Introduction to Networks

MADE BY:

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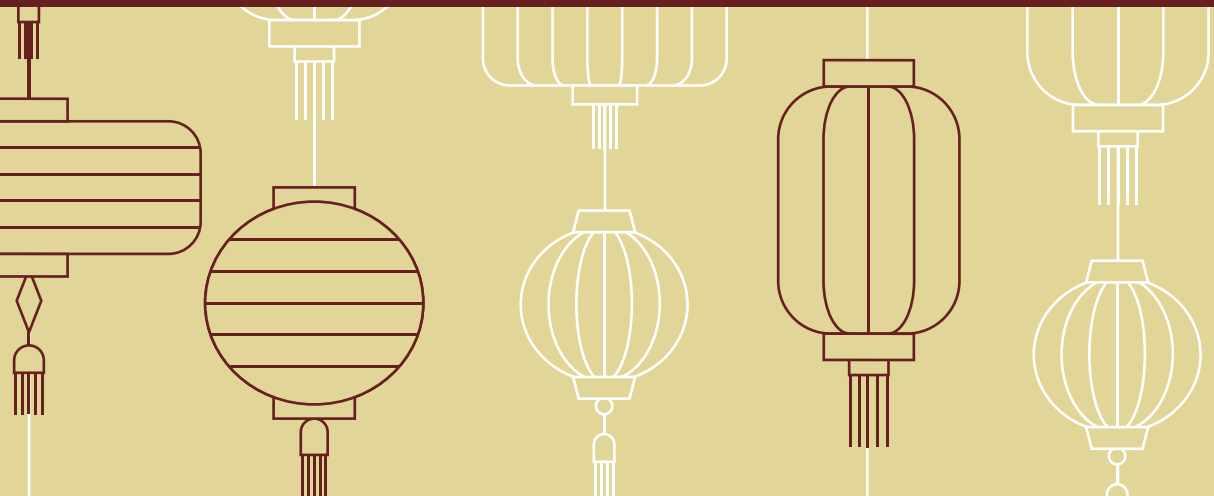


A network is a connection of computers. The Internet is a collection of networks.

There are rules for communication over the internet. These rules are called protocols.

WWW (World Wide Web):

Founded by Tim Berners Lee, www, refers to all the public websites or pages that users can access on their local computers and other devices through the internet.

INTERNET SOCIETY maintains the internet.

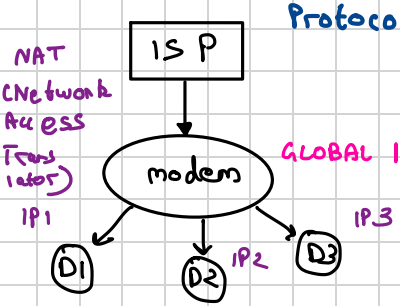
DATA TRANSFER

Data travels as "packets" over the internet.

↳ IP Address: Identifies each computer using the Internet Protocol to communicate over a network.

x . x . x . x

↳ 0 - 255



DHCP
(Dynamic Host Config. Protocol)

← Identifies PC IP

> curl ifconfig.me -s

- **IP Address** decides what device to send the data.
- **Ports** decide what application requested the data.
  - ↳ 16-bit number
  - ↳ 2^{16} ports available ≈ 65,000

Ephemeral ports decide the instance

HTTP = 80
MONGO = 2707
0 - 1023
↳ Reserved ports
1024 - 49152
↳ Application Registered

→ Mbps: MEGA BITS PER SECOND

1 mbps = 10^6 b/s
1 kbps = 10^3 b/s
1 gbps = 10^9 b/s

Sending Data → Upload Speed
Getting Data → Download Speed

THE WHOLE WORLD IS CONNECTED USING
SUBMARINE CABLES

Physical Connection: Optical Fibre, Coaxial Cables
Wireless Connection: Bluetooth, WiFi, LTE, 5G

LAN
- Small Networks
- Ethernet / WiFi

MAN
- Spans Cities

WAN
- Spans Countries
- Optical Fibre Cables

INTERNET

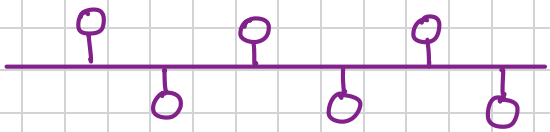
SONET: Synchronous Optical Networking
Frame Relay: Way to connect LAN to internet

MODEM: Used to convert digital signals to analog signal.

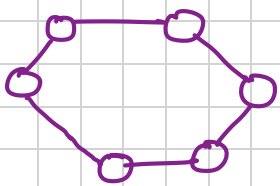
ROUTER: Routes the data and sends it to the right place based on the IP address.

