IP Addressing

Network mask

	N	H	Range
Class A :- 255.0.0.0 unicasting	0 ___ (2^7-2) 8 bit	$(2^{24}-2)$ 24 bit	0 - DHCP client 1 - 126 127 - LBA
Class B :- 255.255.0.0 unicasting	10 ___ (2^{14}) 16 bit	$(2^{16}-2)$ 16 bit	+64 128-191
Class C :- 255.255.255.0 Multicasting	110 ___ (2^{21}) 24 bit	(2^8-2) 8 bit	+32 192-223
Class D :-	1110 ___		+16 [224-239]
Research Class E :-	1111		+16 [240-255]

→ for Network ID all host bit will be 0.
→ for DBA, host bit with all 1.

0	1	1	1	1	1	1	1
64	96	112	120	124	126	127	

1	1	1	1	1	1	1	1
128	192	224	240	248	252	254	255

Private IP range :- { 10.0.0.0 - 10.255.255.255 , 172.16.0.0 - 172.31.255.255
192.168.0.0 - 192.168.255.255 }

NAT Router :- NAT router convert private IP into public IP when packet is going out of network, same router convert public IP into private, when packet is coming inside the network.

→ A computer can have Multiple IP address at different Instances of time. NOTE :- This concept is known as same mac multiple IP address at different instances of the time.
→ A computer can have multiple MAC addresses to support fault tolerance. NOTE :- This concept is known as Multiple MAC and same IP at different instances of time.

Subnet

Q1.) IP_1 = 199.48.98.99

Subnet Mask = 255.255.255.224

i.) Subnet ID :- 224 = 111 00000

99 = 011 00011

96 = 011 00000 (bitwise AND)

= 199.48.98.96

ii.) No. of Subnets = (255.255.255.224) (subnet mask)

N H → S: 111, H: 00000

Subtracting 2 from No. of subnets. for Net ID and DBA of the Network

$2^3 - 2 = 6$.

iii.) No. of Hosts in each subnet = $2^5 - 2 = 30$

Subtracting 2 from No. of Hosts. for subnet ID and DBA of that net

S H

iv.) 1st subnet id = 001 00000 = 199.48.98.32

v.) 2nd subnet id = 010 00000 = 199.48.98.64

vi.) 3rd subnet id = 011 00000 = 199.48.98.96

vii.) last subnet id = 110 00000 = 199.48.98.192.

NOTE - wherever there is a continuous mask, (there will be a pattern) no need to calculate further subnet id, (x+32) formula use to calculate further subnet id. (continuous mask means → 224 111 00000 ↓ continuous 1's)

viii.) 1st host of 1st Subnet = 001 00001 = 199.48.98.33

ix.) Subnet id of 1st Subnet = 001 00000 = 199.48.98.32

x.) DBA of 1st Subnet = 001 11111 = 199.48.98.63

xi.) last host of 1st Subnet = 001 11110 = 199.48.98.62

x.) Net ID = 000 00000 = 199.48.98.0

xi.) DBA of network = 111 11111 = 199.48.98.255

xii.) Last Subnet id = 110 00000 = 199.48.98.192. (↓ No of subnets = 6.)

xiii.) 4th host of 5th Subnet = 101 00100 = 199.48.98.164.

ex2:) IP_1 = 199.88.99.123 IP_2 = 199.88.99.65 IP_3 = 199.88.99.87

Subnet mask = 255.255.255.240.

Identify which host of which subnet they belongs to?

Ans:) IP_1 ⇒ 0111 1011 ⇒ 11th host 7th Subnet

IP_2 ⇒ 0100 0001 ⇒ 1st host of 4th Subnet

IP_3 ⇒ 0101 0111 ⇒ 7th host of 5th Subnet.

ex3:) IP_1 = 192.98.88.141 IP_2 = 192.98.88.161 IP_3 = 192.98.88.151

Subnet Mask = 255.255.255.240. Identify IP's belong to same subnet?

Ans:) 240 – 1111 0000 161 = 1010 0001

141 – 1000 1101 151 = 1001 ——

NOTE:- If question asked for Identify same subnet, check for subnet only, no need to find host.

ex4:) IP_1 = 200.89.99.119. Subnet Mask = 255.255.255.41. → 0 0 1 0 1 0 0 1

↓

Discontinuous mask.

