

Host address -
 → IPv4 address
 → IPv6 address
 → MAC Address
 ↓ 48 bits

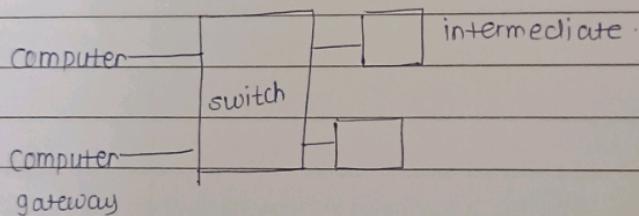
Ethernet Address
 ↓

NIC → LAN Case 1.

TP-add

— — — —
 8 bit 8 8 8

decimal conversion.



Gateway to pass the message through switch
 Subnet mask is used to create the network.

255.255.255.00000000

Host bit.

8 bits - $2^8 \rightarrow$ Address can be created.

$2^8 - 2 = 254 \rightarrow$ maximum no. of

computer can be connected.

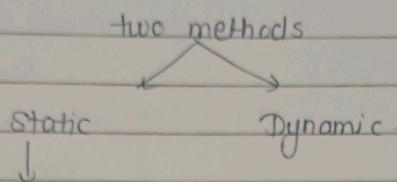
256 - 2 ip's are reserved.

1st is network id

2nd is Broadcast address. → ip's.

Switch - To connect number of Host to send packet within same N/W.

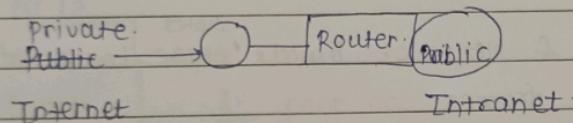
• How to assign the address?



- | | | |
|----------------------|--|-----------------|
| 1) Assign IP address | | inside network |
| 2) Subnet mask | | |
| 3) Gateway | | outside network |
| 4) DN switch | | |

MAC is by default

* Router is used to connect the Net from LAN to LAN.



Dynamic. DHCP server → Assign IP address immediately
 ↓ lease address
 IP Address. --- Dynamic.

static → comp

class c

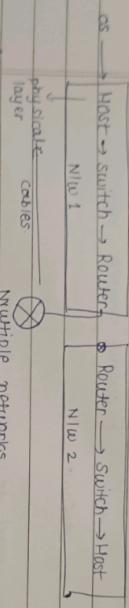
192.168.0.1

static IP address is assign to server

dynamic IP address is assign to LAN.

Optical fiber

Multimode
Single mode
Use in large distance



OS → Host → Switch → Router → Router → Switch → Host
↓
N/w 1 N/w 2
↓
Physical cables
layer
Multiple networks.

Switch → Portlink & Networic. Builds ^{tables} (MAC table or ARP table)
to forward frames.

Backs → Computer N/w up to down

(kurase)

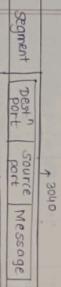
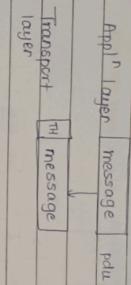
Data Communication (frozen)

- o Can client and server be Host ?
 - Source host

TCP / IP Model

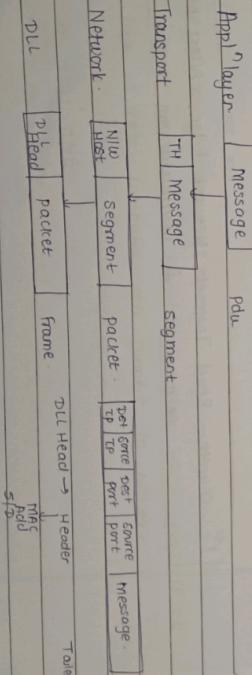
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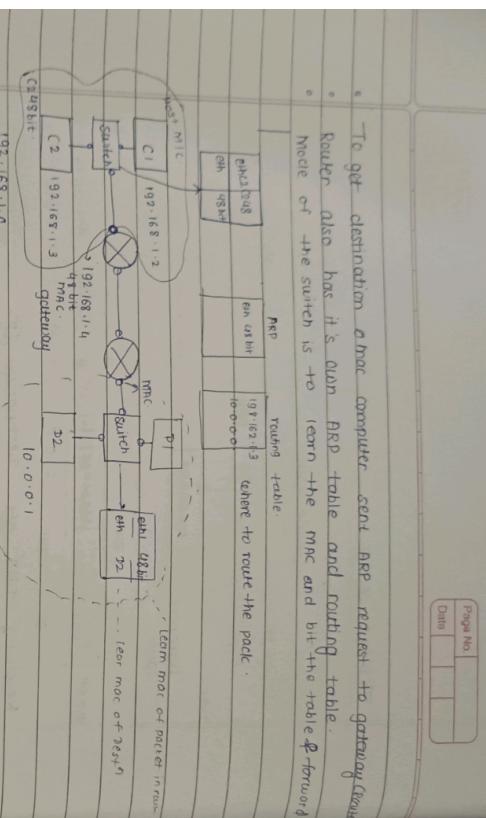


Resolving DNS get Destination IP.

HTTP
Service → Well known port : 80 → Port source - temporary port assign
TFTP → 69 → port no.
Telnet → 23 → Destination - well known port
SSH → 22 → i.e. 23.



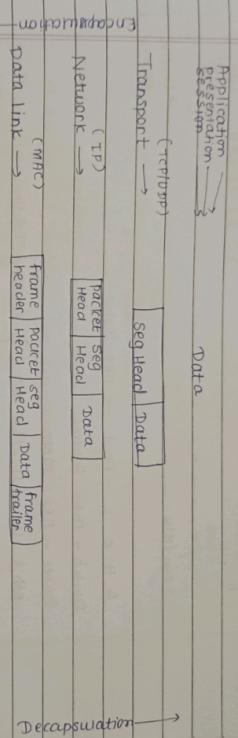
- To get destination a host computer sent ARP request to gateway.
- Router also has its own ARP table and routing table.
- Need of the switch is to learn the mac and bit the table & forward.



