

Computer :- commonly oriented machine particularly used for training education and research.

computer network

practice of connecting two or more computers or computing devices through communication channels so they can share data, resources and services.

Internet:

collection of computer networks

ARPA

Advance Research Projects Agency

ARPA Net



TCP was used
In ARPA Net

first computer
Network

Linking, and Referencing was
still missing

world wide web :

To solve linking and Referencing world wide web comes into picture. developed by Tim Berner.

www stores
documents

documents and other web resources are
identified by URL

URL uniform resource locators

world's first website was www

No search engine
only hyperlinks to visit a website

Internet society

Manages, controls the rules of how Internet works and how different computers communicate

Server client architecture and protocols



your computer
client

your own computer
can also work as
server

TCP

confirms data
is not corrupted or lost

Transmission
control protocol

data may be lost
or corrupted

UDP

user
datagram protocol

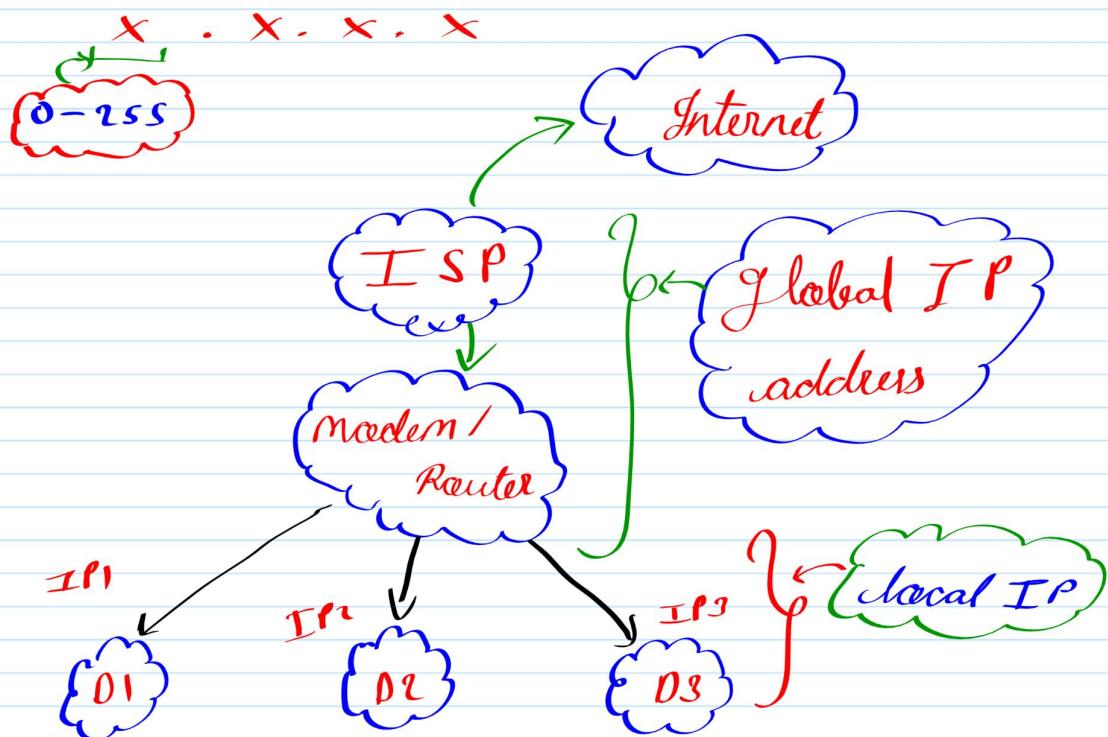
HTTP

used by web browsers
to transfer web data

Hyper text transfer
protocol

IP address

a numerical identifier assigned to each device on a computer network that uses the Internet Protocol (IP), used to identify and locate the device for communication.



Modem/Router assigns IPs to different devices using **DHCP** - Dynamic host control protocol

Modem / Router also manages who made the request and who should receive the response

using **NAT**
Network Access
translate

Port number

To decide which application to send the data to port no. are used



Total Port no. = $2^{16} \approx 65000$

HTTP = 80

0 - 1023 → reserved ports

SQL = 1433

1024 - 49152

registered for application

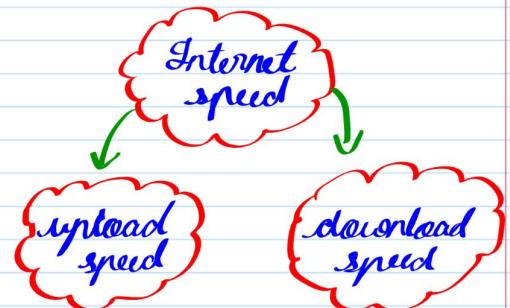
Internet speed

depends on the ISP (Internet service provider)

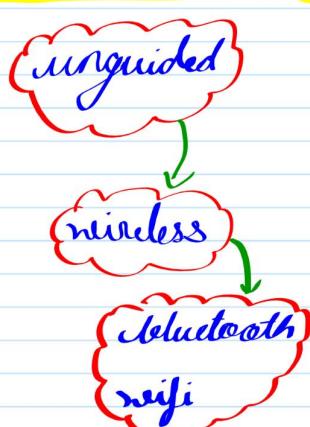
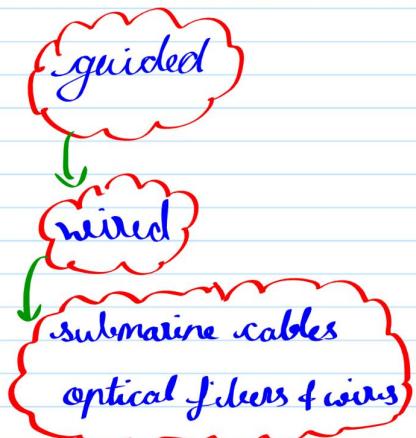
1 mbps = 1000,000 bits/sec

1 gbps = 10^9 bits/sec

1 kbps = 1000 bits/sec



Communication between computers happen in two ways:



Submarinecablemap.com

map of submarine cables throughout the world.