Ans:) Discontinuous mask is used in security because we cannot determine the values from standard equation.

NOTE:- (x+32) formula cannot use for Discontinuous mask.

ex5:) D.B.A of subnet is given as 201.55.77.31, which of the following will be suitable subnet mask? → 0 0 0 1 | 1 1 1 1 → first subnet

↓

Minimum 4 digit subnet required

∝ a.) 255.255.255.192 – 11 000000 (S / H)

∝ b.) 255.255.255.128 – 1 0000000 (S / H)

✓ c.) 255.255.255.240 – 1111 0000 (S / H)

d.) None

ex6:) Company 60 Hosts, subnet mask?

Ans:) No. of hosts = $2^6 - 2 = 62$

N + S + H

24 + 2 + 6

S = 2

255.255.255.192

ARP = MAC
RARP = IP

LAN, MAC address

Networking Devices

1. Bridge – Not a Broadcast Domain separator.
   - Collision Domain Separator.
   - fault tolerant.
   - Learning, forwarding & Blocking.
   - connect similar Network.

2. Router – WAN Device, operations based on IP Address.
   - Connecting Dissimilar Networks.
   - Broadcast Domain Separator.
   - Collision Domain Separator.
   - Not a Multiprotocol converter.
   - Sophisticated device. (Host to Host addressing)

3. GATEWAY – Broadcast Domain Separator.
   Collision Domain Separator.
   Multiprotocol converter.
   Highly sophisticated router.

4. Repeaters & Hubs – Not a Broadcast Domain Separator.
   Not a Collision Domain Separator.

5) Switches – It maintains a lookup table for forwarding the frames.
   (Datalink layer) ↓
   Collision Domain Separator.
   ~~Not a Broadcast Domain Separator.~~

→ **IPV4 & IPV6:-** By default IPv4 is a stateful protocol & IPv6 is a stateless protocol. IPv4 is slow compare to IPv6.
- → IPv6 doesn't require ARP protocol because MAC address itself is a part of IPv6 address.
- → By default IPv6 doesn't require DHCP server configuration.
- → In IPv6, A computer can have multiple IP Addresses at the same time.
- → In IPv6, we don't need a NAT router because there is no need of translation from public IP to private IP or vice versa.
- → By default, IPv6 doesn't require NAT configuration because from the origin point, it has the public IP address.
- → IPv6 doesn't support, broadcasting, it supports only Multicasting.
- → IPv6 supports Anycasting i.e. All nodes will have the same address, but the service is provided by nearest node.
- ⇒ for mobile Networks or Wireless Networks - IPv6 is best suitable because of its stateless auto configuration.
- → IPv6 doesn't require any mapping table for IP address to MAC address mapping.

"PING":- (Packet Internet groupher):- Ping command is used to troubleshoot in the network. It is used to test the reachability of the system in the network". ICMP protocol is used to implement "ping".