- Every device communicate with each other through mac address.
 - Router doesn't touch packet message but touch NW & MAC.
 - Router only known NW IP.
 - Router is used to route and take decision of routing interface.
 - ARP request happen at DM.
- 1st chapter - Read Internet, Network Edge, Access network, core encapsulation & decapsulation, Host.

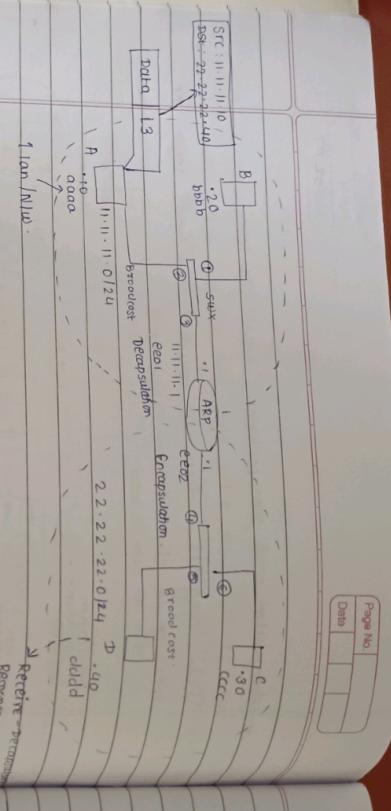
• Encapsulation & Decapsulation in OSI Model

When msg is forward toward transport layer the message is divided into segment.



Q. What is the Dest' MAC from the given Dest' IP, Source IP, Source Mac.

- 255.255.255.255 → Broadcast Address.
- Size of MAC Address = 48 bit.
- 6 octets are used for Broadcast Address → FF:FF:FF:FF:FF:FF
- 124 → 254 Computer can connect to network.
- 125 → 126.
- 11.11.11.11.11.11 → Host.



A, B, C, D - Host → ARP Table.

Switch - MAC Address Table.

Router - ARP Table.

eth1 10.0.0.124 DC Routing Table

eth2 22.22.22.0.124 DC

- Q. What are the distributed application in your device that is connected to internet?
- Q. Who produces (RFC's)
- private nw → intranet
public nw → internet.
- Q. What is connection oriented services and connectionless oriented service.
- Q. Where TCP / UDP use? Why the application used TCP.
- Q. Can host is client or server? → both.

Q what are the codes used in application layer protocol ?

Q How many imgs are sent by web browser?

. FTP- client server architecture.

Q Delay . calculate ?

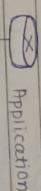
o Types of Delay (marks)

24/07

1. Nodal processing
2. Queueing (Waiting for transmission)
3. Transmission
4. Propagation

o Application layer - OSI and TCP/IP Models.

Chapter 2



DNS Telnet Email DHCP Webserver FTP

DNS - Resolve internet name to IP address

Telnet - Access to server and network devices

SNMP - Transfer of mail messages and

DHCP - Assigns IP address & other parameter to host

HTTP - Transfer file to create web pages

client /
server
FTP - Transfer file between system

Communication

Peer-to-Peer Client & Server

Q. What is part of ... Commonly used protocols in Application layer.

1. Domain Name System -
2. Hypertext Transfer -
3. Simple Mail Transfer Protocol -

4.

DNS - Domain Name System.

To translate a host name into an IP address.

13. Root server in DNS.

https://share.hp.com.
Root DNS server. First level root.

[org] [com] [edu] [net] Top Level

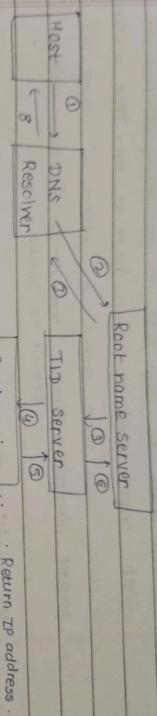
[wikipedia] [hp] [harvard] [princeton] [php] Second

Third

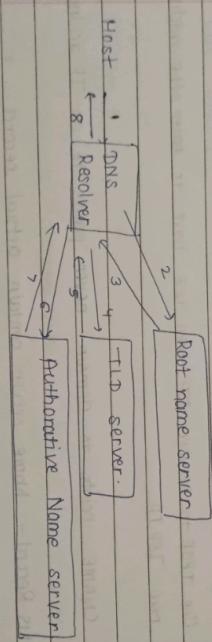
[store] [www] Fourth

Q. URL given tell the levels.

Q Explain Recursive Query.



• Iterative Query



Two types of queries : Recursive and Iterative.

Nonrecursive Query

- What is the port used by DNS?
- What server hierarchical?
- What are the queues used by DNS to get webpage?
- How many Root Server are there?

- A and AAAA Records - " ↗
 - A record used to map host to an IPv4 address
 - AAAA record used to map host to an IPv6 address
- CNAME Record - directs traffic to the new address
Domain → Domain.
- MX Record - directs email to a mail server.
MTA responsible for querying MX.
- TXT Record - Resource type

Q. What is the uses of these records? [What are other Records]

One ISP to another ISP then we have to enter the address of new ISP IP

CNAME points to domain never points to an IP address.

◦ NS Record - Name server contain actual record.

- - class type field - Internet
- Record type field - SOA
- zone file is always created on Master server.
- Name server function server field uses - to map IP address
- The refresh time field.
- The negative - cache
- SOA is not - different.

Q Given IP address & subnet mask, find network and broadcast address for given device.

Q For given IP address & subnet mask, find broadcast address for given device.

Q Given IP address & subnet mask, find network & broadcast address for given device.

DNS Chapter 2.

- 1) Explain concept of DNS.
- 2) Types of DNS server → Explain (Resolver, Root, TLD, Authoritative)
- 3) DNS Queries (3)
- 4) DNS Records Resource (ABBA, A, NS, CNAME, TXT, SOA, PTR).

Chapter 1.

Introduction to Computer Network
Definition
ISP
Internet
Public & Private

What are the devices used in CN → switch, router, hub, Host, end system, distributed applications running on host, client server, p2p.

Medium → wired, wireless

TCP/IP layer and OSI layer difference.

Layer architecture

ARP → How mac is obtained.

Which device is used at which layer.

HTTP

- Q • What is RFC 2 → Request for comment .
- Q • private IP has no cost → free . solution at very low cost .
- Q • public IP address has to pay cost because it is provided by ISP .