Physical medium of connection:

optical fiber

c coaxial cable

wireless medium of connection:

Bluetooth

wifi

5G

4G

LTE

3G

short range

long range

Computer Networks classified by their geographical coverage

LAN: Local area Network

single building, house, office, campus

MAN: Metropolitan area Network

city level,
15-50 km radius

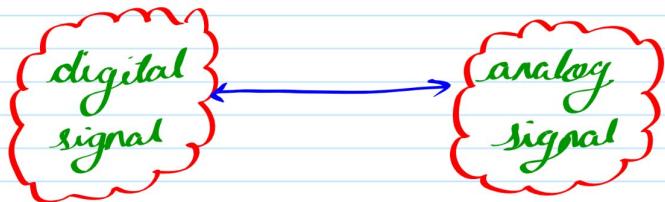
WAN: Wide area Network

connecting cities, countries, continents

SONET: Synchronous Optical Networking
Frame relay

MODEM

converts digital signals to analog signals and vice-versa.

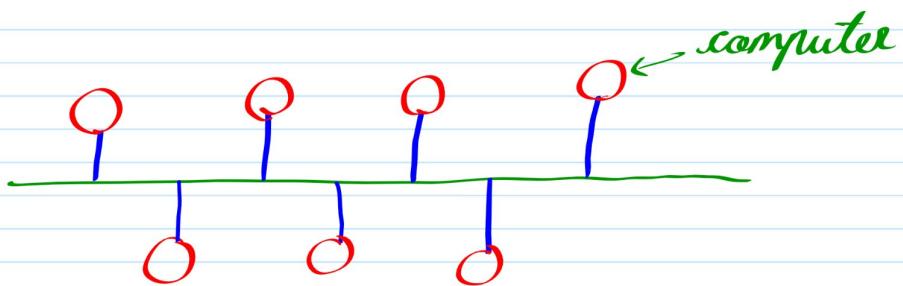


Router

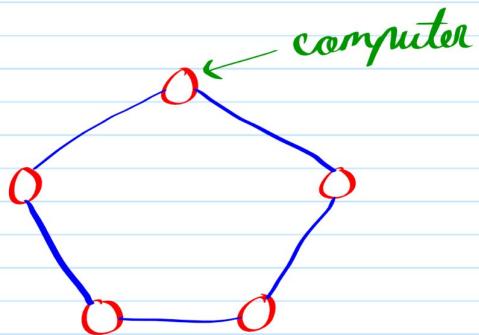
Routes data packets based on their IP addresses

Topologies

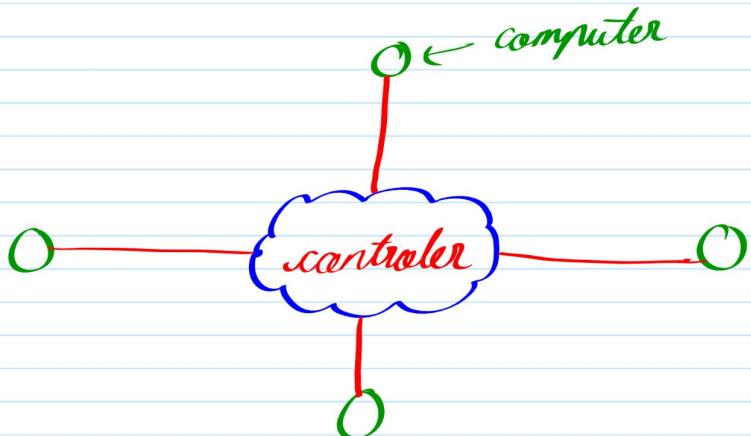
Bus:



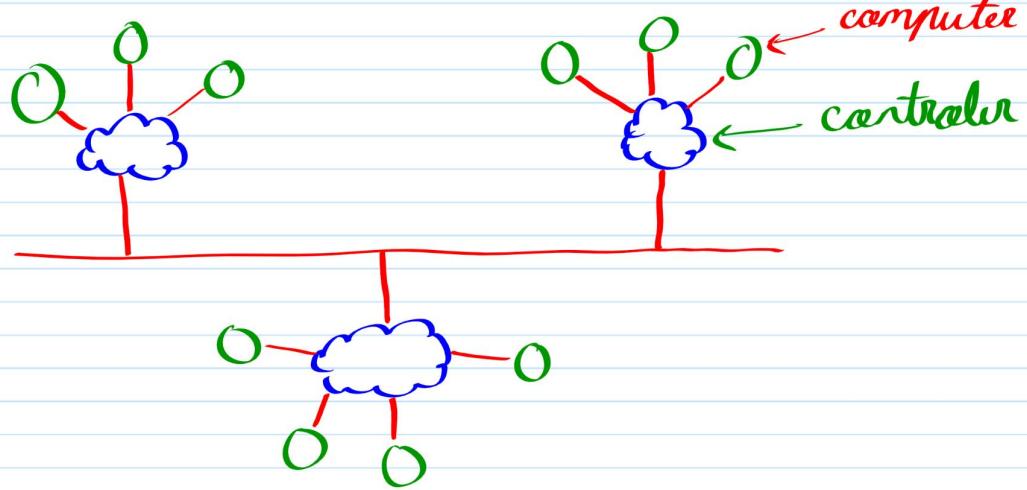
Ring, :