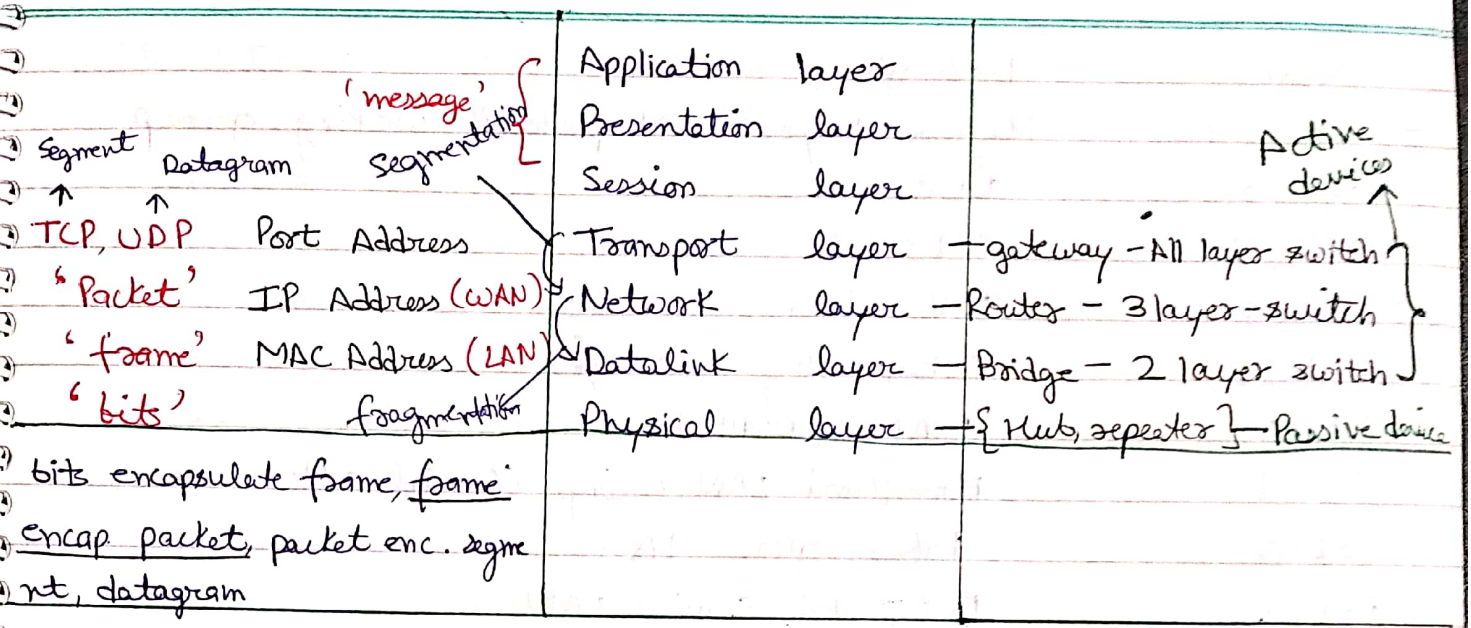
LOOP BACK ADDRESS:- It is used for troubleshooting the self computer whether the computer is properly connected to the port or not.
- ⇒ LBA will never enter into the network.
- → LBA will always be a Destination address only.
- → Even a computer is not assigned any IP still we can troubleshoot the self computer by using DHCP client and Loop Back Address.

NOTE:- LPA is used as a address in the interprocess communication.

DHCP client:-

CIRCUIT SWITCHING	PACKET SWITCHING
→ Three phases:- 1) connection establishment • data transfer • connection release.	→ Data can be transmitted directly • data transfer.
→ Each data unit will have entire path address.	→ Each data unit will have the destination address, the intermediat path is decided by Router.
→ Circuit Switching is not a store and forward technique. The packet simply bypass the queue of the router.	→ Packet switching is a 'store & forward' technique where the packets are stored, Algorithm is applied on the best path.
→ The transmission of packet is done by the source.	→ The transmission of data is done not only by the source but also by intermediate routers.
→ The delay between the dataunits is 'uniform' or same.	The delay between the data units is 'variable'.
→ Resource Reservation is a feature.	→ Resources are sharable.
→ wastage of Resources are more	→ wastage of Resources is less.
→ 'Congestion' can occur during connection establishment phase.	→ 'Congestion' can occur during data transfer phase.
→ It is not a fault tolerant technique because the packets can not be diverted via other paths if link are broken	→ It is a fault tolerant technique because the data can be diverted via other paths if link are broken.
→ Reliable, used for long messages.	→ Unreliable, used for short mes

OSI Model :- 7 layers :-



bits encapsulate frame, frame encap packet, packet enc. segment, datagram

→ Data link layer :- is responsible for 'Node-to-Node' delivery within LAN.
→ Network layer :- is responsible for 'Source to destination' delivery b/w Net work.
→ Transport layer :- responsible for 'process to process' or 'End to End delivery', that can be identified by Port Address.
→ Combination of Port and IP address is known as SOCKET ADDRESS.
→ Network Architecture is known as protocol 'stack' Architecture.

SERVICES OF LAYERS :-

→ APPLICATION LAYER :- Application services like HTTP, FTP, SMTP, DNS, Telnet.
→ Presentation layer :- Syntax and Semantics of data.
→ Session layer :- Dialog control, session Management.
→ Transport layer :- flow control, error control, Segmentation, congestion policies.
→ Network layer :- Routing algorithms, traffic shaping, fragmentation, IP addressing.
→ Data link layer :- flow control, error control, Access control, framing.
→ Physical layer :- Physical & electrical characteristics of cable.