HTTP contains
↓
Where is DNS entry ?

IP address
↓
gateway

DNS

- Q • Which underline protocol used by HTTP? → TCP .

HTTP method - GET , POST , PUT , DELETE . used for request .
HTTP Status codes - used for response by server .

1xx : informational

2xx : success

3xx : redirect

4xx : client error .

5xx : server error .

200 - OK
201 - ok created
301 - Not modified (cached version)
400 - Bad request
401 - unauthorised .
404 - Not found

method
↓
path
↓
version
↓
protocol

HTTP request .

HTTP responses
↓
version of protocol
↓
status

HTTP 1.1
200
OK
→
msg

↓
Header

Request = Request Type URL HTTP version

Response = HTTP Version Status Code Status Phrase

- Q. Status code → can be asked for match the pairs.

web client web server

① Established Tcp connection is established.

② Handshaking then connection is established.

③ Connection establishment is done.

④ Send HTTP request +

⑤ Wait response from server

⑥ send HTTP request for wait response from server

⑦ ;

⑧ some other request

Socket → combination of IP + Port

client IP + port → client socket

server IP + port → HTTP / server

Internet connection

Reliable data transfer

All this is done by TCP

Recording of data

Two methods \Rightarrow persistent \Rightarrow with pipelining

HTTP connection

Non-persistent

• RTT [round-trip time] = A time for small packet to travel from client to server and server to client.

HTTP response Time :

1-RTT to initiate TCP

1-RTT to HTTP request & response

File transmission

HTTP response Time = No. of RTT + File transmit Time

Q. 10 objects and 1 HTML file. How many RTT's required to get web page. (Non-persistent) .

\rightarrow

22.

$$\frac{1+10 \times 2}{1} = 22$$

HTML objects \Rightarrow TCP connection + 1 = 2.

file and HTTP

1 TCP + 22 Images 23x2 = 46 RTT (min NP) 0.02

23+1

24

RTT (max P)

Port

31/07

DNS - 53

HTTP - 80

SMTP - 25

POP3 - 110

Commonly used protocols.

Telnet - 23

TFTP - 67

FTP - 20, 21

Electronic Mail

Most widely used application on the internet .

- for sending mail
- for receiving mail

SMTP

- pure text based protocol
- 7 bit ASCII format
- Based on REC 2821
- Port 25 - non-encrypted port
- Port 465 - send message securly
- Push protocol

Working of SMTP :

- Mail Client - send mail to Mail Server
- Mail Server - forward mail to final destination
- Mail Server - send acknowledgement to client
- Mail Client - receive acknowledgement from server

220 - Service ready

221 - closing trans

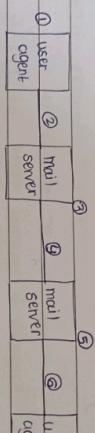
250 - Requested action ok

354 - end with <endl> <crlf>

Internet-mail system

Three major components - user agent, mail server & SMTP protocol

Transfer the email message from mail server ~~to~~ ^{user-to} other mail server to another mail server. → Main use of SMTP



HTTP
or
SMTP

o Hello : 101

EHLO : 211

MAIL : 214

FROM : 220

RCPT TO : 221

DATA : 235

QUIT : 250

VRFY : 354

EXPN : 500

HELP : 510

o Email Server Processes : MTA & MDA.

o Mail Transfer Agent - Used to forward email

Receives msg from MUA on another MB

- Mail Delivery Agent - 1) Accept mail from MTA.
2) place it into appropriate mail box

- MUA - mail user agent.

2) POP3 - Post office Protocol (POP3) version 3

- Pull protocol
- Uses TCP 110
- Download-&-Delete model → retrieve server-store locally - Delete or vice versa
- Download - keep model
- works on two port → 110 - Normal
995 - Secure

3) IMAP - Internet Message Access Protocol.

- Email is not download, but can retained
- Any received email is associated with users INBOX
- Users can create message
- two port → 143 - Normal
993 - Secure.
- Web based email → HTTP is used $\xrightarrow{\text{to}}$ Push
- Pull protocol.

• Proprietary protocol -

- | | |
|-----------------------|------------------------|
| 1) IBM Lotus Notes | → Email server process |
| 2) Novell Groupwise | |
| 3) Microsoft Exchange | |
- Web based -
- | | |
|------------|---|
| 1) Hotmail | MUA, MTA
other internet email format |
| 2) Gmail | |

Q. What is SMTP, POP3, IMAP → Draw diagram, gives scenario and show where it is used.

Ports

- Port - A 16 bit number that identifies the application process that receives an incoming message. $2^{16} = 65536$ port
- Reserved port or well known ports (0 to 1023)
- Client can't use this ports. These are standard ports
telnet, http, ftp.
- Pephemeral port (1024 - 49,151) (49,152 to 65,535)

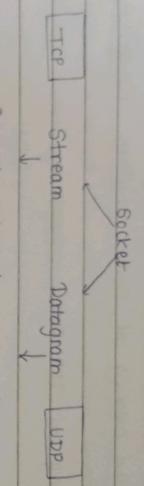
TANIA Ranges

- Well known ports - 0 to 1023
- Registered port - 1024 - 49,151
- Dynamic (or private) - 49,152 to 65,535

Command - netsh int ipv4 show dynamicport +cp.

What is the range of ^{registered} dynamic port?

- Socket is combination of an 32-bit IP address and 16 bit port number
- Use of socket
- as an endpoint for communication.
- A socket is identify by an IP address concatenated with a port.
- Q. What is the use of socket?
a. Differentiate between socket and port?
- Socket is interface between Application layer & transport layer.



- Socket is an endpoint of 2 way communication between programs running on network.

Socket programming is a way of connecting two nodes on the network to communicate with each other.

The main function in <sys/socket.h> are

```

socket() ..... client & server
bind() ..... server
listen() ..... server
connect() ..... client
accept() ..... server
both .. send() | recv() | read() | write() | sendto() | readfrom()
close() ..... both
  
```

- Q. Identify the function used by the client and server in program!

