point-to-point links.

ARP: Resolves IP addresses to MAC addresses.

7. Physical Layer (Layer 1)

Ethernet (Physical signaling): Specifies electrical signals, cabling, etc.

USB: Used to physically connect devices.

Summary with Ports

Application Layer (Layer 7) contains the most recognizable protocols with specific **port numbers** for communication (e.g., **HTTP - Port 80**, **HTTPS - Port 443**, **SMTP - Port 25**).

Layers **2 to 6** typically deal with specific network management functions and do not use port numbers as these layers are responsible for connections and managing data formats.

Port numbers are used primarily in the **Application and Transport Layers** to ensure data is delivered to the correct services and applications running on a computer.

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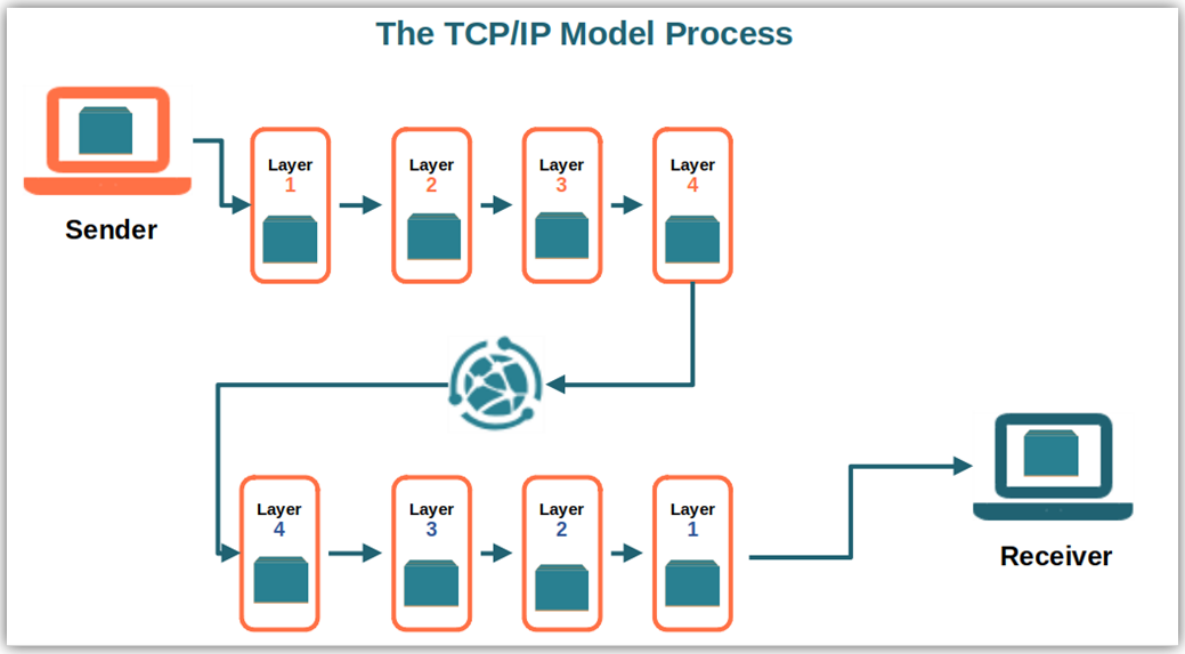
2. TCP/IP Model:

