Internet → Global system of interconnected computer ~~networks~~ networks that uses internet protocol suite to communicate between network and devices.

~~TCP~~

TCP/IP five layer model (traditionly TCP/IP has four layers)*

→ Internet *

#	Layer Name	Protocol	Protocol Data Unit	Addressing
5	Application	HTTP, SMTP, etc.	Messages	n/a
4	Transport	TCP/UDP	Segment	Port #'s
3	Network	IP	Datagram	IP address
2	Data link	Ethernet, Wifi	Frames	MAC Address
1	Physical	10 BaseT, 802.11	Bits	n/a

→ Subnet *

physical → physical devices that ~~help~~ interconnect computer.
↳ specification of network cable
↳ connection ~~that~~ that connect devices together

Data link → Responsible for defining a common way of interpreting these signals so network devices can communicate.
↳ The ~~ether~~ ethernet standards also define a protocol responsible for getting nodes on the same network or link.

network → allow different networks to communicate with each other through devices known as routers
↳ it is responsible for getting data ~~across~~ across a network.
↳ most important protocol → IP

Transport → it is responsible for getting data on right application on a node.
↳ protocol → TCP, UDP

Application → Application specific

OSI Model (Open system interconnection)

In OSI model application layer is divided in 3 different layer

Application
- Application
- Presentation
- session

Application → It provide a set of interfaces for applications to obtain access to networked services as well as access to network services that support application directly.
→ application access security checking and information validations.
→ functions
- File Transfer, Access and Management
- Virtual Terminal
- Mail and Messaging Handling
- Directory Structure
- Common management Information protocol.

Presentation → It is responsible for the format of the data transferred during network communication
→ Data conversion
→ Data compression
→ Cryptography

Session → permits two parties to hold ongoing communication
→ one or two way communication
→ Synchronization

Networking devices

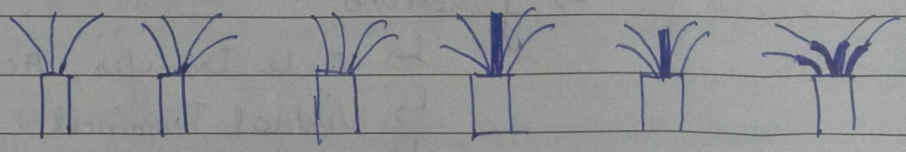
→ Cables
- ↳ copper
- ↳ Fiber

↳ common copper twisted cable
- ↳ cat 5
- ↳ cat 5e
- ↳ cat 6

} difference
- ↳ no. of twists
- ↳ arrangement

↳ low distance on high speed

cat 3 cat 5 cat 5e cat 6 cat 6a cat 7



crosstalk → when an electric pulse on one wire is accidentally detected on another wire.

↳ Individual optical fiber
- ↳ low data loss

⇒ Hubs and switches (Lan)

↳ Hub → A physical layer device that allows for connections from many computers at once.
- → all devices connected to hub talk to all other devices.
  - ↳ they can either ignore or accept data

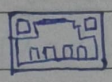
↳ Collision domain → A network segment where only one device can communicate at a time. If multiple system send data at the same time then electric pulse can interfere.

Switch → layer 2 device
↳ It can inspect content of data and find out specific computer to send data.
→ less transmission and higher throughput

Routers → forward data between independent network.
→ layer 3 device.
→ Inspect ip data
→ Backbone of internet
↳ Border gateway protocol (BGP) → it lets routes learn about most optimal path to forward traffic.

The physical layer

→ move one's and zero's from one end of link to another.
→ devices and means of transmissing bit's
→ modulation - a way of varying the voltage of this charge moving across the cable.
→ Duplex - The concept that information can flow in both direction across the cable.
Simplex - one way communication

common port → RJ45 

The data link layer

→ Most widely used protocol to send data is Ethernet
→ Abstract physical layer and hardware in use.

→ eathernet solve the problem of data collison carrier sense multiple access with collison detection (CSMA/CD)

Mac address → A globally unique identifier attached to an individual network address.
→ 48 bit number with 6 groupings of 2 Hex numbers

mac address → xx : xx : xx : xx : xx : xx

Organizational unique identifier (OUI) → manufacturer

↳ unique number given by manufacturer

→ Ethernet uses MAC address to ensure that data it sends has both an address for the machine that send the transmission, as well as the one transmission was intended for.