- socket[] - A connection Endpoint.
 - purpose - It creates socket.
 - Syntax - int socket [int family , int type , int protocol] .
- | | | |
|---------|------|-------------|
| AF_INET | IPV4 | SOCK_STREAM |
| AF_INET | IPV6 | SOCK_DGRAM |

Q. What is the meaning of socket primitive TCP socket.

- Understanding of TCP socket programming.

Server

socket []

↓

bind []

↓

listen []

↓

accept []

↓

client

↓

socket []

↓

connect [].

↓

write []

↓

read []

↓

write []

↓

read []

↓

write []

↓

close []

↓

close []

- getaddrinfo - leverages DNS.

IP - a dns hostname

IP - a list of potential IPs to connect / listen.

- socket - creates a file descriptor, just like open.

Doesn't even use the op of getaddrinfo

- connect -

Given a file descriptor & an IP to connect, create a connection.

• Send & rev

Given a connected file descriptor, submit bytes to the OSI for delivery bytes

• close

given — — — — —, tell kernel that it can terminate this connection.

• bind

— — —, tell the kernel to associate with given IP&port.

• listen

— — — that has been bound to IP&port, tell the os that you wish to start receiving connections.

• accept

— — — that has already been activated via listen, create a new FD that can be used to communicate with individual client. By default this call block until client show up.

import socket

```
#  
ServerSocket = socket.socket()
```

198 -	2	198	0	110
2	198	0	110	
0	0	0	0	

Proto No.	
Data	0 6 0 8 2 4

• Transport Layer

3 bits reserved

17 N/w bits	Host	host	host	1-126
Class A	0	0	0	13
Class B	1	0	0	16
Class C	10	0	0	128-191
Class D	110	0	0	192-223
Class E	1110	0	0	224-239

class : class research.

Q. Binary 1st octet is given find out the class.

- Subnet Size - /24 to /30
- Class C Subnet mask /24

192.168.0.0	→ N/w id
192.168.0.10	↓ 128 subnet
192.168.0.10	and 192.168.0.10
192.168.0.10	255.255.255.0 → Sub netmask
192.168.0.10	192.168.0.0 → N/w id
192.168.0.10	192.168.0.10
192.168.0.10	255.255.255.0 or
192.168.0.255	broadcast → 192.168.0.255 → Broadcast address
192.168.0.255	→ Broadcast address

125
Bit by bit and operation.

125
125
125
125
and
255 255 255 128

192.168.0.0

0010 0101 0000
 0100 0101 0000
 1000 0000 0000
 Date: _____

0.0.0.127 Inversion of 255.255.255.128

or 192.168.0.255
255.255.255.128

192.168.0.127 → Broadcast Address.

192.168.0.140 ← 2nd subnet

192.168.0.128 → Start address of Subnet 2.

Subnet 128 8 8 8 4 ^{unit}_{2^4=16}
 255.255.255.240 255 255 255 0 000
 ↓↓↓↓
 No. of Subnet = 16 128 64 32 16 8 4 2 1

Host per Subnet = $2^9 - 2 = 14$.

192.168.0.250

255.255.255.240

192.168.0.240 → N(w id)

0.0.0.239 16 bit

192.168.0.250

192.168.0.255 → BN id

If subnet is 130 2 computer can be connected.

subnet bit

subnet address

class A 10.0.0.10 /25 → 2¹⁷/128 → 2¹⁷ 0.0.0.

class B 172.16.0.10 /25 → 2⁹/128

class C 192.168.0.10 /25 → 2¹/128

Transport Layer

TP Layer Process to process communication
 NLL Layer Host to Host Communi
 DLL Node to Node commun

- Transport layer is responsible

1. Service point and addressing

- Process level addressing
- Multiplexing & Demultiplexing
 - ① where multiplexing & demultiplexing occurs.
 - Segmentation, packaging & Reassembly → host.
 - Connection Establishment & Management and Termination
 - Relocated gment
 - Flow control

- Network layer : Transport layer

- Process to process achieve through client-server paradigm.
- process on the local host - client , need services from a process on remote host - server . for communication we must define .
 - 1) local host - TP
 - 2) local process - port
 - 3) Remote host - TP
 - 4) Remote process - port
- 0 - 65536 . (16 bit)

MSS - Maximum segment size - TPL
MTU - Maximum Transfer unit - NL

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✓ Provide -

- aggregate data from different applications into a single Stream - Multiplexing.

- distributing that data to different application - Demultiplexing.

Segmentation - host , fragmentation - every node.

• Popular Application of UDP .

✓ 1) Multimedia Streaming .

Q What are the applications supported by UDP

→ DNS TFTP RTP .

SNMP NFS

BOOTP NTP

Q Difference between TCP & UDP .

* Establishing connection between sender & receiver → connection oriented .

✓ UDP data reassembly .

• TCP Protocol → provide a reliable , in-order , byte stream abstraction .
flow and Congestion control .

✓ TCP Segment reassembly

• Connection creation :

↓
Active participant Client Passive participant Server

Active Participant

SYN, sequence no. = x

$\text{SYN} + \text{ACK}, \text{seq } n, \text{no.} = y$
 $\text{ACK} = x+1$

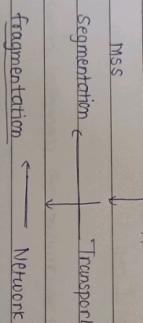
$\text{ACK}, \text{acknowledgment no.} = y+1$

Passive Participant

- Q If seq n what is the acknowledgement no? $\rightarrow y+1$.

Three-way handshaking

- Three-way handshaking.



- Q why segmentation is done at transport layer & why fragmentation is done at N/w layer?