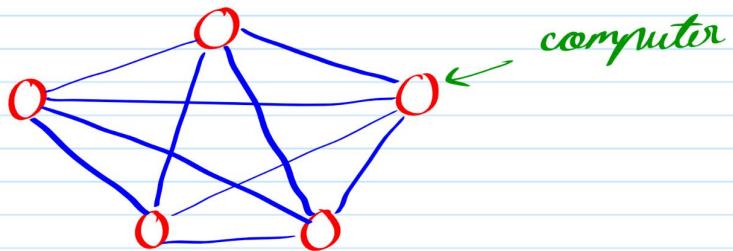
star



Tree



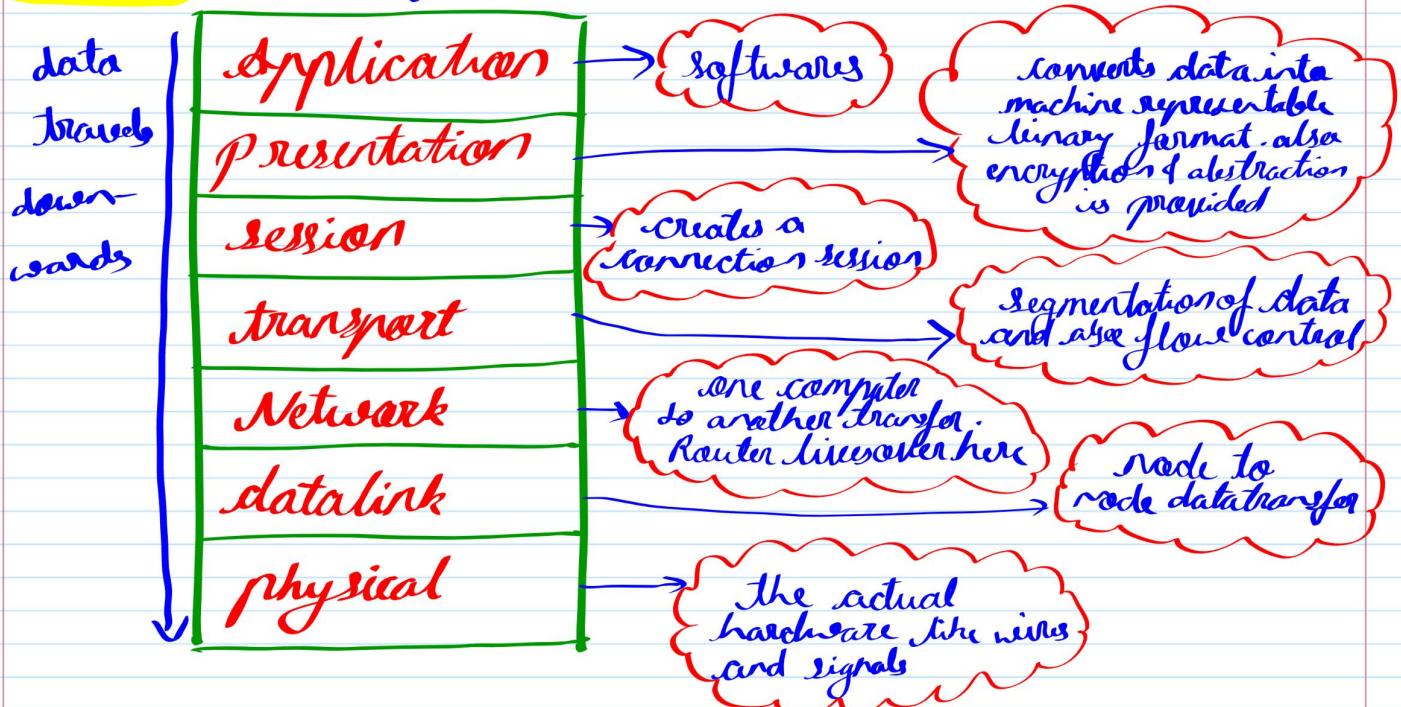
Mesh

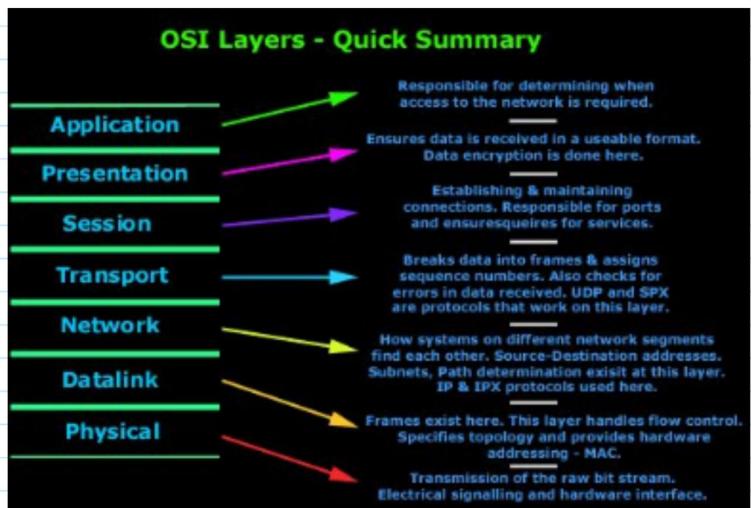


structure of Network

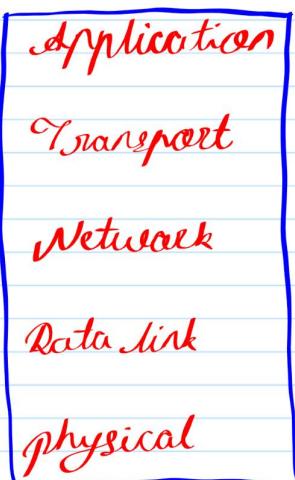
OSI

Open systems Interconnection model

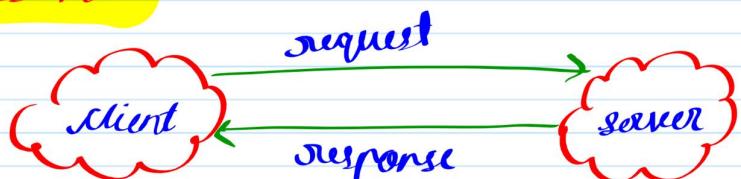




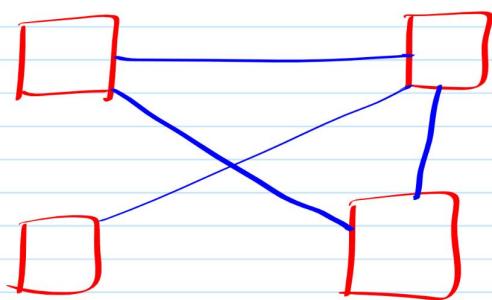
TCP/IP model



client server



P2P



Peer to peer

Repeater :