Name	Description
IEEE 802.1	Higher layer LAN protocols working group
802.2	LLC
802.3	Ethernet
802.4	Token bus
802.5	Token ring MAC layer
802.6	MANs (DQDB)
802.7	Broadband LAN using Coaxial cable
802.8	Fiber optic TAG
802.9	Integrated Services LAN
802.10	Interoperable LAN
802.11	Wireless LAN
802.12	100BaseVG
802.14	Cable modems
802.15	Wireless PAN (Bluetooth)
802.16	Wireless MAN

→ TIME TO LIVE (8-bits):- The purpose of TTL is to identify, if any loop is exist for the packet or not.

→ Whenever a packet is forwarded by a router, TTL value will be decremented.

→ Whenever the packet is in a loop, then at one point of time, TTL value will become 'zero' then the next router will drop the packet.

→ ICMP will take the source IP from the Dropped packet and informs to source by sending Time exceeded message.

→ Whenever the link is broken, there is a chance, that packet might be forwarded in the wrong path.

→ In practice, it is now a hopcount.

→ It also gurantee, that packet don't stay in the network for longer than 255 seconds.

ICMP (Internet Control Message Protocol):-

(i.) Source Quench Messages:- when more no of packets coming in less time then the router buffer will be full in no time. that router is congested, then some packets are dropped.

→ ICMP protocol will take the source IP from the dropped packet and inform to source by sending 'Source Quench Message' then source will reduce the speed of transmission then the congested router will be free from congestion.

→ If the congested router is far away from the source then ICMP will send, Hop-by-hop source quench messages then every router via the path will reduce the speed of transmission.

ii.) Parameter Problem:-

→ Once the data is transmitted, header bits are modified by the noise then the calculated Header checksum will not be equal to received header-checksum then the packets will be dropped.

→ ICMP will take the Source-IP from the dropped packets & inform to the source by sending 'Parameter Problem' message.

iii.) Time Exceeded Message:- when some fragments are lost in the Networks then the holding fragments will be dropped by the router.

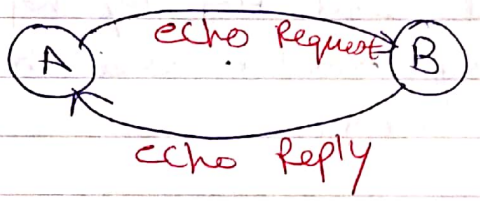
→ ICMP will take the source IP from the dropped fragment and informs to source by sending 'Time exceeded message'.

iv.) Destination Unreachable:- ICMP Error messages are transmitting not only by the router but also by the destination host.

v.) Redirection Message :- whenever a packet is forwarded in a wrong direction, and later it is redirected in correct direction, then ICMP will send Redirection message to update with correct entries.

ICMP Query Messages :-

i.) Echo Request and Reply :- Designed for the diagnostic purpose. These messages are used to determine whether two systems can communicate with each other.



ii.) Time stamp Request & Reply :- Two machines uses these messages to determine the RTT needed for an IP datagram to travel b/w them.

TCP TIMERS :- Time out Timer, Time wait Timer, Keep Alive Timer, Persistent Timer.

1.) Time out Timer :-

> TCP uses a time out Timer for retransmission of lost segments.

→ Sender starts a time out timer after transmitting a TCP segment to the receiver.
→ If sender receives an acknowledgement before the timer goes off, it stops the timer.
→ If sender does not receives any acknowledgement and the timer goes off, then TCP Retransmission occurs.
→ Sender retransmits the same segment and resets the timer.
→ The value of time out timer is dynamic and changes with the amount of traffic in the network.

Time Wait Timer:-

> TCP uses a time wait timer during connection termination.

→ Sender starts the time wait timer after sending the ACK for the second FIN segment.
→ It allows to resend the final acknowledgement if it get lost.
→ It prevents the just closed port from reopening again quickly to some other application.
→ It ensures that all the segments heading towards the just closed port are discarded.
→ The value of time wait timer is usually set to twice the lifetime of a TCP segment.

Keep Alive Timer-

> TCP uses a keep alive timer to prevent long idle TCP connections.