NETWORK TOPOLOGY:

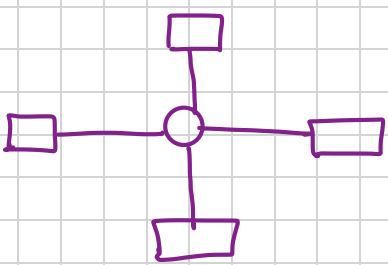
1) **Bus:**



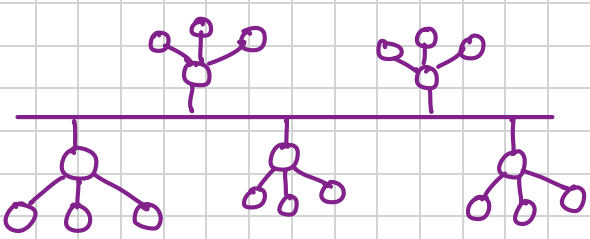
2) **Ring:**



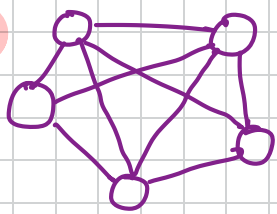
3) **Star:**



4) **Tree:** (Bus + Star)



5) **Mesh:**



NETWORK STRUCTURE

OSI Model (Open Systems Interconnection)

7	Application Layer	Human-computer interaction layer, where applications can access the network services
6	Presentation Layer	Ensures that data is in a usable format and is where data encryption occurs
5	Session Layer	Maintains connections and is responsible for controlling ports and sessions
4	Transport Layer	Transmits data using transmission protocols including TCP and UDP
3	Network Layer	Decides which physical path the data will take
2	Data Link Layer	Defines the format of data on the network
1	Physical Layer	Transmits raw bit stream over the physical medium

→ makes segments

→ Router lives here

→ Allows upper layers to pass frames

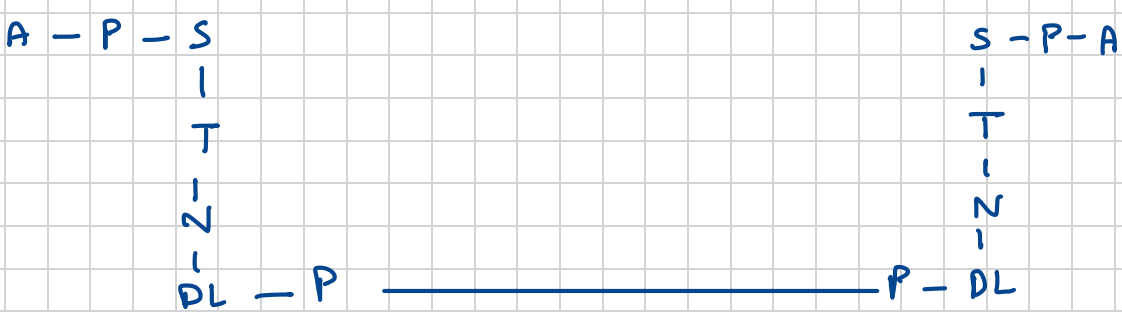
- Sender IP
- Receiver IP
- Subnet Mask

→ Packet

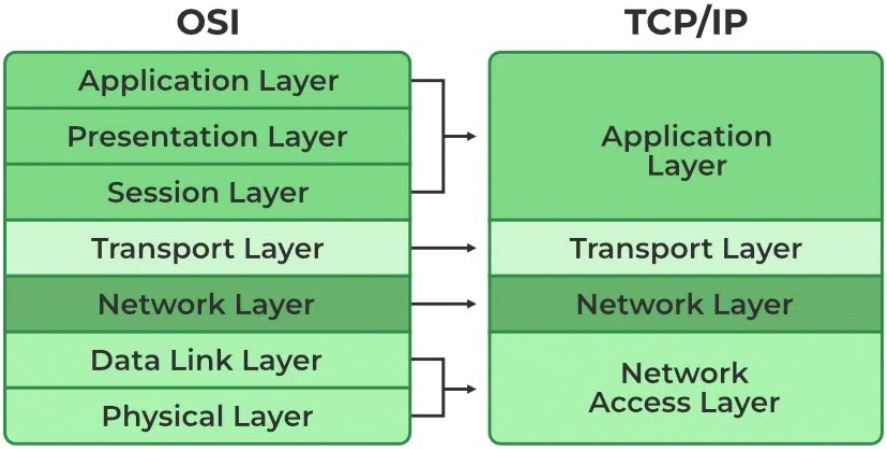
↓ transportation over wires

SENDER

RECEIVER



TCP/IP Model



PING: The time it takes for a small data set to be transmitted from your device to a server on the internet and back to your device again.