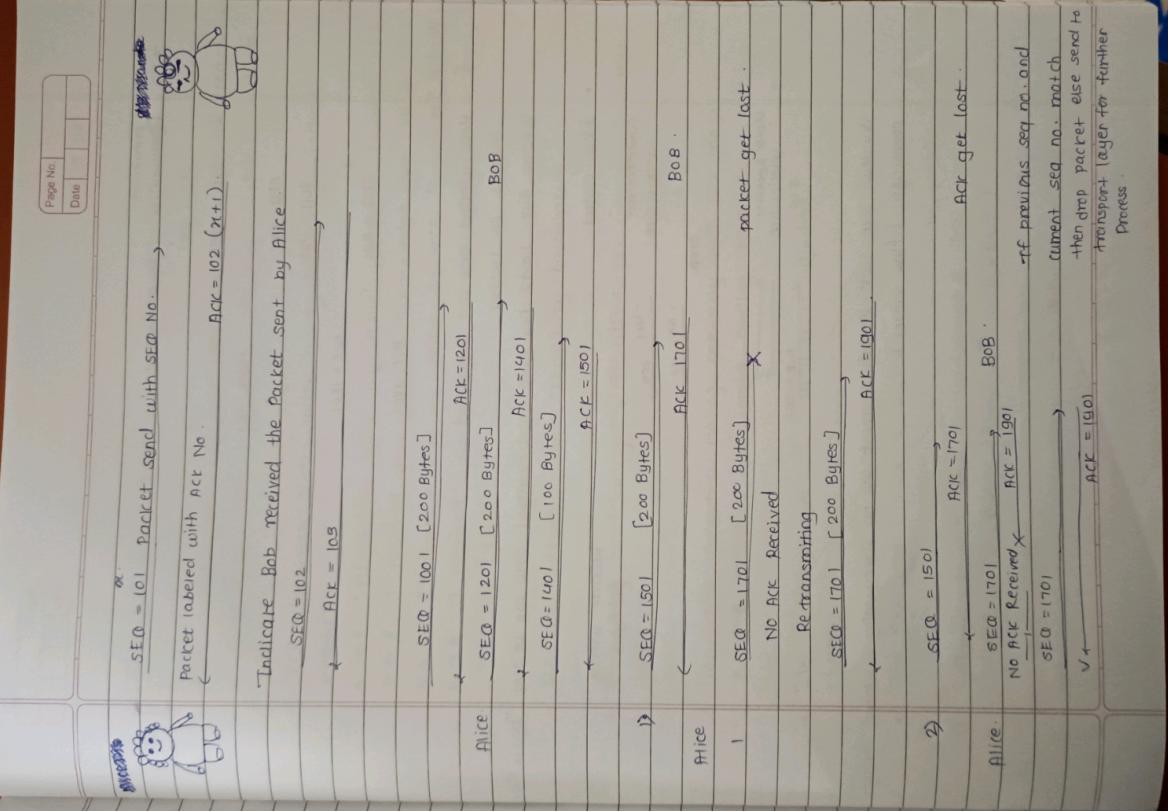
Maximum Transport unit (MTU) 1500 bytes.

- In between node or router fragmentation is done.

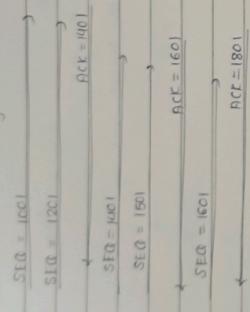
Host performs segmentation.

If DF = 1 at router → Drop packet from router to router.

- Q If DF = 1 at receiver → fragment is received by receiver do not fragment (Do not fragment).



3 • Cumulative Acknowledgment



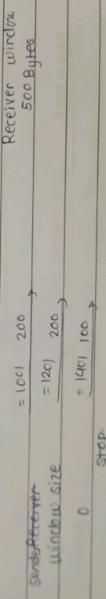
Window Size

Q. How window size is determined.

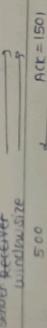
Depends on receiver.

Window Size limits how much unacknowledged data can be sent. "like in Project"

• Flow Control



• Sender Receiver



Window Size Start in each segment can be dynamically updated through connection (flow control).

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Initial Sequence Number

TCP is bidirectional - both peers can send data. Both the peer have SEQ to track by test send. Both peer have On Flit \neq to that

+ TCP connection starts with 3-way handshaking , includes a events :

A \rightarrow B SYNchonize with my initial sequence Number of X.

A \leftarrow B I received your SYN , I Acknowledge that I am ready [n+1]

A \leftarrow B SYNchonize with my initial sequence Number of Y

A \rightarrow B I received your SYN , I Acknowledge that I am ready for [Y+1]

Q . TCP Connection setup . Three way handshaking ?

+ four - way handshaking with FIN flags . Graceful connection closing

+ Ungraceful connection closing one-way with RST flags
A \leftrightarrow B something went wrong sending RESET flag .

• The window principle : why it is adjusted .
Size of window is 1 .

• TCP Flow control 1, 2, 3, 4, 5, 6

Q. How advertise window is calculated ?

Active wind = MAX RCV Buffer - (LastByte - LostByteRead)

SendWindow = AdvertisedWindow - (LostByte Sent - LostByteReceived)

- Page No. _____ Date. _____
- Initial Advertised Window is 300.
 - Receiver capability = Advertised window.
 - Q What is sender window size and receiver window size?
and how much data is remaining to send from the sender?
 - Q Find out effective window?

$\begin{cases} \text{last byte written} = 3000 \\ \text{sender} \\ \text{last byte send} = 2600 \\ \text{last byte ack} = 2000 \end{cases}$	$\begin{cases} \text{Receiver Buffer Size} = 1600 \text{ Bytes} \\ \text{last byte} = 1700 \\ \text{Received} = 2400 \\ \text{next expected} = 2401 \end{cases}$	$\begin{cases} \text{Advertised Window} = 1700 - 2400 - 1600 = 90 \\ \text{Effective Window (Sender Window)} = 200. \\ \text{= Advertised window - Outstanding bytes} \end{cases}$
---	--	--
 - Error Control

$RDT = 1.0$	$\begin{cases} \text{Reliable Data Transfer} \\ \text{RDT} = 1.0 \end{cases}$
$RDT = 2.0$	$\begin{cases} \text{Error handling} \\ \text{RDT} = 2.0 \end{cases}$
$RDT = 3.0$	$\begin{cases} \text{ACK, NAK, SEC} \\ \text{RDT} = 3.0 \end{cases}$