→ Each time server hears from the client, it resets the keep alive timer to 2 hours.
→ If server does not hear from the client for 2 hours, it sends 10 probe segments to the client.
→ These probe segments are sent at a gap of 75 seconds.
→ If server receives no response after sending 10 probe segments, it assumes that the client is down.
→ Then, server terminates the connection automatically.

Persistent Timer-

- TCP uses a persistent timer to deal with a zero-window-size deadlock situation.
- It keeps the window size information flowing even if the other end closes its receiver window.

5) acknowledgment timer.

DNS – Port-53
POP3 – Port-110

TCP	UDP
1. Dynamic header (20-60) Bytes.	1. Fixed Header 8 Bytes.
2. It is the connection oriented with the help of sequence no.	2. It is connectionless (no seq. no's)
3. Flow Control.	3. Has No flow control (each datagram is Independent).
4. Slow (Seq. no are waiting for all seq. to come and send in sequence)	4. Fast (each datagram is independent & not waiting for another datagram to come).
5. Checksum is mandatory.	5. checksum is optional.
6. Error Control.	6. UDP has no error control.
7. It does not support Multicasting or broad casting.	7. It supports Multicasting or Broadcasting. (Link state ___)
8. HTTP, FTP, SMTP, Telnet.	8. TFTP, DNS, SNMP.
9. Doesn't depend on ICMP Protocol for error control.	9. Depends on ICMP protocol.

FTP	TELNET
i) Downloading a large file.	i) Chat operations (exchange of words)
ii) Control (21) connection, Data (20) connection.	ii) common connection. 23
iii) Ports 20, 21 are used	iii) Port 23

FTP	TFTP
1) TCP as Transport Layer.	1) UDP as Transport Layer.
2) FTP has no flow control at A.L.	2) TFTP has flow control at A.L.
3) FTP are Antivirus experts.	3)
4) FTP allows authorized user. i) Internet ii) Downloading file.	4) TFTP allows Anonymous user. (i) Net access. (ii) Antivirus software.

APPLICATION LAYER

APPLICATION LAYER:-

"HTTP PROTOCOL":- (hypertext transfer protocol)

(1.) Client - server Protocol.
(2.) Synchronous Protocol.
(3.) Port 80.

→ It is a synchronous protocol because the clock of the client is synchronized with the clock of the server.

4.) HTTP Connection :-

Persistent Http Connection.
Non-persistent Http Connection.
stateless Protocol.

Persistent HTTP:-

→ In case of persistent http, connection will be there only so we can access 'n' no. of objects.

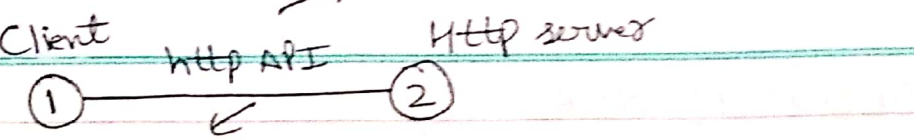
→ This is for user friendly requirement.

"Non-Persistent HTTP":-

→ In Non-persistent http, for every individual object a separate connection should be established.

→ This is provided for security concern.

HTTP API:-



http methods :-

{ get() head() option()
post() connect() put()
Trace(). }

1.) Get Method :- It is used to retrieve the document.
2.) Put Method :- It is used to modify the existing document.
3.) Post Method :- It is used to place the modified document back to the directory in the server.
4.) Head Method :- Head Method is used to get the information about the document.
5.) Connect Method :- It is used data will go via a secure channel that to in encrypted form.

http ——— Connect() ——— https.

6.) Trace Method :- Trace & option() both work like a record root in IP.

NOTE :- By default IPv_6 is stateless but we can make it stateful with the help of $DHCPv_6$ server.
HTTP is a stateless protocol because client will not store any information about the server once the transaction has been done.

Cookies :- Cookies is a piece of code that is transmitted by a server or a mediating agency to the client Browser.

→ The Advantage of Cookies is :-
(i.) Authorization
(ii.) faster response.

File Transfer Protocol :- (FTP)

1) Downloading a file. 2) Client-Server Protocol.