operates at physical layer

1 port device

regenerates the signal over the same network before the signal becomes too weak or corrupted

doesn't amplify the signal

Hub

is a multiport repeater

cannot filter data so data send to all connected devices

Bridge

operates at datalink layer

repeater with add on functionalities of filtering by MAC addresses

also used for interconnecting two LAN's working on same protocol

It has single input and single output port making it a two port device



Switch

multipoint Bridge with a buffer and a design that can boost its efficiency and performance

data link layer device which can perform error checking before forwarding data

Router

Routes datapackets based on their IP address.

connects LANs & WANs together

Network layer device

has a dynamically updating routing table

Gateway

connects two network together that may work upon different network model

messenger agents that take data from one system, interpret it and transfer it to another system

also called protocol converters and can operate at any network layer

Brounter

Bridge + Router = Brounter

Protocols

web protocols

TCP / IP :

HTTP → Hypertext transfer protocol

DHCP → Dynamic host control protocol

FTP → File transfer protocol

SMTP → simple mail transfer protocol

POP3 → Post office protocol

SSH → Secured shell

IMAP → Internet message access protocol

CellNet



UDP



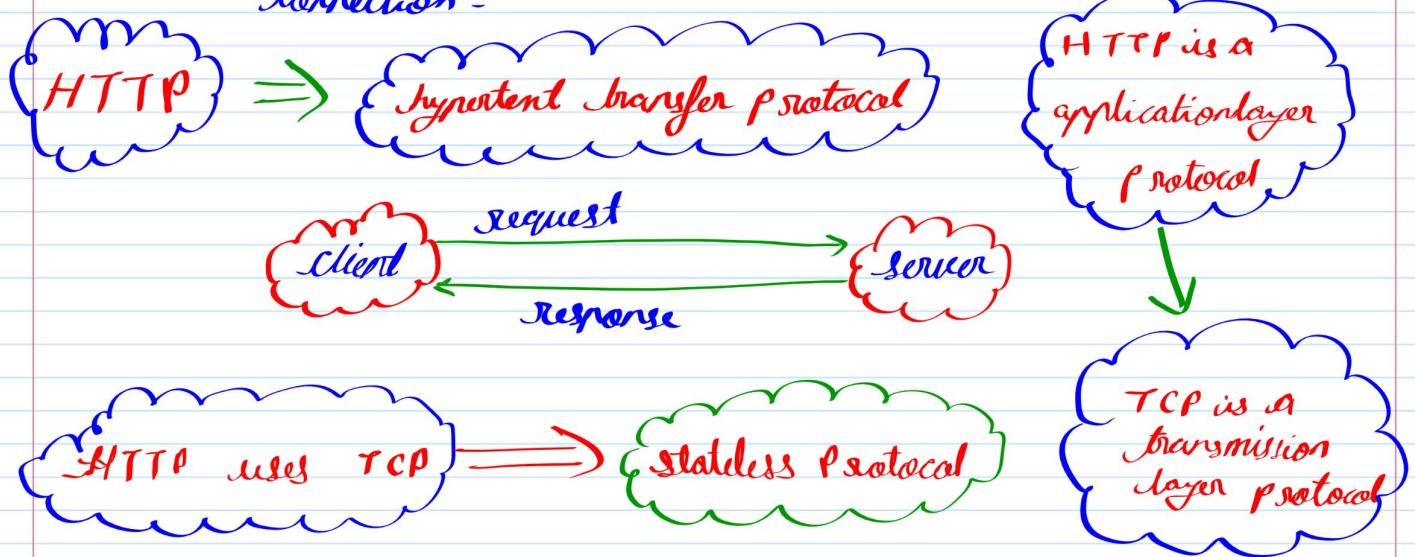
Program: set of instruction, algorithm or code.

Process: Program in Execution.

Thread: lightweight process.

Sockets: a software that enables two way communication between two programs running on the same network.

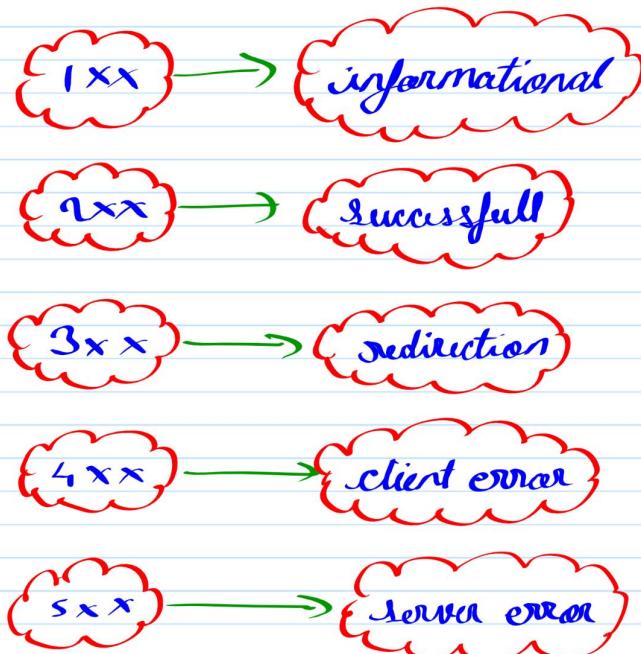
Ports: a logical construct that serves as a communication endpoint, allowing a computer to manage multiple network services simultaneously over a single physical connection.