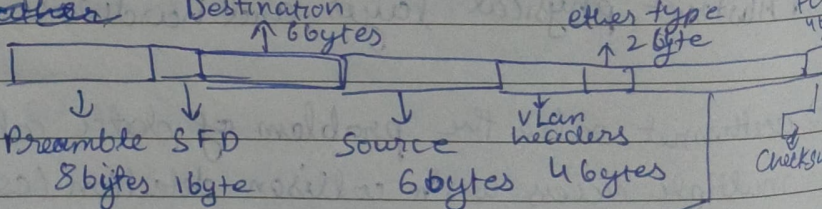
→ Unicast → it is just for one receiving address.
↳ if least significant bit of first octate is set to 0

→ Multicast → accepted and discarded by each device based on certain criteria aside from their own mac address.
→ if least significant bit of first octat is set to 1

→ Broadcast → send to all devices on lan.
→ special destination ⇒ FF : FF : FF : FF : FF : F
↳ brocadcast addres

→ Data packet → An all-encompassing term that represents any single set of binary data bei sent across a network link.
→ at ethernet level ⇒ ethernet fra

→ ethernet frame →



VLan → multiple logical lan on same physical equipment.

Payload → actual data

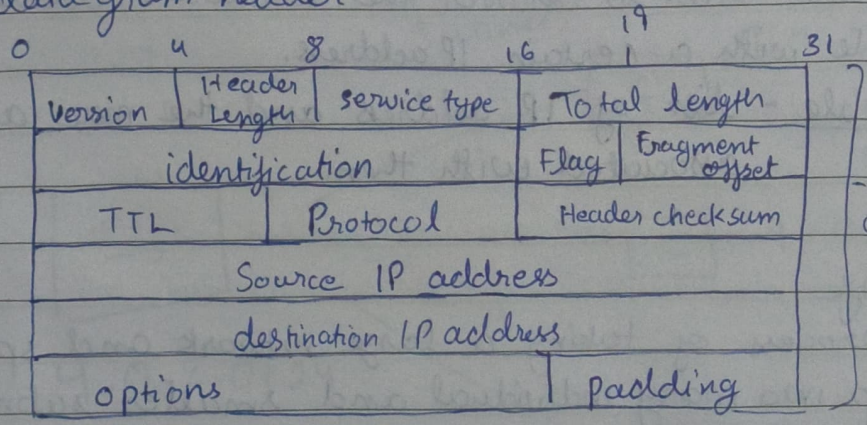
Network Layer

IP → 12.34.56.78 —binary→ 00001100.00100010.00111000.01001110

- ↳ each octet can represent no. from 0 to 255
- ↳ distributed in large section to various organization and companies.
- ↳ IP address belong to networks, not to devices attached to those networks.
- ↳ Ip are assigned automatically by Dynamic Host Configuration Protocol (DHCP).
  - ↳ dynamic IP → reserved for clients
  - ↳ static IP → must be configured manually
    - ↳ reserved for servers and network devices.

IP datagram (data packet at network layer)

IP datagram header



→ The maximum size of a single datagram is the largest number you can represent with 16 bits → 65,535.

if total amount of data that needs to be sent is larger than what can fit in a single datagram, the IP layer needs to split this data up into many individual packets.

IP → 9.100.100.100 → Host ID

→ network ID

→ Address Class System → A way of defining how the global IP address space is split up. → Network ID

↳ class A ⇒ 9. 100.100.100 → host ID
network ID

↳ class B ⇒ 9.100.100.100 — host ID
→ network ID

↳ class C ⇒ 9.100.100.100 - host ID

class	Left most bit	Starting IP	Last IP
A	0xxx	0.0.0.0	127.255.255.255
B	10xx	128.0.0.0	191.255.255.255
C	110x	192.0.0.0	223.255.255.255
D	1110	224.0.0.0	239.255.255.255
E	1111	240.0.0.0	255.255.255.255

→ Testing purpo

↳ replaced by CIDR

Address resolution protocol

↳ A protocol used to discover the hardware address of a node with a certain IP address.

↳ Arp table - list of IP address and the mac address associated with them.

Subnetting

↳ The process of taking a large network and splitting it up into many individual and smaller subnetworks or subnets.