→ FTP will send control commands on port 21 via a control connection.
→ Once the file is about to download, a separate data connection is established on port 20.
→ Once the file is completely downloaded, data connection is closed, but control connection will remain to download

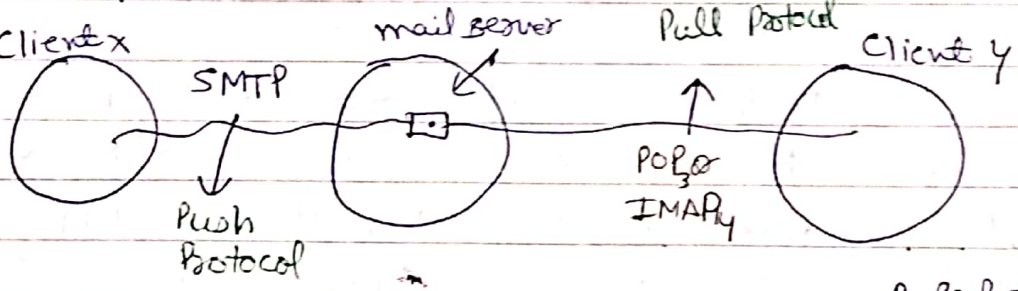
SMTP (Simple Mail Transfer Protocol) :-

Multimedia internet mail Extension.

1) Text-based Protocol :- Internet ⟶ MIME Extension

SMTP is a text based protocol, but we can send graphical data, with the help of MIME Extension, which is provided by Internet Browser.

2) Port - 25
3) TCP as T.L.
4)



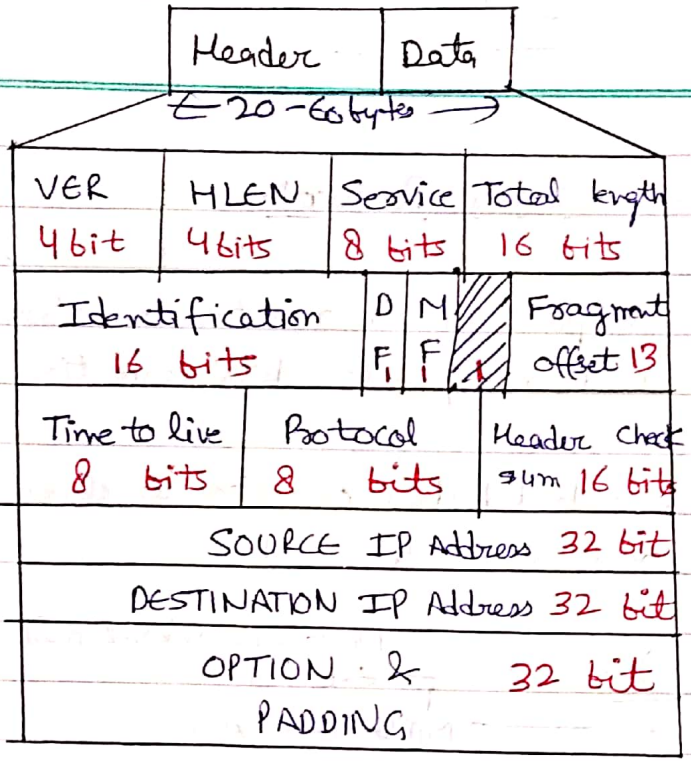
POP: Post office Protocol

→ SMTP is a Push Protocol, because it is used for sending mail to mail server.
→ POP_3 or $IMAP_4$ are Pull Protocol because they are used for retrieving the mail from mail server.
→ SMTP combined with POP_3 or $IMAP_4$ is a client to client protocol with a mediation done by mail servers.
→ SMTP with POP_3 is applying store & forward technique.

NOTE:- The transfer of mail from one mail server to other mail server will be done by SMTP protocol.