HTTP Method

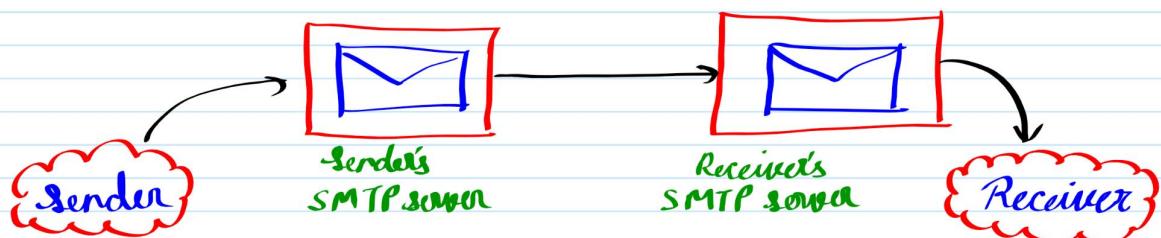


Status codes

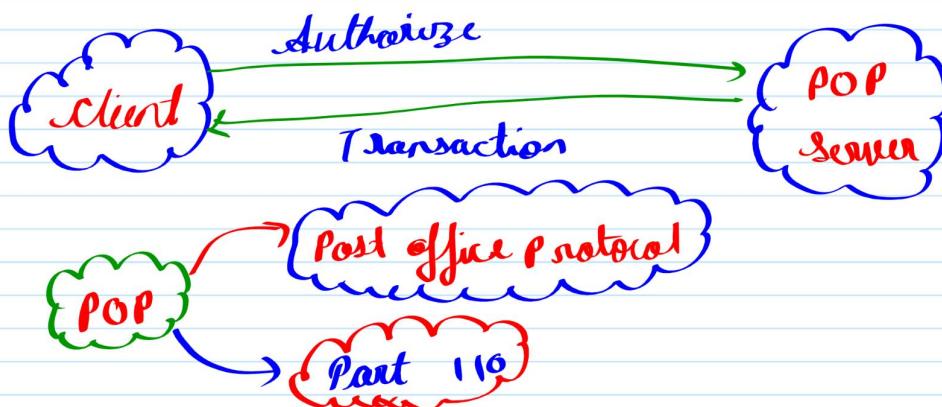


Cookies

A small piece of data sent from a website and stored on a user's device by their web browser.



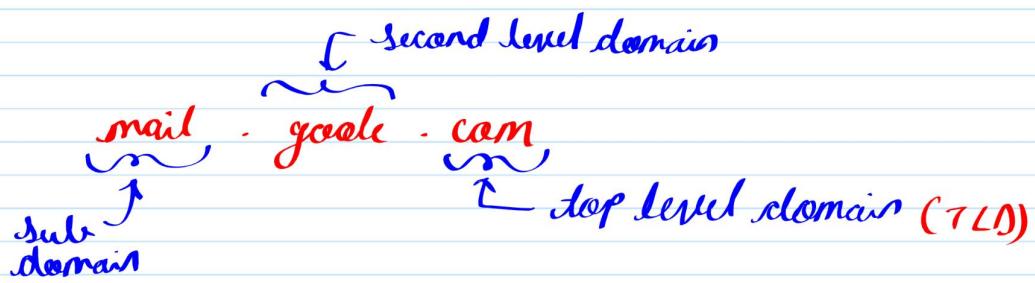
SMTP : simple mail transfer protocol



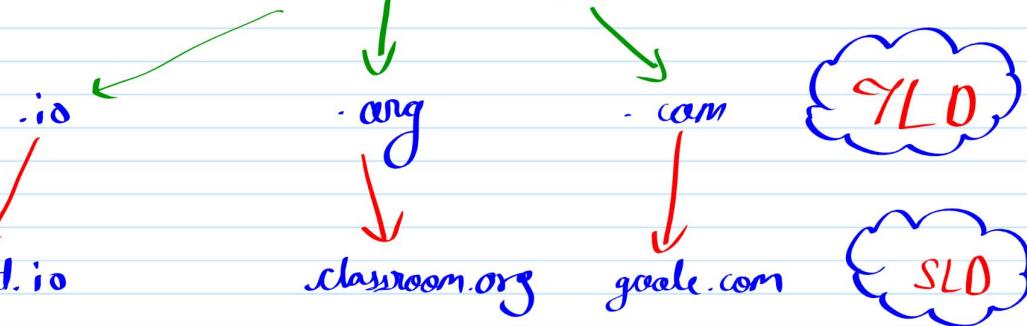
URL → **Unified Resource Locator**

DNS: Domain Name System

A hierarchical and distributed naming system that translates human readable domain names into machine readable Internet Protocol (IP) addresses