Subnetting mask

↳ 32 bit number, written out as four octets.

IP → 10.0.1.10
subnet ID
network ID
host ID

ip → 9 . 100 . 100 . 100

0000 1001 . 0110 0100 . 0110 0100 . 0110 0100

padded with 0's to make 8 bit

Space for host ID

Subnet ID → 255.255.255.0

Subnet mask → 1111 1111 . 1111 1111 . 1111 1111 . 0000 0000

IP → 0000 1001 . 01100100 . 0110 0100 . 0110 0100

~~Subnet mask~~ Subnet mask → 225 . 225 . 225 . 224

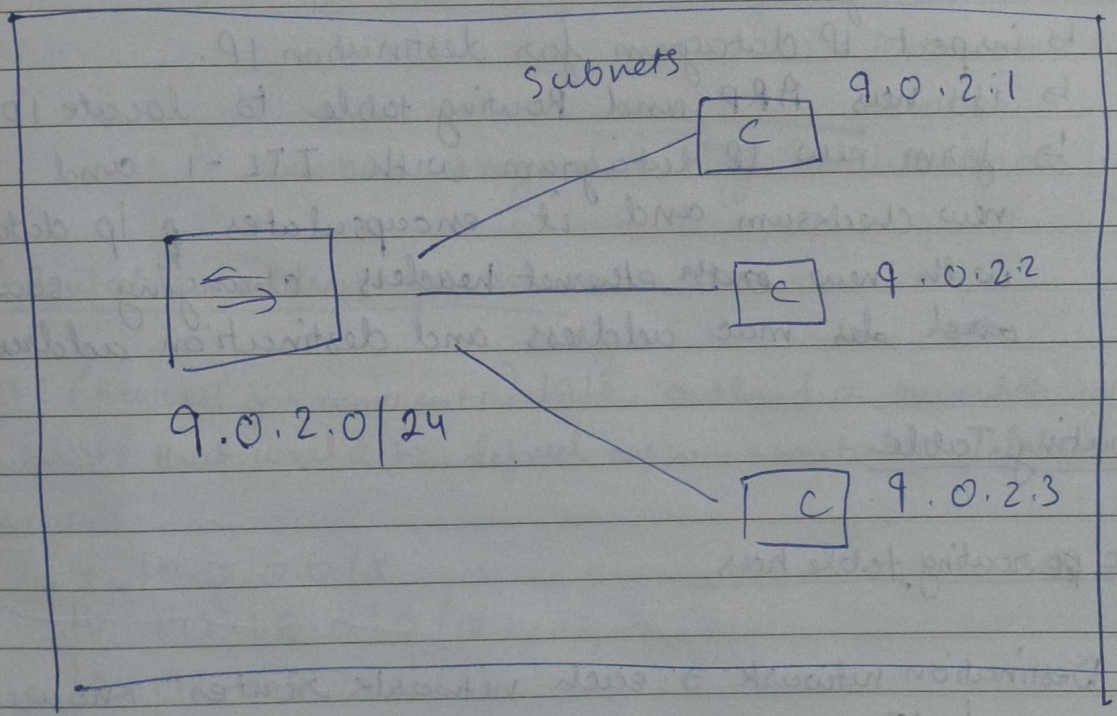
11111111 . 11111111 . 11111111 . 111 00000

5 bit of host ID space

27 → 1's and 5 → 0's

So we refrence it as '/27'

ip + subnet ⇒ 9 . 100 . 100 . 100/27



CIDR

↳ classless inter-Domain Routing

↳ network id and subnet id are combined in one

→ ~~9~~00 9 . 100 . 100 . 100/24] → cider notation

↳ Host

↳ network

~~Host~~

Routing

↳ A network device that forwards traffic depending on the destination address of that traffic.

Basic routing

- ↳ Receive data packet
- ↳ examines destination IP
- ↳ Look up IP destination network in routing table
- ↳ forward traffic to destination

↳ repeated as often as needed.

- procedure
  - ↳ router has interface on each network.
  - ↳ strips data link layer encapsulation leaving IP datagram.
  - ↳ inspect IP datagram for destination IP.
  - ↳ it has ARP and Routing table to locate IP.
  - ↳ form new IP datagram with TTL-1 and new checksum and it encapsulates ip datagram with new ethernet headers changing source mac address and destination address.