Repeater: Operates at physical layer. Regenerates signal over the same network by copying the weak signal bit by bit and getting it to its original strength.

Hub: Multiport repeater. No intelligence to find out the best path for data packets.

→ Active: Have power supply. Clean, boost and relay the signal along the network.

→ Passive: Collect wiring from nodes and power supply from active hub. No cleaning and boosting.

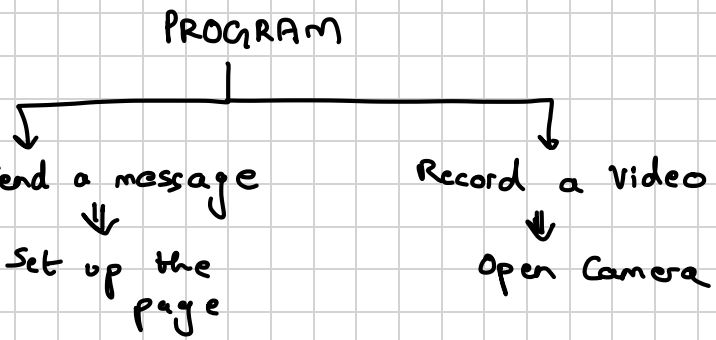
Switch: A switch serves as a controller, enabling networked devices to talk to each other.

↳ Managed switch
↳ Un managed switch

Bridge: Bridge is like a repeater or a hub. However, bridges maintain the media access control (MAC) address table as soon as they discover new segments, so subsequent transmissions are sent only to the desired recipient.

⇒ PROTOCOLS IN DEPTH:

- TCP/IP:
  - ✱ Http
  - ✱ DHCP
  - ✱ FTP
  - ✱ SMTP
  - ✱ POP 3 & IMAC
  - ✱ SSH
  - ✱ VNC
  - ✱ Telnet
- TELNET
- UDP



PROCESS:

THREAD:

Sockets: Interface between a process and the internet

→ **HTTP Protocol:** Client-server protocol that states how the client sends a request and how the server responds.

[Application layer]

- It uses TCP (Transmission Control Protocol) that works on transport layer.
- It is stateless. Doesn't store any client info.

HTTP METHODS

GET → Requesting Data
POST → Sending data to server
PUT → Puts data in a specific location
DELETE → Delete data from server
PATCH → Update data in server

STATUS CODES

Way to know whether the request was successful or not.

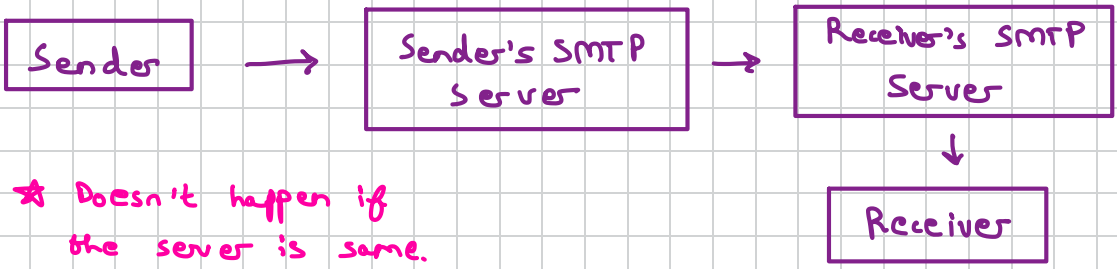
1xx → Informational
2xx → Success code
3xx → Redirecting Purpose
4xx → Client error
5xx → Server error

Eg.)
200 → Successful req.
404 → Not found
400 → Bad Request
500 → Internal server error

- **Cookies:** Unique string stored on the client's browser. This helps to maintain state.
  - ↳ Third-party cookies: Cookies set for URL's that you do not visit.

WORKING OF THE EMAIL:

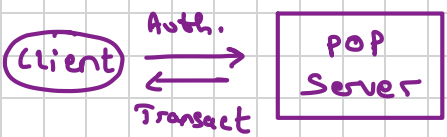
Application layer: SMTP (simple mail Transfer protocol)
Transport layer: TCP (Transmission control protocol)



* Doesn't happen if the server is same.

