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# **GATE**

## **Computer Science**

**Ravindrababu Ravula GATE CSE**  
**Hand Written Notes**

**-: SUBJECT :-**  
**Computer Networks**

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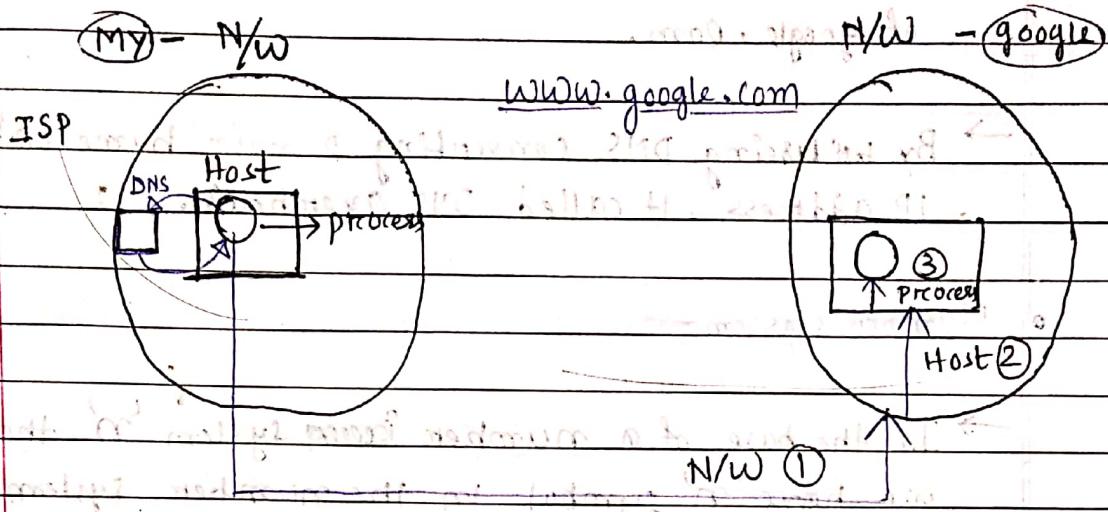
Standard: Division: Roll:

Subject: Computer Network.

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IP address Subnetting & SupernettingINTRODUCTION TO COMPUTER NETWORK AND IP ADDRESS:

→ www.google.com (using this domain name we can identify destination N/w, destination host and destination process)

→ www.google.com (this Domain name convert into some numbers so that it can identify N/w, host, process)

www.google.com



IP address.

N/w ID	Host ID
--------	---------

(port num)

→ here, N/w ID to identify destination N/w. and Host ID to identify destination Host.

→ port number (80) used to reach in destination process. (most of the port numbers fixed)

- ISP (Internet Service provider) provide DNS (Domain name server) inside the Net N/w <sup>it</sup> provide the IP address of google.com.
- By using DNS converting domain name into IP address, it called DNS overhead.

### • Number system —

→ If the base of a number system 'n', then we have 'n' symbol in the number system.  
 $0, 1, 2, \dots, (n-1)$

Unary — 0

\*Binary — 0, 1

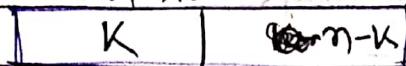
Octa — 0, 1, 2, 3, 4, ..., 7

Decimal — 0, 1, 2, 3, ..., 9

Hexadecimal — 0, 1, 2, ..., 9, A, B, ..., F

$(2^1)$ 1bit	$(2^2)$ 2bit	$(2^3)$ 3bit
$2^{10} - K$	0 0	0 0 0
$2^{20} - M$	1	0 1
$2^{30} - Gc$		1 0
$2^{40} - T$		1 1
		1 0 0
		1 0 1
		1 1 0
		1 1 1

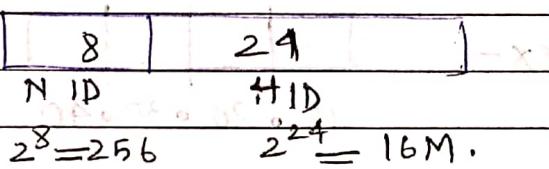
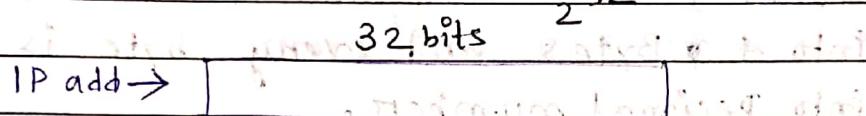
1 — 2  
 $2 - 2^1 = 1$  part  
 $3 - 2^2 = 4$  part  
 $4 - 2^3 = 8$  part

$n$  bit

$2^n$

# of choose,  $K \rightarrow 2^K$  (devide) $2^K$  parts  $\rightarrow 2^n$  numbers.

1 part  $\rightarrow \frac{2^n}{2^K} = 2^{n-K}$ .