Routing Table

Basic routing table has

- ↳ Destination network → each network router knows abt
  - ↳ IP
  - ↳ subnet Mask
  - ↳ CIDR
- ↳ next hop → next routers that should receive data.
- ↳ Total hops
- ↳ Interface → which interface it should send data

Interior Gateway protocols → information about every router is available to others
↳ Link state protocols
↳ distance-vector protocols (older) → they know only their direct neighbour.

→ used by routers to share information within a single autonomous system;
↳ a collection of networks that all fall under the control of a single network operator.

Exterior Gateway protocols

↳ sharing data with different autonomous system
↳ IANA → internet assigned Numbers authority is a non-profit organization that helps manage things like IP address allocation.
↳ It is also responsible for ASN
↳ Autonomous system number
↳ Numbers assigned to different autonomous system

Non-Routable address spaces

→ RFC (Request for comments) 1918, outlined a number of networks that would be defined as non-routable address ranges
↳ 10.0.0.0/8
↳ 172.16.0.0/12
↳ 192.168.0.0/16

The transport layer

multiplexing → nodes on the network have the ability to direct traffic towards many different receiving services.
demultiplexing → receiving all networkes aimed at same node and delivering it to proper receiving services.

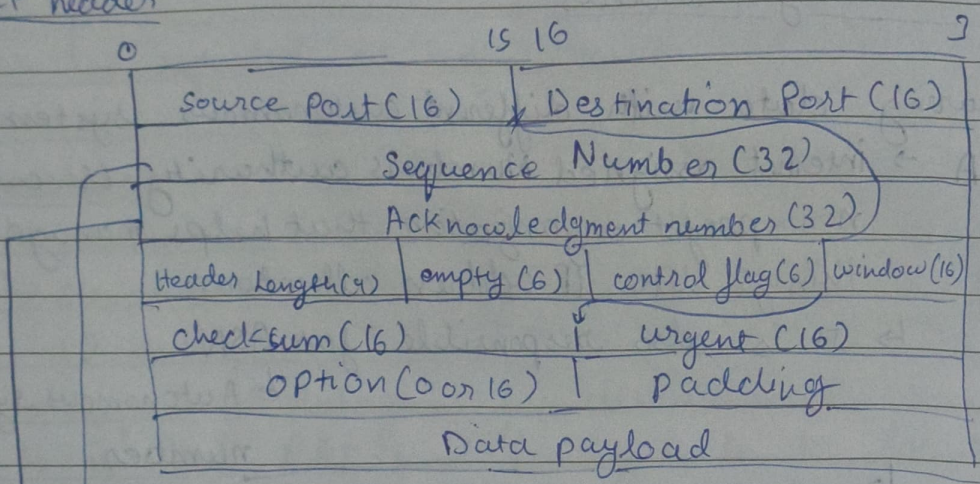
→ port → A 16-bit number that's used to direct traffic to specific services running on a networked computer.

↳ 10.1.1.100:80
↳ IP ↳ port

↳ socket address or socket number

TCP segment

↳ TCP header



↳ keep track where in a sequence of TCP segments this one is expected to be

↳ next expected segment

& TCP control flag

↳ URG (urgent) → segment is considered urgent and urgent pointer field has more data about it.

↳ ACK (acknowledged) → acknowledgement number should be examined.

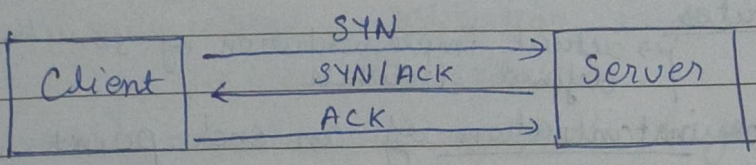
↳ PSH (push) → transmitting device wants the receiving device to push currently buffered data to the application on receiving end as a

↳ RST (reset) → one side in TCP connection hasn't been abl to properly recover from series of missing or malformed segments.