- Handling Bit Errors
 - Error detection
 - Corrupt ACK / NAK packet
 - option 1
 - Sender interrupts corrupt ACK / NAK = Ret.
 - Receives misses data packet.
 - option 2 - RDT 2.0 without sequence number.
 - Sender interrupts corrupt ACK / NAK
- Bug fix - with seqⁿ no.
- | | |
|--------------------|----------------------------|
| Packet to made = a | } Seq ⁿ number. |
| Packet to made = l | |
- | | |
|--------------------|---|
| Packet to made = o | = |
|--------------------|---|
- Version 2.1 . with seqⁿ no . SEQ + ACK + NAK .
- 2.2 . with SEQ + ACK without NAK . \rightarrow corrupted packet
- Version 3.0 with SEQ + ACK + Timeout .
- Lost packets
 - Packet lost , Handelling lost packets \rightarrow packet lost.
 - Performance Problem with stop-and-wait (wait too long)
 - T_r = transmission delay $\approx 64 \text{ kb} \times 8 \text{ bits/B} = 5 \text{ ms}$
 - 10 Mbps.
 - T_r = T_r
 - $T_r + \text{link entity} = T_r + \text{RTT}$

19/08

- Pipelined protocol - error handling method 2
Go Back N (GBN)
- Why seq no. is small in selective repeat protocol.

- TCP connection setup.

-Three way handshake.

TCP SEQ + ACK.

Q what is ACK & SEQ?

- Selective Acknowledgement Option (SACK)

10/08

- TCP Header & UDP Header

Q Find out sequence number

Source port, destination port, seq number, Ack number, Header length, Reserved bits, URG bit, ACK bit, PSH bit, RST bit.

Header length (4 bits)

Q What is the size of TCP header.

0101 → 5 (sel)

1010 → A (10)

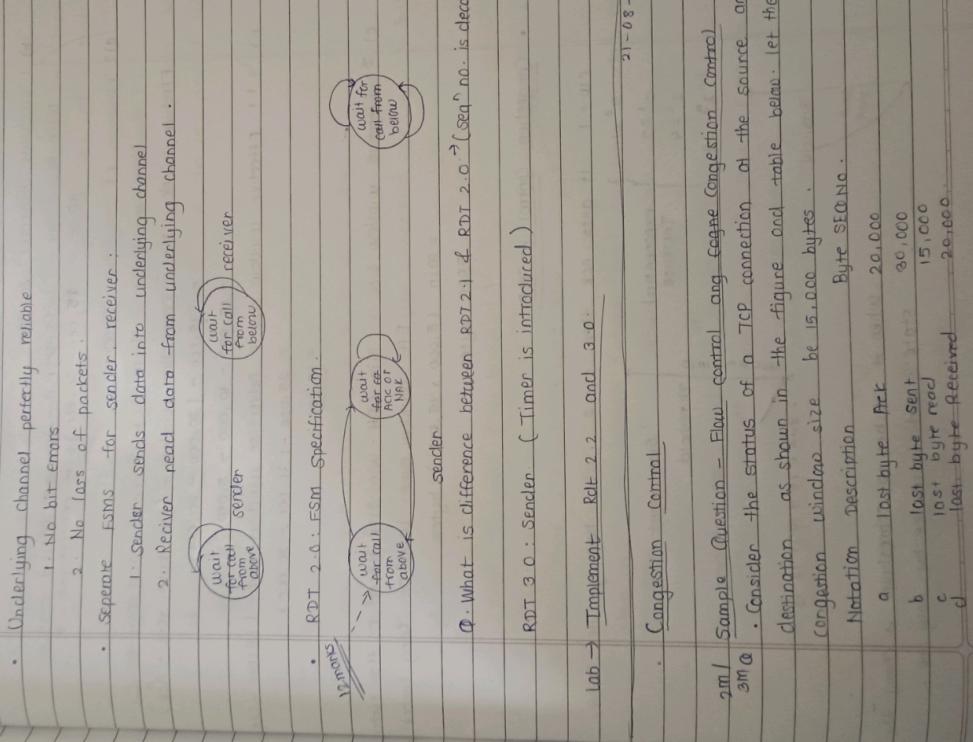
1111 → F (15) (all fields will hold their default value)

- Concept of scaling factor-

Q Hex value will be given using Hex 1 bit, 2 bit . . .
Find IP, Port, flag set, length.

• UDP Header contains four fields

checksum calculation → find sum and negate the sum.



Page No.	
Date	

a) Only congestion control b) only flow control c) Both fc + cc

b) i. calculate Advertise window.

$$\text{MAX Rev Buffer} = (\text{last Byte Read} - \text{last Byte Read}) = 25,000$$

$$30,000 - (45,000 - 20,000) = 15,000 - 10,000 = 5,000$$

a) 2. minimum of congestion window.

$$= \text{Max Recv Buffer} = (\text{last Byte received} - \text{last Byte Read})$$

$$\text{Effective Window Size} = \text{Congestion window} - (\text{last Byte sent} - \text{Ack})$$

$$= 15,000 - (30,000 - 20,000)$$

$$= (5,000 - 10,000) = 5,000$$

$$\text{b) 1. Effective window size} = \text{Advertise window size} - (\text{last sent} - \text{Ack})$$

$$= 25,000 - (30,000 - 20,000)$$

$$= 15,000$$

$$\text{c) 3. Effective window size} = \min(\text{Eff. Win. Size based on flow control}, \text{Eff. window size based on Cong. Control})$$

$$= \min(5,000, 15,000) \text{ bytes}$$

$$= 5,000 \text{ bytes}$$

- Congestion Control in TCP

CW = 1 it gets ACK then CW = 2 when both get ACK CW = 4.

$$2^0 = 1$$

$$2^1 = 2$$

$$2^2 = 4$$

$$2^3 = 8$$

Exponential Increase

Slow start

9 Threshold

8

7

6

5

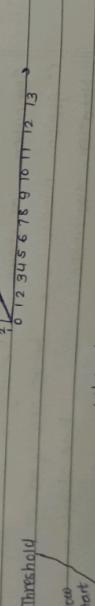
4

3

2

1

0



when it reaches to threshold it changes the state and increases by only one.

- Two states.

0-TCP has two state: slow start and congestion avoidance.
2) A window size threshold governs the state transition.

- AIMD (Additive increase & multiplicative decrease).

at
1 → 2, packet loss, 2 → 10, 10 → 30, packet loss, 30 → 15, 15 → 20, packet loss, 20 → 10, 10 → 16, packet loss.
16 → 8, 8 → ...