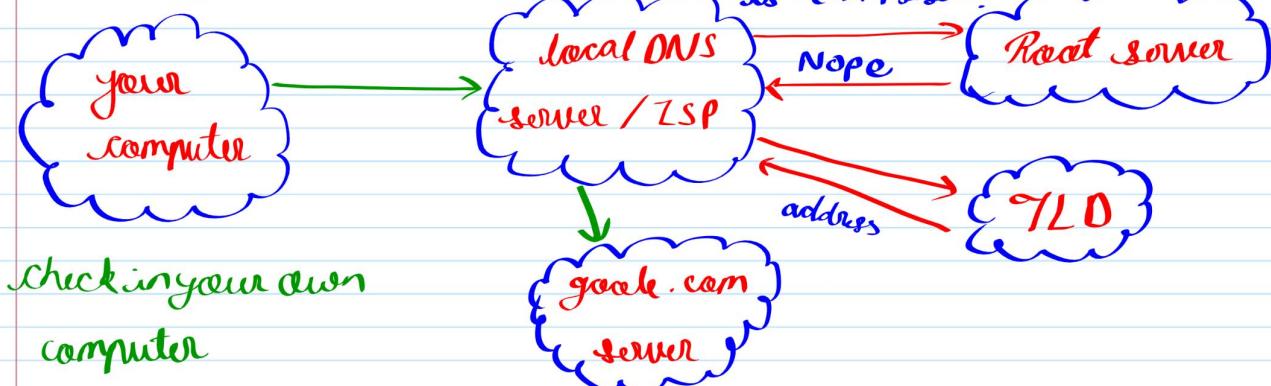
Root DNS servers



TLD

SLD

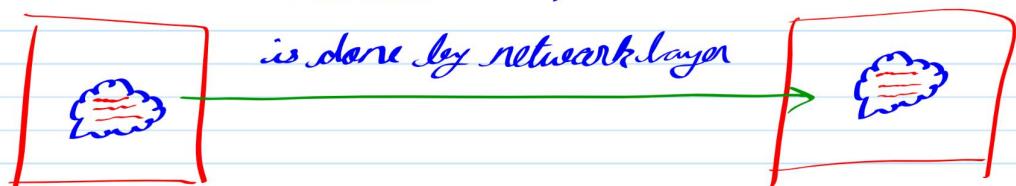
Searching IP



Checking in your own computer

② Transport layer

The actual transportation



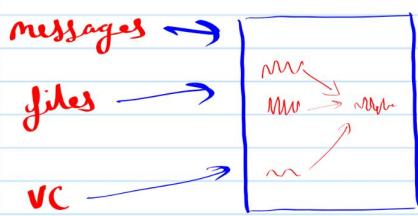
You

Your friend

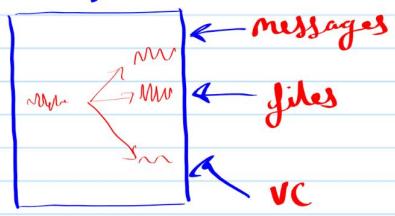
The transportation of data from network to application is done by transport layer.

Multiplexing, demultiplexing (multiple ports handling)

Multiplexer



Demultiplexer



Transport layer attaches part numbers to packets

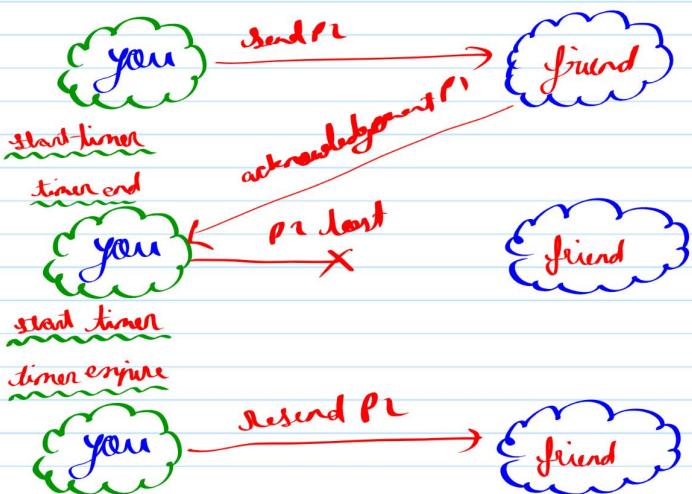
Transport layer also takes care of congestion control

check sum:

used to detect errors in the data

Timer

P1 = Packet 1

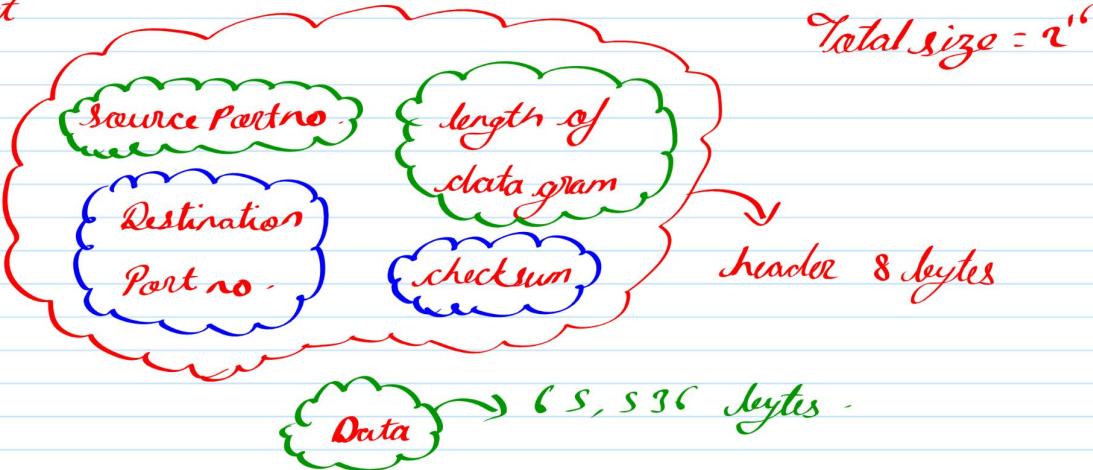


Sequence no. is used
to identify packets

UDP - user datagram protocol

Data may or may not be delivered
data may change
data may not be in order

UDP Packet



usecases

- very fast
- video conferencing app
- DNS → UDP
- Gaming

TCP - Transmission Control Protocol

- Transport layer protocol
- Application layer sends lots of raw data TCP segments this data — divide in chunks and headers. It may also collect the data from network layer
- congestion control -