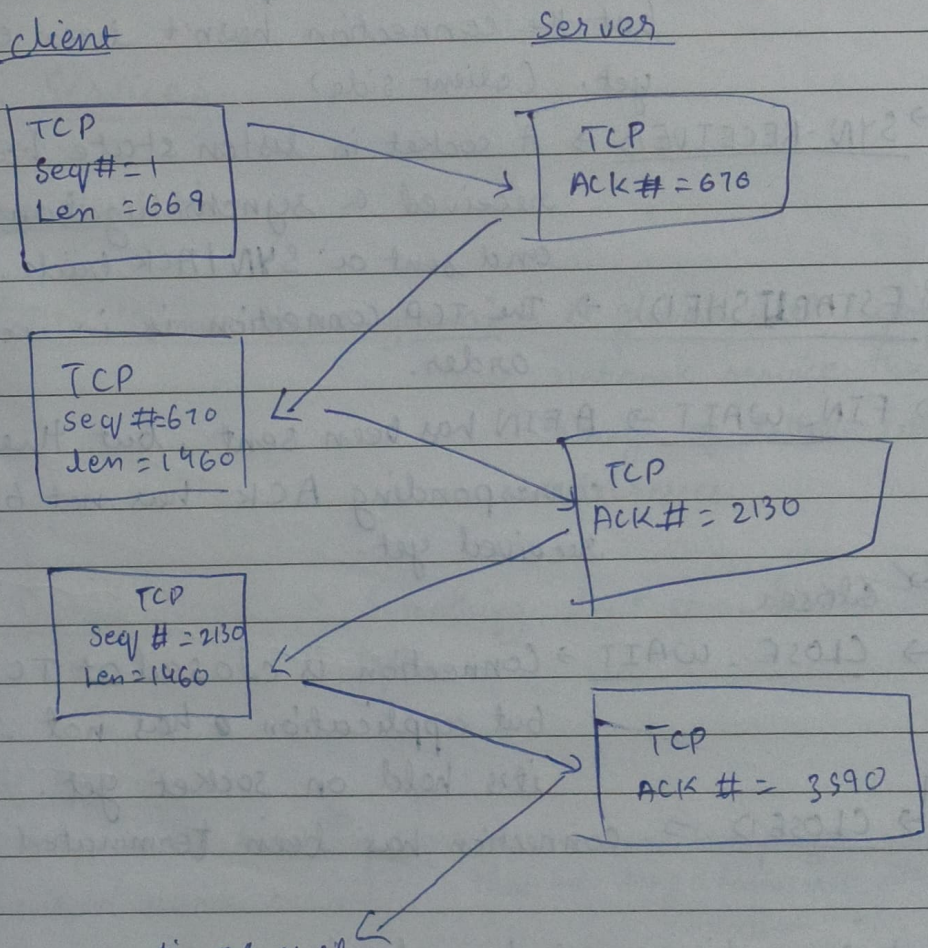
→ SIN (Syncronize) → used when first establishing a TCP connection and make sure that receiving end knows to examine the sequence number field.

→ FIN (finish) → connection can be closed.

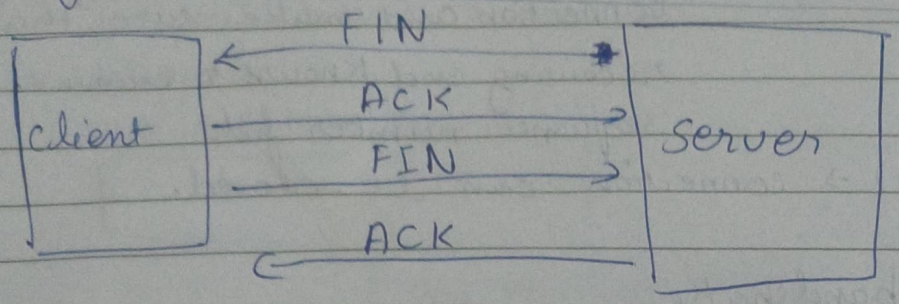
Three way handshake



→ handshake is a way for two devices to ensure that they're speaking the same protocol and will be able to understand each other.



→ Four way handshake (when closing connection)



→ TCP socket states
  ↳ actual implementation of something defined elsewhere.

→ Socket → The instantiation of an end-point in a potential TCP connection.

↳ Listen → A TCP socket is ready and listning for incoming connections. (server side)

↳ SYN_SENT → A synchronization request has been sent, but the connection hasn't been established yet. (client side)

↳ SYN-RECEIVED → A socket in listen state has received a synchronization request and sent a SYN/ACK back.

↳ ESTABLISHED → The TCP connection is in working order.