1. Slow Start.

Initial CW is 1

Slow start phase: 1, 2, 4, 8, 16, 32, 64

When it is about to reach 64 2 window size reduces to 1

First time reach threshold, New threshold is set to half of previous: $40/2 = 20$.

2. Fast Recovery (No threshold)

when packet lost, it will go to half of previous window size.

Slow start + AIMD is used here.

Slow start - Exponential increase until congestion window reaches congestion threshold or advertised window.

Ex: 30 packets are send, if packet is loss, 15th, 22nd and 27th packet is lost, 5th packet lost. By using AIMD how many RTT's are required to send 30 packets.

RTT	seq no. packet
1	1
2	2, 3
3	4, 5, 6
4	5

RTT Seq no. of packet

⑤	6, 7	<ul style="list-style-type: none"> • It takes 16 RTTs to send 30 packets.
⑥	8, 9, 10	
⑦	11, 12, 13, 14	
⑧	15, 16, 17, 18, 19	
⑨	15, 16	
10	17, 18, 19	
11	20, 21, 22, 23	
12	22, 23	
13	22, 25, 26	
14	27, 28, 29, 30	
15	27, 28	
16	29, 30,	

- ① Slow start + congestion avoidance
packet lost : 5, 15, 22, 27

→ RTT Seq No. of packet

1	1	
2	2, 3	
3	4, ⑤ 6, 7	
4	5	cong. Threshold = 2 (Threshold = cw = 2)
5	6, 7	
6	8, 9, 10	
7	11, 12, 13, 14	
8	15, 16, 17, 18, 19	cong. Threshold = 2 (Threshold = cw = 2)
9	15	
10	16, 17	
11	18, 19, 20	
12	21, 22, 23, 24	cong. Threshold = 2
13	22	
14	23, 24	
15	25, 26, 27	cong. Threshold = 1 (Threshold = (cw) / 2 = 1)

16	27
17	28, 29
18	30

It takes 18 RTT to send 30 packets.

CEP
27-08

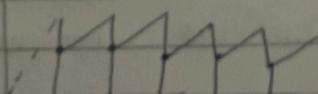
$$\text{The throughput} = \frac{(30 \text{ packet} * 1 \text{ KB/packet})}{(18 \text{ RTTs} * 100 \text{ ms/RTT})} = 136533 \text{ bit/sec}$$

Fast Recovery

- Q. Solve some problem using fast Recovery 5, 15, 22, 27. How many RTTs will be required to sent 30 packets.

- ① 1
- 2 2, 3
- 3 4, 5, 6, 7 $w = 4/2 = 2$
- 4 5, 6
- 5 7, 8, 9
- RTT=5 6 10, 11, 12, 13
- 7 14, 15, 16, 17, 18 $w = 5/2 = 2$
- 8 15, 16
- 9 17, 18, 19
- 10 20, 21, 22, 23 $w = 4/2 = 2$
- 11 22, 23
- 12 24, 25, 26
- 13 27, 28, 29, 30 $w = 4/2 = 2$
- 14 27, 28
- 15 29, 30

^{1st} Exponential increase
^{2nd} Additive increase



TCP Tahoe

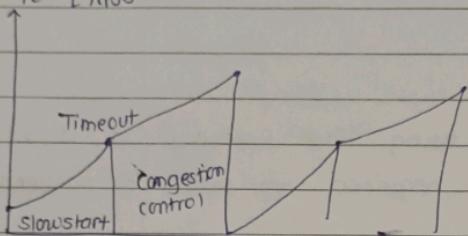
(4 - 6 marks)

slow start and congestion avoidance

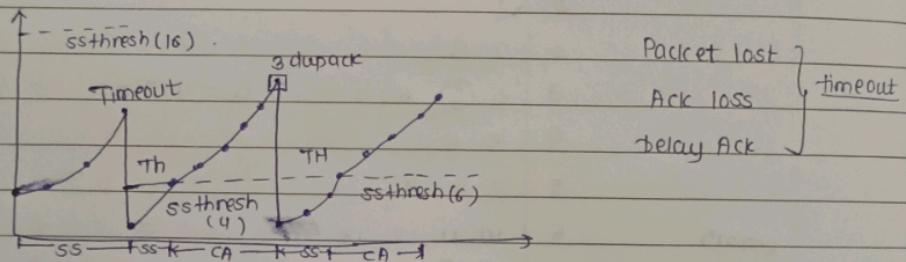
TCP Tahoe treats the two signals used for congestion detection,

time-out three duplicate segments.

cwnd to 1 mss.



(4 - 6 marks)



TCP Reno

two signals of engine congestion

time-out the arrival of three duplicate ACKs

It behaves like the slow start, in which cwnd grows exponentially
cwnd start with the value ssthresh plus 3 mss (instead of 1)

- Q. Same problem → Difference between TCP Tahoe & Reno?
- Q. What is the threshold value in TCP Tahoe and Reno?

"TCP Tahoe : SS + AL + Fast Retransmit"

Step 1 - Assume that the cwnd = 8 and sender has sent segments 31-38, and 31 is lost.

Step 2 - Receiver will reply with 7 duplicate ACKs of segment 30 (indicating it is waiting for 31).

Step 3 - On receiving 3 duplicate ACKs, would cwnd is set to 1 if 31 is retransmitted, and SS phase is started.

Step 4 - Restart in slow start by sending segment 39.