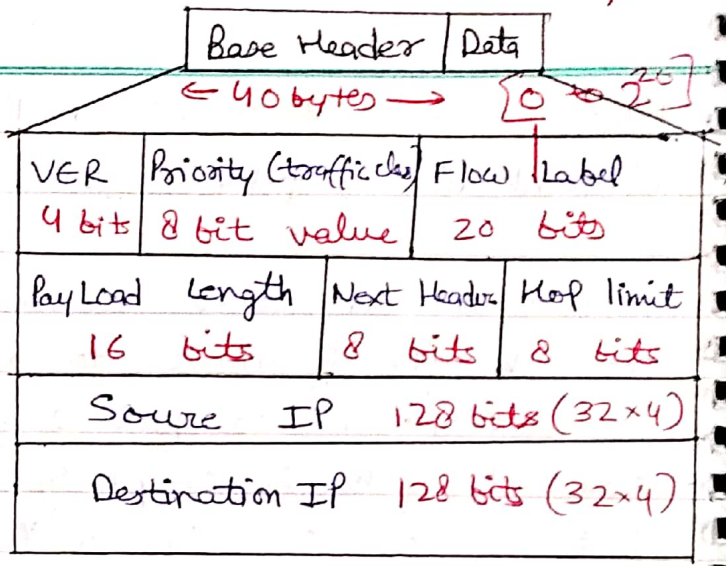
→ Mails can be kept in hierarchy in case of $IMAP_4$, whereas all mails are equal or serial in case of POP_3.
→ Security to the mails or attachments are provided by the $IMAP_4$, but not by POP_3.

IPV4 Header

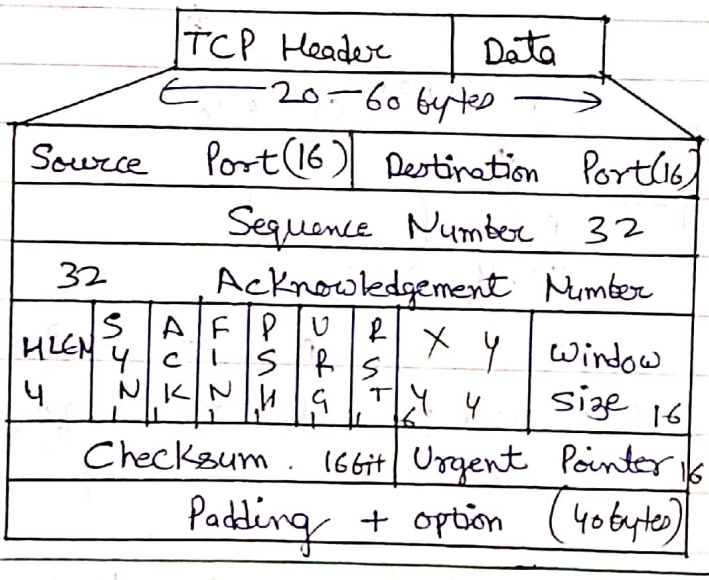


IPV6

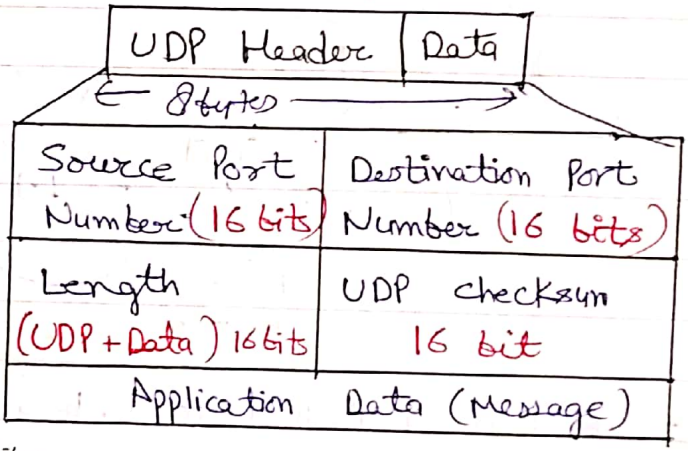
65535 bytes



TCP Datagram format



UDP PROTOCOL



- DNS : TCP/UDP Port 53
- HTTP : TCP Port 80.
- SMTP : TCP Port 25
- POP : UDP Port 110
- Telnet : TCP Port 23
- Dynamic Host Configuration Protocol : UDP Port 67
- FTP : TCP Ports 20 and 21.

ARP - MAC
RARP - IP

- Listen(): Used on server side, cause a bound TCP socket to enter listening state.
- Bind(): Associates a socket with socket address structure.
- Connect(): It assigns a free local port number to a socket. In case of TCP socket, it causes an attempt to establish a new TCP connection.
- Accept(): Accepts a received incoming attempt to create a new TCP connection from the remote client.