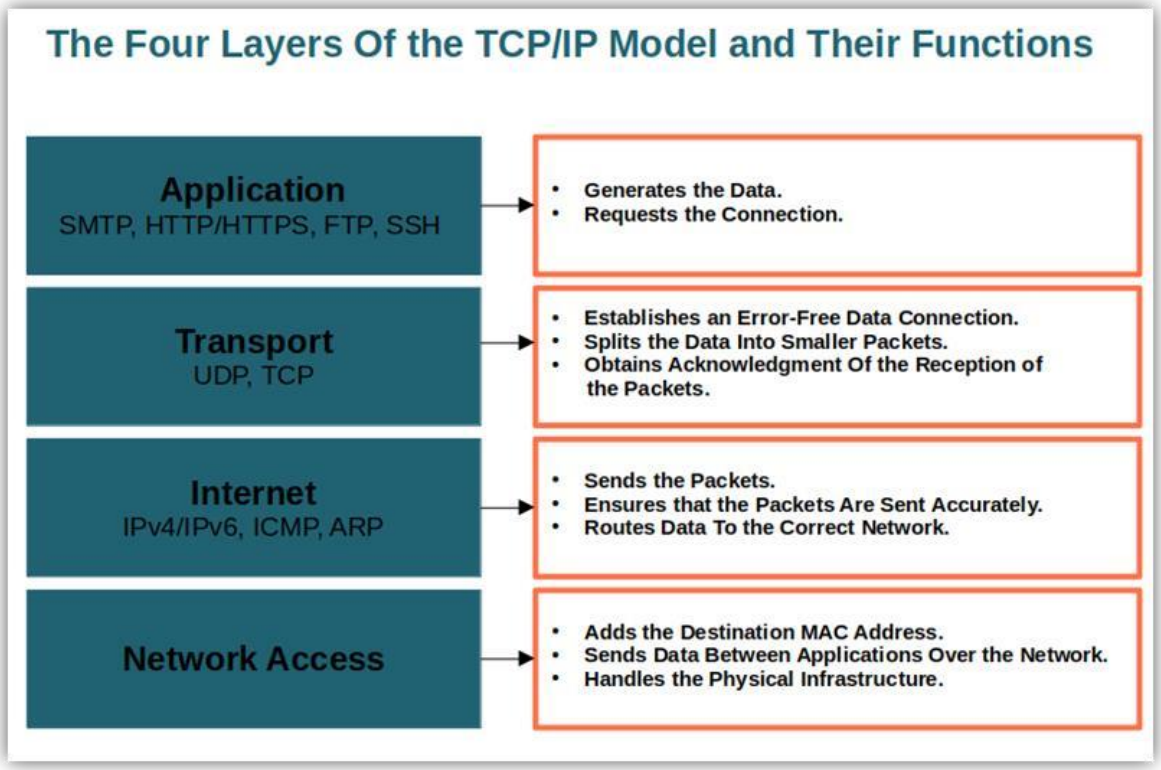
The
TCP/IP model, also known as the **Internet Protocol Suite**, is a simplified version of the OSI model with only **4 layers** instead of 7.

This model is a real model which actually works in real. This model consists of 4 layers.

1. Application Layer = (Application Layer + Presentation Layer + Session Layer) of OSI model
2. Transport Layer
3. Network Layer
4. Network Interface Layer = (Data Link Layer + Physical Layer) of OSI



model `(remaining all are same like OSI model discussed above.)`



Ports and Protocols:

1. **HTTP (Hypertext Transfer Protocol):**

It is a client server stateless (means it never stores any data of client) protocol, and it tells us how it requests any data from the server and also tells us how the server will send the data back to the client.

- - When a client makes a request - HTTP request
- - When server sends response to client - HTTP response -- Some HTTP methods used to make any request

```
    GET :- Get some data from server
POST :- Post some form/data to server
PUT :- Put some data
DELETE :- Delete some data in server
```

- - **Status Codes**

Status codes are issued by a server in response to a client's request made to the server.

There are 4 categories of HTTP responses:

1. 200s: Successful responses
2. 300s: Redirects
3. 400s: Client errors
4. 500s: Server errors

Take a look at some of the most common response codes:

Code	What It's Telling	What it Means
200	OK	Request succeeded.
302, 307	Found, Temporary Redirect	The URI of the requested resource has been changed temporarily.
301, 308	Moved Permanently, Permanent Redirect	The URI of the requested resource has been changed *permanently.*
400	Bad Request	The server can't understand the request being sent.

401	Unauthorized	The client must authenticate itself before sending the request.
403	Forbidden	The client does not have enough permission to access the content.
404	Not Found	The server can't find the requested resource.
408	Request Timeout	The response was sent to an idle connection, and the server wants to terminate it.
500	Internal Server Error	The server does not know how to handle a request.
502	Bad Gateway	The server you are trying to access is a gateway or a reverse proxy (it sits between the client and an actual server that serves the page). You get this error when the gateway gets an incorrect response from a source server.
503	Service Unavailable	The server can't process the request. This usually happens when a server is down or overloaded.
504	Gateway timeout	Similar to 502, the gateway can't get a response in time.