EX - TCP Tahoe (1/2), (2/2)

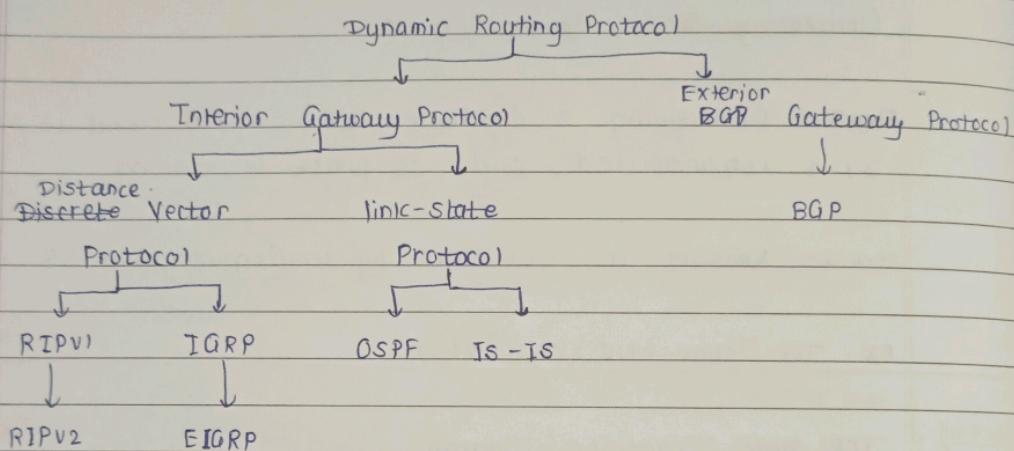
- TCP State Transition Diagram (do it own)
Connection establishment and connection reestablishment.
(do it own)
 - Web caching and DNS caching - chapter 2.
 - CDN
 - Bit torrent in p-to-p architecture.

Chapter 8.4

- Static Vs Dynamic Routes:

- Routing Protocol

Q) Diagram is given where BGP and IGP used?



1) Distance Vector Routing Protocols:

Provides two characteristics → Distance → how far destination is.

→ Vector → direction of the next-hop

R₁ and R₂ should be in one subnet.

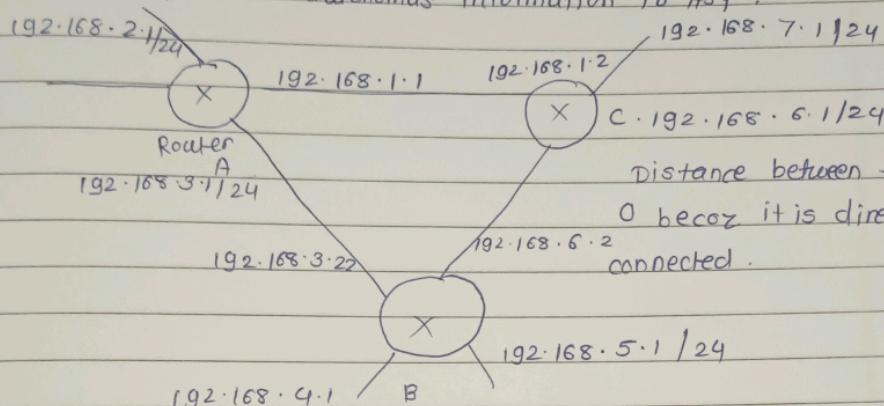
2) Link State Routing Protocol.

3) Interior Gateway Protocols

4) Exterior gateway protocol is used to do this:

Asy and Asy

Q. How ASX provide autonomous information to ASY?



Distance between this is
0 becoz it is directly
connected.

- Metrics - is a variable assigned to routes as a means of worst or from most preferred to least preferred.

- Hop Count -

- Bandwidth

- Load

- Autonomous System (AS)

- collecting of routers whose prefixes & routing policies are under common administrative protocol.
cgp (Interior Gateway Protocol).

Dynamic IGP :- Protocol used to distribute routing information within an AS.

Dynamic EGP :- [Exterior Gateway Protocol]

- Switching via bus
 - datagram from lib part memory to lib part interface
 - via shared bus
 - bus connection - switching speed limited by bus bandwidth
 - 32 Mbps
- Switching via intermediate network or crossbar
 - multistage switch
 - exploiting
- * Input port Queuing
 - queuing delay or loss due to input buffer overflow
 - Head-of-the-line (HOL) blocking : (common)
- * Output port Queuing
 - queuing and loss due to output buffer overflow !

- (a) (b)
- Buffer Management
 1. drop $\cancel{\text{fair}}$ priority
 2. marking
 3. Random
 - Packet Scheduling : FCFS
 - first come, first serve
 - priority
 - round robin
 - weighted fairshare queue
 - FIFO

Queue Operation

- 1. Packets are served in the order they arrive
- 2. After the transmission of packets

Prioritized Traffic

Prioritized Queuing

Create prioritized Queue with Two priority classes - 1) high priority 2) low priority
packet arrival and Transmission

Packet Classification

- 1) High priority
- 2) Low priority class

pkt 1 pkt 2
pkt 2 pkt 3
pkt 3 pkt 4
pkt 4 pkt 5
pkt 5

Scheduling Policies: Round Robin discipline

- packets are sorted into classes similar to priority queuing.
- basic operations

Operation of Two-classes Round Robin Queuing

Class 1

Class 2

- packets : Class 1 : pkt 1, pkt 2, pkt 4
- Class 2 : pkt 3, pkt 5

Weighted Fair Queuing

Scheduling Mechanism

Sidebar: Network Neutrality

What is network neutrality?

- technical : how an ISP should share / allocation its resources → Decide & the buffer managing mechanism
- social, economic principles
 - protecting free speech
 - encouraging innovation, competition
 - enforced legal rules and policies

Different countries have different "takes" on network neutrality.

IPv4 Header Format

TcpV4 checksum is applied to only header not for entire segment.

Version -

Header Length - min 20 bytes max 60 bytes.

- (Q) calculate, version, header length, IP address, source and destination address. find ?

- (Q) When an IP datagram fragmented?

DF Bit -

DF = 1 no fragmentation

DF = 0 allow for fragmentation.

MF Bit

MF = 0 - last fragment

MF = 1 - given permission for more fragmentation on process begin.

Fragment Offset - 13 bit field

Q = size of datagram is given what is the no of fragmentation can be done?

Time to live

concept of scaling factor
fragment offset = fragment offset / 8.
frequent offset value field = fragment offset / 8.

Time to live value is decremented by 1 when packet travelling from one hop to another.

If the value of TTL becomes 0 better reaching the destination, the datagram is discarded.

Protocol Field

- protocol number of TCP is 1, 1-2, TCP is found & and UDP 17

Header checksum

checksum of header contains includes IP header only
At each intermediate device checksum is checked.

Source IP

destination
options. This field is used for several purpose.

1. Routing

2.