↳ FIN_WAIT → A FIN has been sent, but the corresponding ACK has not been received yet.

~~Closed~~

↳ CLOSE_WAIT → Connection is closed at TCP layer but application has not released it's hold on socket yet.

↳ CLOSED → connection has been terminated.

→ TCP is connection oriented protocol,
  ↳ establishes a connection and uses this to ensure that all data has been properly transmitte

UDP
↳ User datagram protocol
↳ connectionless protocol
↳ it directly connects to server
↳ packets may be lost

→ Firewalls
↳ blocks traffic that meets certain criteria.
↳ They can inspect application layers.
↳ blocking certain IP addresses.
↳ generally used in transport layer, they block traffic to a certain ports while allowing traffic to other ports.

Application Layer
↳ Applications send and receive data using application layer.

Network Services
↳ Name Resolution
↳ DNS (Domain Name System) → A global and highly distributed network service that resolves strings of letters into IP addresses.
↳ Domain Name → Something that can be resolved by DNS.

→ Type of DNS Server
↳ Caching name server → store domain name lookup for some time.
↳ Recursive name server → TTL → Time how long a nameserver allow to cache entry
↳ Root name server
↳ TLD name server
↳ Authoritative name server

Recursive nameserver Steps

↳ contact root server,
↳ redirect query to appropriate TLD name server → authoritive server

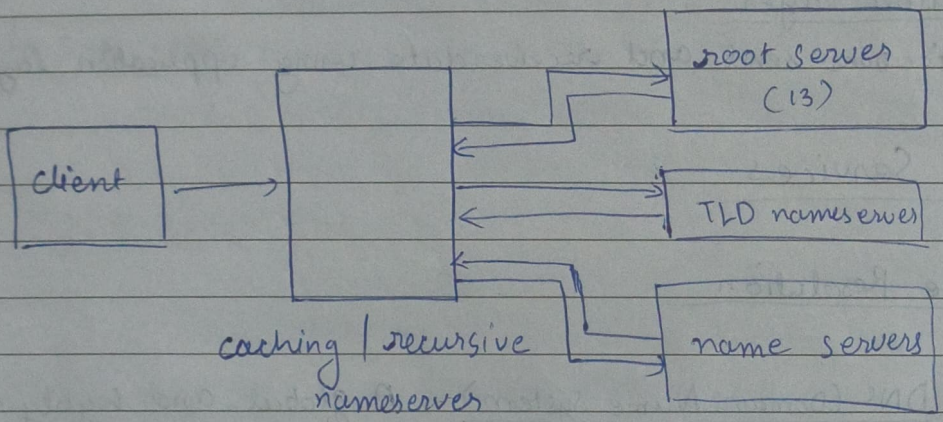
→ www.google.com

↓

TLD (Top level domain)

↳ TLD will redirect, informing the computer with what authoritative name server to contact.

↳ contact authoritative server for IP.



→ DNS uses UDP

Resource Record type

↳ A record → it is used to point a certain domain name at certain IPv4 IP address.

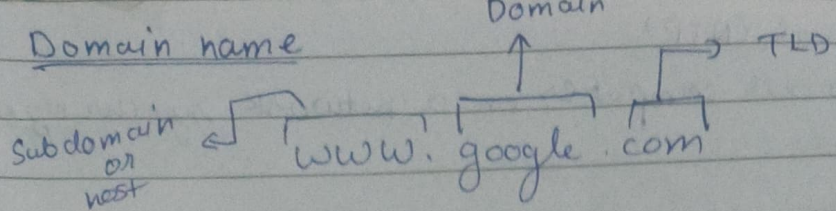
↳ AAAA - quad A → return ipv6 address

↳ CName → redirect traffic from one domain name to another.

↳ Mx record → mail exchange
↳ SRV record → service record

↳ TXT record → text

Domain name



→ administration and definition of TLD's is handled by a non-profit organization known as ICANN.
↳ Internet corporation of assigned names and numbers.

↳ They control DNS
↳ DNS can support upto 127 levels of domain in total for single fully qualified domain name.

→ DNS zone
↳ easier control over multiple level of domain.
→ Zone file
↳ simple configuration file that declare all resource records for a perticular zone.

Dynamic Host configuration Protocol (DHCP)

↳ An application layer protocol that automates the configuration process of host on a network.