Find the complete list of status codes with detailed explanations by Mr. Abhishek Veeramalla (Thank you!):

iam-veeramalla/http-status-codes: Repo to demonstrate HTTP status codes

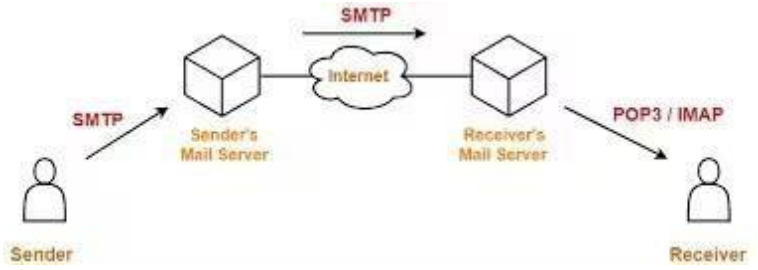
I have said that HTTP is a stateless protocol, means it never store any data of client in server. Then suppose when you will search for the second time `amazon.com` then it should be logged out from the server, and you have to log in again for second time visit, but you don't. In second time, it's automatically logged in, and you can see all of your saved carts 🛒 and all data. So how it is possible?? Here, **cookies** come into the picture.

> Cookies is a unique string stored as a file in your browser and when you search for the second time the website you visited previously, cookies which saved in your browser will send the details through HTTP to the server and server will check it and automatically logged you in.

2. **SMTP/POP (Simple Mail Transfer Protocol and Post Office Protocol):**

SMTP is used in sending and receiving any email from senders SMTP server to Receiver's SMTP server

POP is used to download any email from POP server



3. **FTP (File Transfer Protocol):**

FTP is used to download, upload and transfer files from one host to another host.

4. **Secure shell (SSH):**

Similar to Telnet. It's used by system administrators to securely access to access a computer over an insecure network.

5. **TCP (Transmission Control Protocol):**

Reliable and **connection-oriented** protocol.

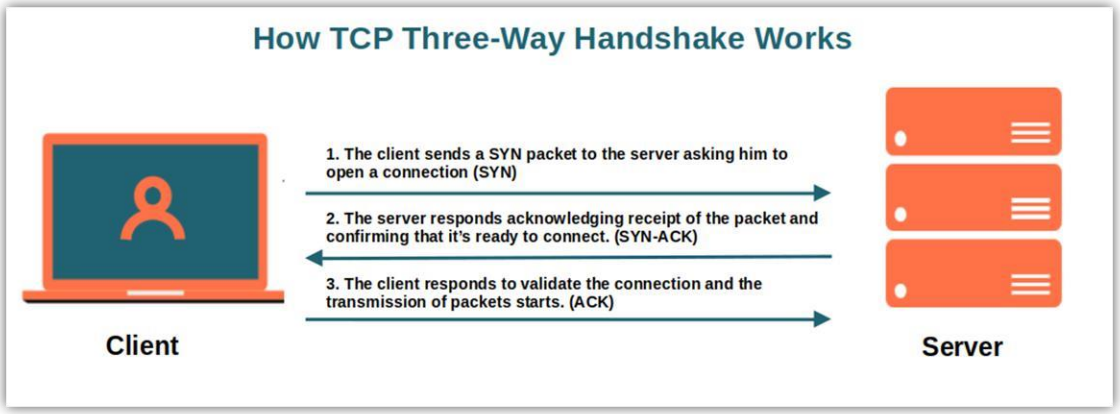
Ensures data is delivered successfully with **acknowledgements** and **retransmission** if needed.

Used for applications where data integrity is crucial.

Example: **HTTP** (port 80), **SQL** (port 1433).

TCP and the Three-Way Handshake:

Before transmitting packets, TCP must ensure that a stable connection has been set up between the sender and the recipient. This is where the three- way handshake (or SYN-SYN-ACK) comes in.



6. **UDP (User Datagram Protocol):**

   Unreliable and **connectionless** protocol.

   No acknowledgements, no retransmission; **faster** but no guarantee of delivery.

   Used for applications needing **speed** over reliability.

   Example: **Video Streaming** or **DNS** queries.