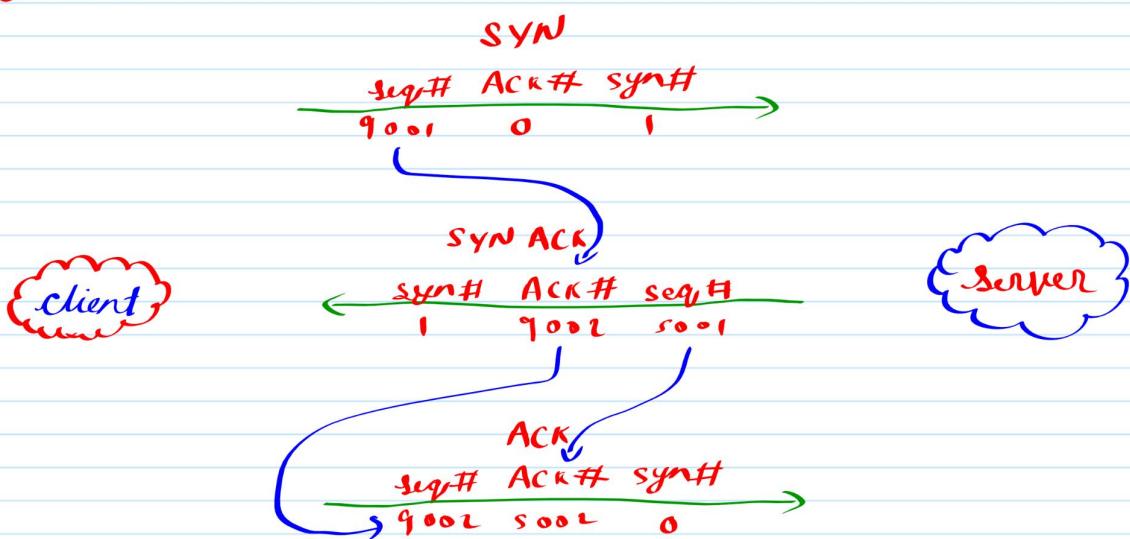
takes care of

- when data doesn't arrive
- maintains order

features

- connection oriented
- error control
- congestion control
- full duplex

3 way handshake → used to establish connection



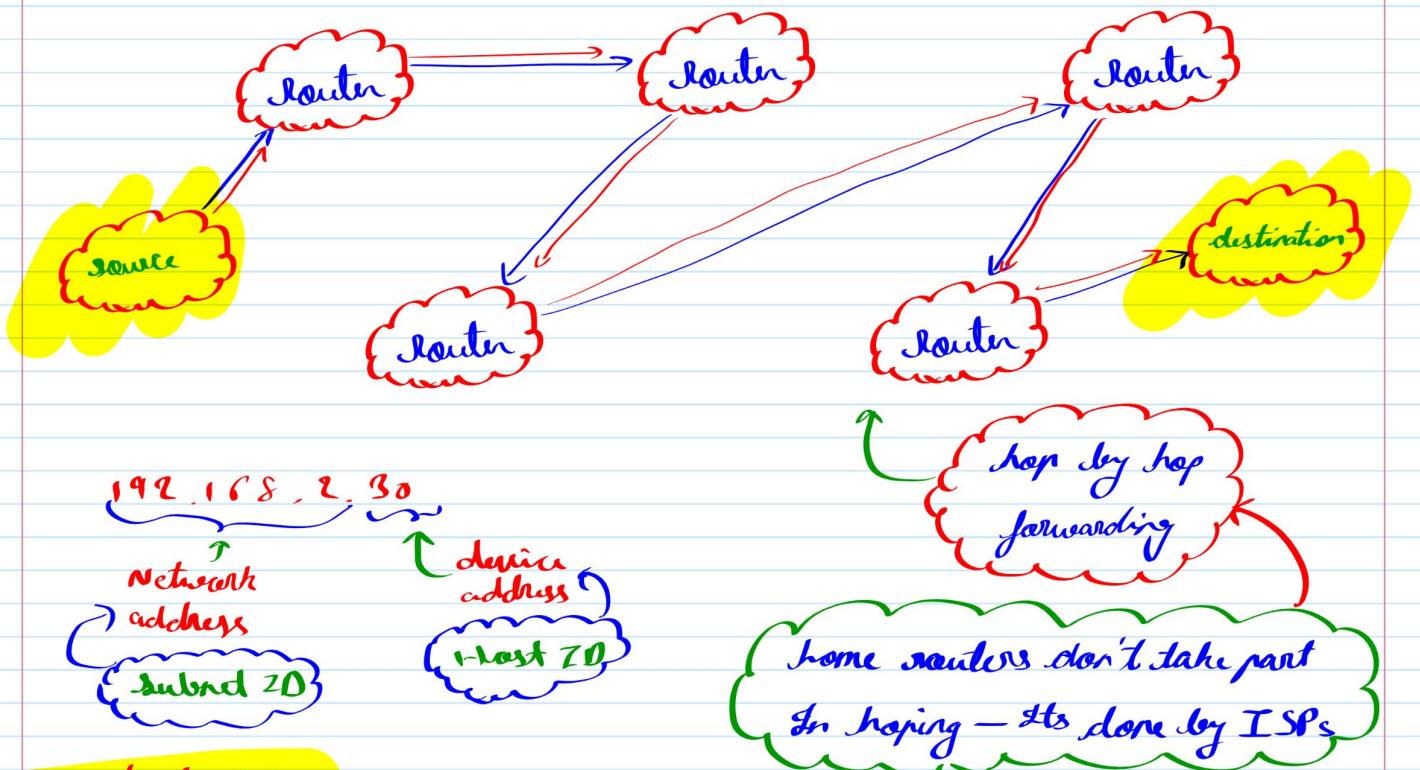
layers

Transport → segments

Network → packets

Datalink → frames

Network layer → how we work with routers -



control Plane

Brain of the Network
controls how data should flow

Routers = **Nodes**

links = **edges**

types of routing

1) static routing

- manually adding routes

2) dynamic routing

- change in network, updates automatically.
- uses bellmanford, dijkstra, and more path finding algorithms

Internet protocol (IP)