↳ Dynamic allocation
↳ A range of IP address is set aside for client devices and one of these IPs is issued to these devices when they request one.

↳ Automatic allocation
↳ it assignes the same IP to the device everytime if possible

↳ Fixed allocation
↳ fixed ip is assigned everytime.

↳ Network time protocol (NTP)
↳ used to keep all computer on a network synchroniz in time.

⇒ DHCP discovery → The process by which a client configured to use DHCP attemps to get network configuration information.

→ Network Address Translation (NAT)

↳ Take one IP address and translate it into other.
↳ security ~~safeguarde~~ safeguard and to preserve the limited amounts of available IPV4 space.

↳ It is a technology that allows a gateway, to rewrite the source IP of an outgoing IP datagram while retaining the original IP in order to rewrite it into the response.
(IP masquerading)

↳ Port preservation → A technique where the source port chosen by a client is the same port used by router.

↳ Port forwarding → A technique where specific destination port can be configured to always be delivered to specific nodes.

→ Virtual private network (VPN)

↳ A technology that allows for the extensions of a private or local network to hosts that might not be on that local network.

Proxy Services

↳ A server that act on behalf of client in order to access another service

↳ provides

↳ Anonymity

↳ Security

↳ Content filtering

↳ Increased Performance

→ Reverse Proxy

↳ A service that might appear to be a single server to external clients, but actually represents many servers living behind it.

↳ also used for encryption and decryption.

→ Broadband

↳ Any connection technology that isn't dial-up internet.

→ T-connection → (old)

↳ Any telephone network connection capable of speed = 1.544 megabits per second.

→ Digital subscriber line → (old)

↳ Transfer of data over telephone line on different frequency.

→ cable Broadband

↳ Transfer of data over TV cables.

↳ shared bandwidth

→ Fiber connection

↳ data transfer using optical cable

→ point-to-point vpn

↳ also called site to site vpn.

↳ establishes a vpn tunnel between two sites.

↳ managed by network devices.

* Wireless networking

↳ most common specification IEEE 802.11 standards

↳ these specifications also known as 802.11 family make up wifi technology.

↳ communicate through radio waves.

↳ most common frequency band for wifi 2.4 GHz and 5 GHz

↳ 802.11 specifications

↳ 802.11b
↳ 802.11a
↳ 802.11g
↳ 802.11n
↳ 802.11ac

some improvement

↳ 802.11 frame

Octates	2	2	6	6	6	2	6	0-7951	
	Frame Control	Duration/ ID	Address 1	Address 2	Address 3	Sequence control	Address 4	Data payload	F

↳ How long frame is
↳ describe how frame should be processed.

↳ wireless access point

↳ it bridges wireless and wired portion of network.

→ wireless network configuration

↳ Adhoc networks → every device involved with the network communicate with every other device.

↳ wireless lan (WLAN)

↳ Mesh networks

→ channels
↳ individual, smaller section of frequency band used by a wireless network.

↳ wireless network band range
↳ 2.400 GHz to 2.500 GHz.
↳ similarly ~~note~~ networks start at 5.000 GHz.

→ wireless security

↳ Wired Equivalent Privacy (WEP)

↳ An encryption technology that provides a very low level of privacy.
↳ 40 bit key

↳ Wifi protected Access (WPA)
↳ uses 128 bit key
↳ most commonly used encryption algorithm is WPA2.
↳ it uses 256-bit key

Public DNS server

↳ Level 3 communication
↳ 4.2.2.1
↳ 4.2.2.2
↳ 4.2.2.3
↳ ~~4.2.2.4~~ 4.2.2.4
↳ 4.2.2.5
↳ 4.2.2.6

not ~~acknowledged~~ acknowledge or documented officially

↳ Google DNS
↳ 8.8.8.8
↳ 8.8.4.4

↳ cisco openDNS
  ↳ 208.67.222.222
  ↳ 208.67.220.220

↳ cloudflare
  ↳ [redacted] 1.1.1.1
  ↳ 1.0.0.1

↳ Quad 9
  ↳ 9.9.9.9
  ↳ 149.112.112.112

↳ comodo
  ↳ 8.26.56.26
  ↳ 8.20.247.20

→ Cloud

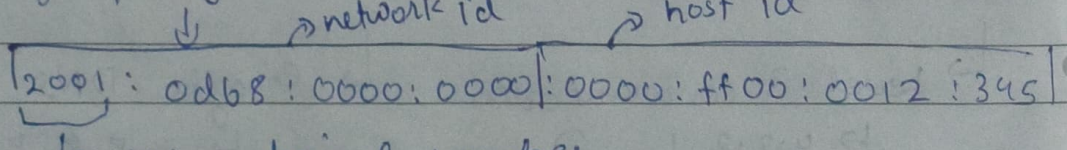
→ cloud computing
  ↳ it is a technological ~~approct~~ approach where computing resources are provisioned in a ~~shera~~ shareable way, so that lot of users get what they need, when they need it.