Find the link below for Common Ports and Protocols Cheat Sheet (Thanks to Stationx):

Common Ports Cheat Sheet: The Ultimate List

Routing:

So how do we get a packet of information from a host on one network to a host in another? In one word: Routing.

We use tables to help us determine the routes we want to take. This screenshot demonstrates a typical route table in AWS:

Destination	Target
10.21.0.0/16	local
10.0.0.0/8	tgw-02b7d78edbc6fa7b3
0.0.0.0/0	nat-0a9a7a4b5947e0aa5

When making a routing decision, more narrow rules are evaluated first:

If a packet destination is in a range of 10.21.0.0/16 – it will remain in a local network (your neighborhood).

If a packet destination is in a range of 10.0.0.0/8 – it will be sent to the transit gateway (TGW) interface (your state highways).

If a packet destination does not fall in any of these ranges, the widest one is evaluated which is 0.0.0.0/0 which means it is internet traffic. And the packet will be redirected to the Network Address Translation (NAT) interface.

DNS (Domain Name System):

DNS (Domain Name System) translates human-readable domain names (e.g., **www.example.com**) into IP addresses (for example, 192.0.2.44).

Root DNS Server stores all the Top-level domain e.g : - .com, .in, .org, .io etc.

DNS works like the **phonebook** of the internet, allowing humans to use readable names while machines use numerical addresses.

How DNS Works

- When you type a **website address** (e.g., `www.example.com`) into your browser, it needs to know the **IP address** of that server.

The DNS process involves looking up the domain name and finding the corresponding IP address through multiple DNS servers.

Example: Visiting a Website

1. **User Request**:

   You type **www.example.com** into your web browser.

2. **DNS Query**:

Your browser sends a request to a **DNS server** to get the **IP address** of `www.example.com`.

3. **DNS Resolution**:

   The DNS server checks if it has the IP address cached. If not, it contacts **other DNS servers** (root, TLD, and authoritative servers) to find the IP address.

4. **IP Address Found**:

   Once the IP address (e.g., **93.184.216.34**) is found, the DNS server sends it back to your browser.

5. **Connecting to the Website**:

   The browser uses this IP address to connect to the **web server**, and the website loads on your screen.

Domains, Zones, and Delegation:

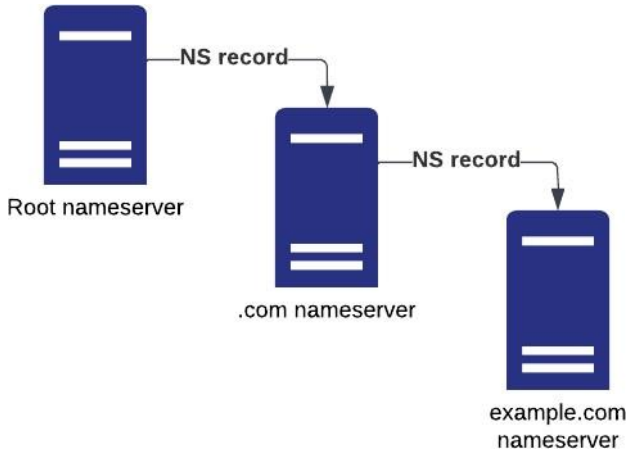
1. **Domains**: Domains are like branches in a tree-like structure of the internet. The **root domain** is the highest level, followed by **top-level domains (TLDs)** like `.com`, `.org`, etc. Subdomains (e.g., `example.com`) branch off from TLDs.

2. **Zones**: A **zone** is a portion of the domain that is managed by a specific organization. For instance, `.com` is a zone controlled by **Verisign**. **ICANN** manages the root zone at the top of the DNS tree, while different organizations manage subdomains.

3. **Delegation**: **Delegation** allows one organization to hand over control of part of its domain to another organization. This is done using **Nameserver (NS) records**.

   - For example, ICANN controls the root domain and delegates `.com` to Verisign.
   - Verisign can then delegate control over `example.com` to "Example Ltd" by adding an NS record those points to their nameserver.

The **NS records** direct traffic to the appropriate nameserver that manages a domain, allowing different parts of the DNS tree to be managed independently by different organizations.



DNS record types:

DNS records, also known as zone files, provide information about a domain. This includes the IP address that is associated with this domain and how to handle queries for it. Each DNS record has a time-to-live setting (TTL) which indicates how often a DNS server will refresh it.