IPv4 → 32 bits | 4 words 8 bits each

IPv6 → 128 bits

classes of IP addresses

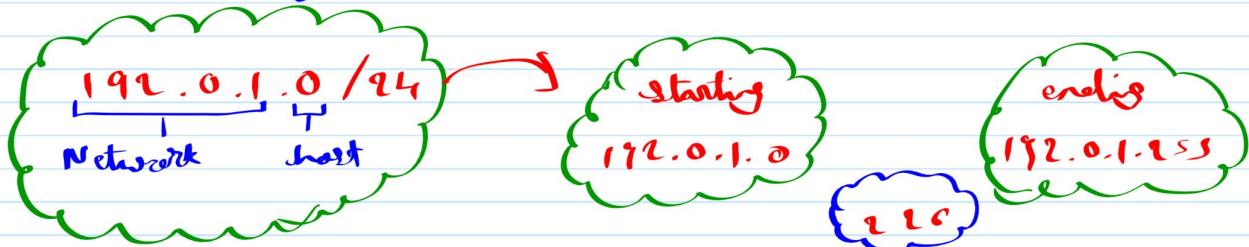
class A	→ 0.0.0.0	-	127.255.255.255
class B	→ 128.0.0.0	-	191.255.255.255
class C	→ 192.0.0.0	-	223.255.255.255
class D	→ 224.0.0.0	-	239.255.255.255
class E	→ 240.0.0.0	-	255.255.255.255

subnet masking

subnet masking is a method used to divide an IP into two parts. the network portion and the host portion, enabling efficient network segmentation and routing.

Variable Length Subnet Mask (VLSM)

it's a subnetting technique that allows network administrators to divide an IP network into subnets of different sizes by using varying subnet masks for different subnets.



Some IPv4 addresses are reserved.

127.0.0.0 /8 → loop back addresses → testing purpose
Ex : localhost : 127.0.0.1

↓
server of client
on same machine

Packets



IPv6

IPv4 : $2^{32} \approx 4.2$

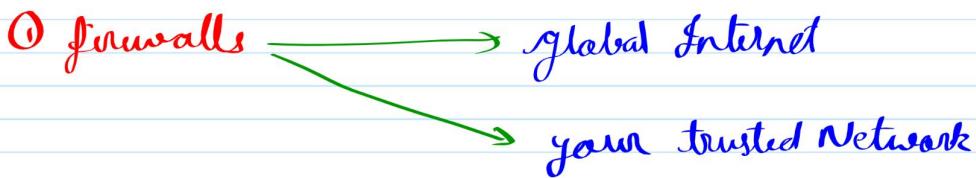
IPv6 : $2^{128} = 2^{128} \approx 3.4 \times 10^{38}$

- cons : - Not backward compatible
- ISPs would have to shift, lot of hardware work

IPv6



Middle Boxes:



filter out IP packets based on various rules

- address
- modified packets
- port no.
- flags
- protocols

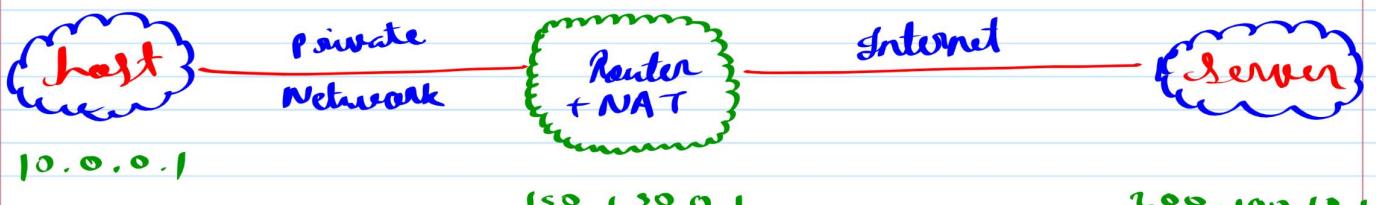
firewall provides these filters

stateless firewall

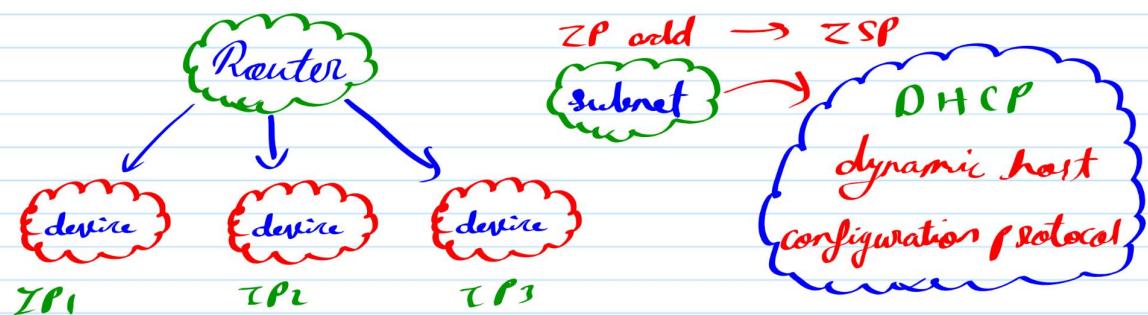
+ statefull firewall

NAT: Network Access translator

A Protocol which allows multiple devices to share a single public IP address when accessing the Internet



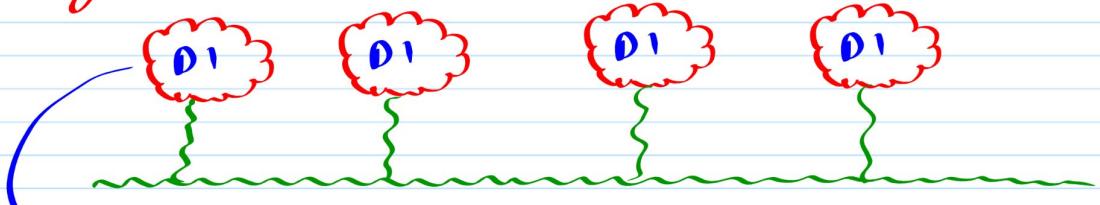
Data link layer (TCP)



many devices connected in LAN:

these devices communicate using data link

layer addresses



check for address to communicate on LAN

if not
found in
cache

① cache

② ARP cache (Address resolution Protocol)

Datalink layer (DLc) frame

DLLA of sender

ZR of destination

Datalink layer addresses and
MAC (Media Access control) addresses
are one of the same