Command: nslookup -type=mx gmail.com

- **POP:** Post office Protocol [Port 110]

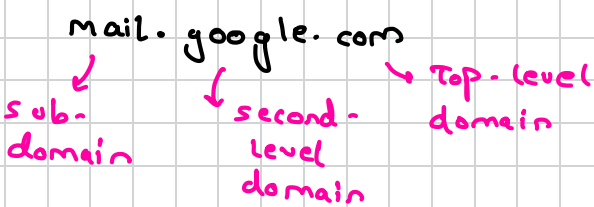


You can only download and delete. Other folders are not synced, only on one device.

- **IMAP:** Internet message access protocol. You can use multiple devices and all folders are synced.

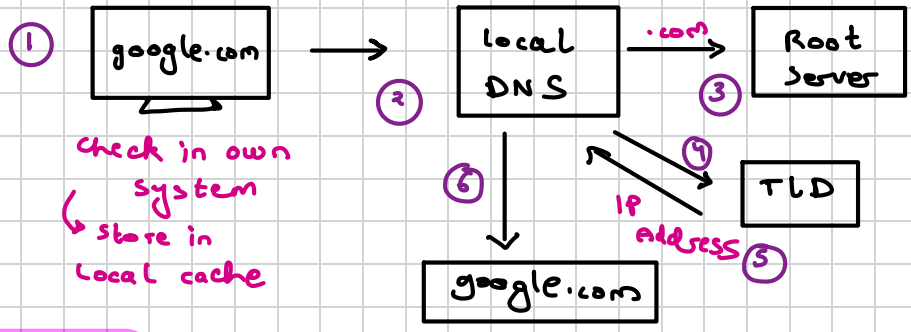
DOMAIN NAME SYSTEM:

Domain names are mapped to IP addresses. It is a directory/database.



- **Root DNS servers:**
  First point of contact. Have top level domains and second level domains.

ICANN (Internet corporation for assigned names and number) → Manage top level domains

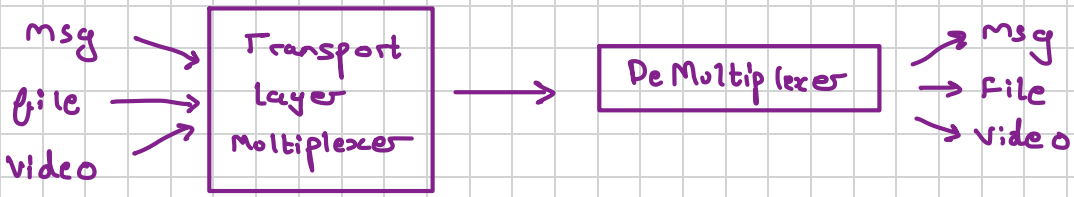


COMMAND: dig google.com

↳ DNS lookup utility

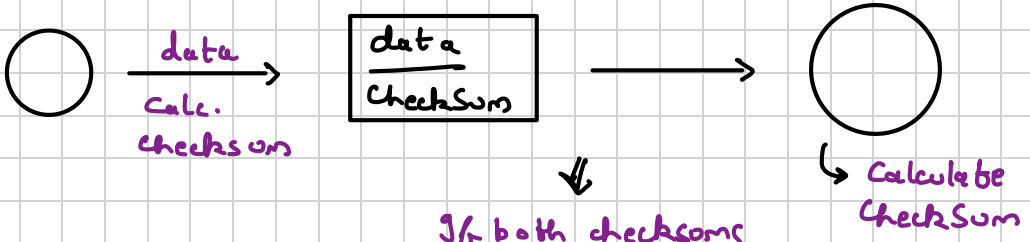
TRANSPORT LAYER: Take the information from the network to the apps. Actual transportation is done by the network layer. Transport layer gives data to the network layer.

- **TCP/IP Model:**

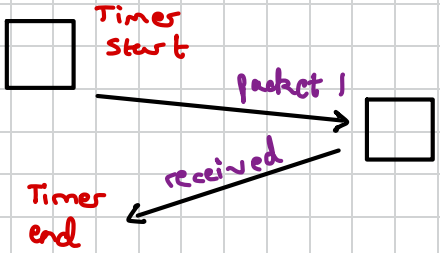


- Data travels in packets.
- Transport layer will attach these socket port numbers to those packets.
- Transport layer also takes care of congestion control.
- Congestion control Algos built in TCP.

- **Checksum:**



- **Timers:**



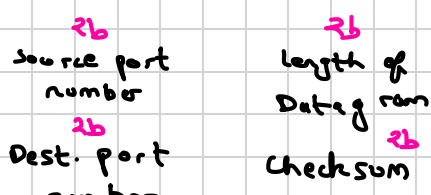
- If the packet isn't received, timer expires and you know something went wrong.