Below are the most commonly used types of DNS records and their meaning:

Type	Name	Description
A	Host address	The most basic and the most commonly used DNS record. It translates human-friendly domain names into computer-friendly IP addresses.
AAAA	IPv6 host address	Same as A but for IPv6 (a host address that can have more than one IP address).
CNAME	Canonical name for an alias	Maps a name to another name. It should only be used when there are no other records on that name.
ALIAS	Auto resolved alias	Maps a name to another name but can coexist with other records on that name.
MX	Mail eXchange	Specifies the e-mail server(s) responsible for a domain name.
NS	Name Server	Identifies the DNS servers responsible for a zone. One NS record for each DNS server in a zone.
TXT	Descriptive Text	Holds general information about a domain name such as who is hosting it, contact person, phone

		numbers, etc. Widely used for domain ownership verification.

DHCP

DHCP (Dynamic Host Configuration Protocol) is a network management protocol that **automatically assigns IP addresses** and other network configurations (such as **subnet mask, gateway, DNS servers**) to devices on a network.

Example:

When you connect your laptop to a Wi-Fi network, a **DHCP server** assigns it an **IP address** automatically, allowing it to communicate with other devices on the network without manual configuration.

Network Components and Services

Routers and Switches

Routers: Connect different networks and direct data packets between them.

Switches: Connect devices within the same network and use MAC addresses to forward data to the correct device.

Firewalls

Firewalls control incoming and outgoing network traffic based on predetermined security rules.

Load Balancers

Load balancers distribute incoming network traffic across multiple servers to ensure no single server becomes overwhelmed.

VPN

VPN (Virtual Private Network) provides a secure connection between remote users and the corporate network over the internet.

Network Troubleshooting Tools:

1. ping

Purpose: Test internet network connections.

How It Works: Uses the **ICMP ECHO_REQUEST** to get an **ICMP ECHO_RESPONSE** from a remote host.

Usage: For basic troubleshooting, you can run `ping www.google.com` to check network connectivity and see response times and packet loss.

2. traceroute (or tracert on Windows)

Purpose: Track the route packets take to reach their destination.

How It Works: Sends **UDP probes** with increasing TTL values, showing each router along the route and the delay in reaching it.

Usage: Helps find which gateway is causing a delay by showing response times and where packets fail (indicated by).

3. telnet

Purpose: Test network connections and protocols.

How It Works: Attempts to establish a connection to a specified IP and port.

Usage: Test if a specific service is reachable, e.g., `telnet google.com 443` .

4. curl

- **Purpose**: Transfer data using multiple protocols, often for HTTP requests.
- **Usage**:
  - Basic GET request: `curl http://example.com` .
  - Check headers: `curl -I http://example.com` .
  - POST request: `curl -X POST http://example.com` .
  - Save response to file: `curl http://example.com/file -o output.file` .

5. dig (Domain Information Groper)

- **Purpose**: Troubleshoot **DNS** problems and verify DNS records.
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How It Works: Performs DNS lookups and displays information such as IP addresses.

- **Usage**: `dig google.com` to get information like IP addresses, TTL, and DNS record types.

6. netstat

Purpose: Show network connections and port listening information.

Usage:

- `netstat -lp` : List listening servers and their program names. `netstat -a` :
- Show all active ports.
- `netstat -r` : Show routing table.

7. nmap (Network Mapper)

Purpose: Discover hosts and services on a network.

How It Works: Sends raw packets to identify hosts, services, and operating systems.

Usage:

- Discover hosts: `nmap -sn 172.31.44.35/20` .
- Scan ports on a host: `nmap -A 172.31.36.237` .

8. ssh (Secure Socket Shell)

- **Purpose**: Securely connect to remote machines to execute commands.
- **Usage**:
  - Connect to a server: `ssh username@hostname` .
  - Secure and encrypted, used for remote management and file transfers.

9. scp (Secure Copy Protocol)

Purpose: Securely copy files between local and remote hosts.

Usage:

- Copy file to a remote server: `scp localfile.txt user@remote:/path/to/destination` .

These tools are invaluable for **network diagnostics, troubleshooting, and secure communications**, which are critical skills for any **DevOps engineer**.