  ↳ core of cloud → Hardware virtulization

  ↳ Hypervisor
    ↳ A piece of software that runs and manages virtual machines, while other offering these guests a virtual operating platform that's indistinguishable from actual hardware.

→ IPV6

↳ no. of bits = 128 bits
↳ 8 groups of 16 bit each



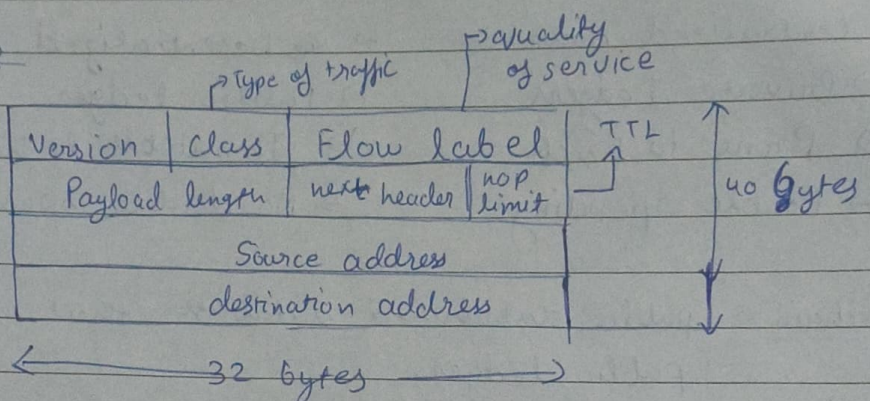
↳ 4 hexadecimal numbers

↳ Multicast
  ↳ A way of addressing groups of hosts all at once.

↳ Link - local unicast address

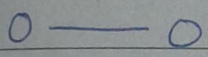
↳ allow for local network segment communications and are configured based upon a host mac address.

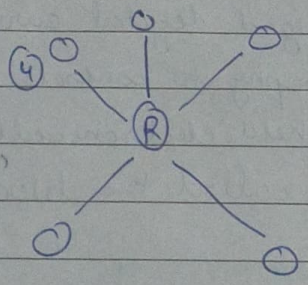
↳ IPV6 headers



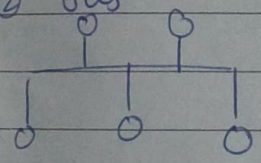
Network Topology

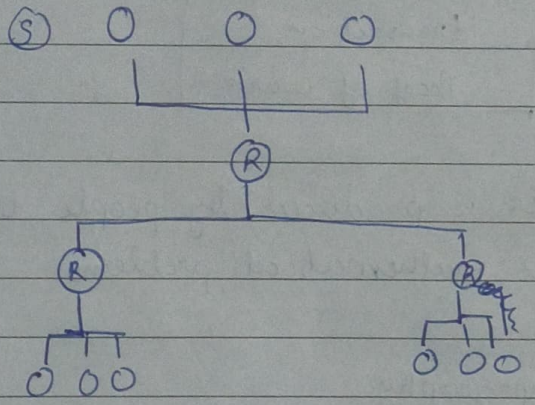
① point to point



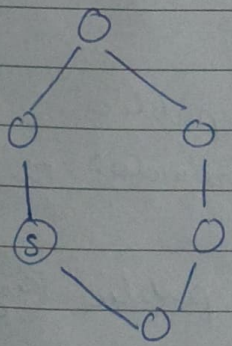


② bus

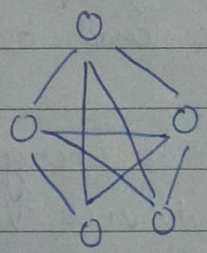




③ Ring



④ Mesh



⑤ hybrid