- What if there are duplicate packets? We use sequence numbers. A unique number for every segment.

→ UDP: USER DATAGRAM PROTOCOL:

- Data may or may not be delivered.
- Comectionless protocol
- UDP uses checksums but doesn't care about errors.

UDP Packet:



Uses:
- → video conf.
- → DNS
- → Gaming
- → V. first

sudo tcpdump -c 5

TCP: TRANSMISSION CONTROL PROTOCOL:

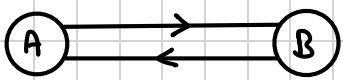
→ Transport layer protocol.

→ Application layer sends a lot of raw data. TCP segments this data, divides it in chunks, adds headers etc. It may also collect the data from network layer and the small chunks are put into one in the receiving end.

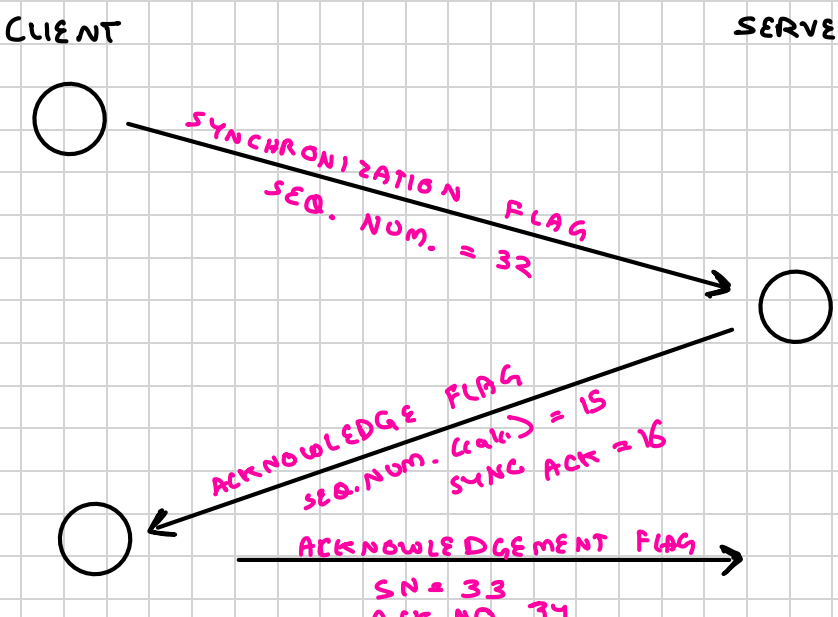
→ Congestion control.

→ Takes care of:
  → When data does not arrive.
  → Maintains the order of data using sequence numbers.

- **FEATURES:**
  → Connection Oriented
  → Error Control
  → Congestion Control
  → Full Duplex



- **3 WAY HANDSHAKE:**



⇒ NETWORK LAYER:

Transport → segments
Network → Packets
Data link → Frames

- Every router has a NETWORK ADDRESS.
- Every router will check whether the packet is for that router, if not, it will forward that using forward table in the routing table.

Control Plane:

Used to build routing tables.

Router → Nodes
links → Edges

192.168.2.30

Network Address (subnet id)

device address (host id)

① Static Routing: → Adding addresses manually
→ It's not adaptive

② Dynamic Routing: → when there is a change in network it will evolve accordingly

- IP (Internet Protocol):

IPv4 → 32 bit, 4-words
IPv6 → 128 bits

Blocks of IP addresses are assigned to the ISP. This is known as SUBNETTING.

⇒ Class of IP Addresses:

A	0.0.0.0	127.255.255.255
B	128.0.0.0	128.255.255.255
C	192.0.0.0	223.255.255.255
D	224.0.0.0	239.255.255.255
E	240.0.0.0	255.255.255.255

IETF assigns IP to ISPs [Internet Engineering Task force]

- **PACKETS:**

→ Header is of 20 bytes: IPv, Length, flags, identification, protocols, TTL (time to live).

* IPv 4: $2^{32} \approx 4.3$ billion
* IPv 6: $2^{32 \times 4} \approx 2^{128} \approx 3.4 \times 10^{34}$
  - ↳ Not backward compatible
  - ↳ ISPs shift, lot of hardware work

a.a.a.a.a.a.a.a

↳ Hexadecimal (16-bit)

- **MiddleBoxes:** Extra devices that interacts with packets.

* Firewall:
  - Global Internet
  - Your trusted network
  - Filters out IP based on various rules.

  ↳ i) Stateless Firewall
  ii) Stateful Firewall

* NAT: Network Address Translation