 $\rightarrow$  In computer network IP address is 32 bits.

here N/W are very less than Host.

### • Classfull IP address -

32 bit  $= 2^{32}$



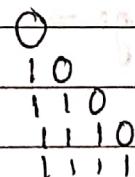
Class-A	Class-B	Class-C	Class-D	Class-E
0	10	110	1110	1111
$2^{31}$	$2^{30}$	$2^9$	$2^8$	$2^8$
0	10	110	1110	1111
0	10	110	1110	1111
:	10	110	1110	1111
1	11	111	1111	1111
$2^{31}$	$2^{30}$	$2^9$	$2^8$	$2^8$
1	11	111	1111	1111

$$\downarrow$$

Total add space  $= 2^{32}$

choose bit = 1

size of each part  $= \frac{2^{32}}{2^1} = \frac{31}{2}$



IP Address Representation -

→ IP add represent in three way's

(A) **BINARY REPRESENTATION**: 0's & 1's of 32 bits.

(B) Convert the entire 32 bit in it decimal numbers.

\* (C) Dotted Decimal Representation: 32 bit are divided into 4 bytes and every byte is converted into decimal number.

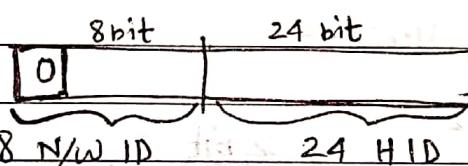
ex -



10 . 20 . 30 . 40

Class-A:

→ # IP in class-A is  $2^{24}$ .

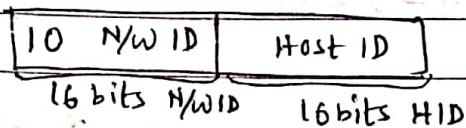


with 7 bits,  $2^7 = 128$  N/W of class A.

$$2^{24} = 16M \text{ IP/N/W}, \text{ so total IP add present} \\ = 2^{24} \times 2^7 \\ = 2^{31}$$

0 0 0 0 0 0 0 - 0 X	0 0 0 0 0 0 1 - 2	0 0 0 0 0 1 0 - 2	(1-126)	$2^8 - 2^7$
		- 126		$= 128$
		1 1 1 1 1 1 - 127 X		

range = B/W  $[1-126] \Rightarrow$  class A.

Class - B:Total IP address =  $2^{30}$ 

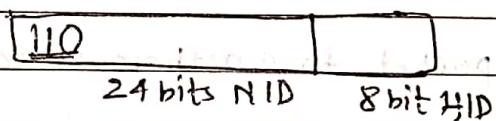
# N/W  $2^{14} \approx 16K$

$2^{16}$  IP / N/W

so, Total IP address present in class-B =  $2^{14} \times 2^{16} = 2^{30}$

Range of class-B B/W 128-191

10 000000 - 128	$2^8 - 2^6$
000001 - 129	= 192
000010 - 130	
.....	
111111 - 191	

Class - CTotal IP address =  $2^{29}$ 

# N/W  $2^{21} \approx 2M$

$2^8$  IP / N/W

so, Total IP add present in class-C =  $2^{21} \times 2^8 = 2^{29}$

Range of class-C B/W 192-223

$2^8 - 2^5$	
= 224	

Range of class-C B/W 192-223

0000 0 - 192

0000 1 - 193

0001 0 - 194

1111 1 - 223

Class-D

total number of IP address present =  $2^{28}$ , later

and range =  $(224 - 239)$

$$\begin{array}{r}
 1110 \dots \\
 0000 - 224 \\
 0001 - 225 \\
 0010 - 226 \\
 \hline
 1111 - 239
 \end{array}$$

(2<sup>8</sup> - 2<sup>4</sup>) \\
 [224 + 2<sup>4</sup>] \\
 \Rightarrow 240 \\
 \hline
 224 \\
 16 \\
 \hline
 240

Class-E

range =  $(240 - 255)$

$$\begin{array}{r}
 1110 \dots \\
 0000 \dots \\
 0001 \dots \\
 0010 \dots \\
 \hline
 1111 - 255
 \end{array}$$

[240 + 2<sup>4</sup>] \\
 \Rightarrow 256

- Type of casting - (Unicast, Limited Broadcast, Directed Broadcast)

→ Sending one packet to another, is called casting.

→ casting '2' types :

(1) unicast : means sending a packet from one host to only one particular host.

(2) Broadcast : means sending a packet from one host to many hosts.

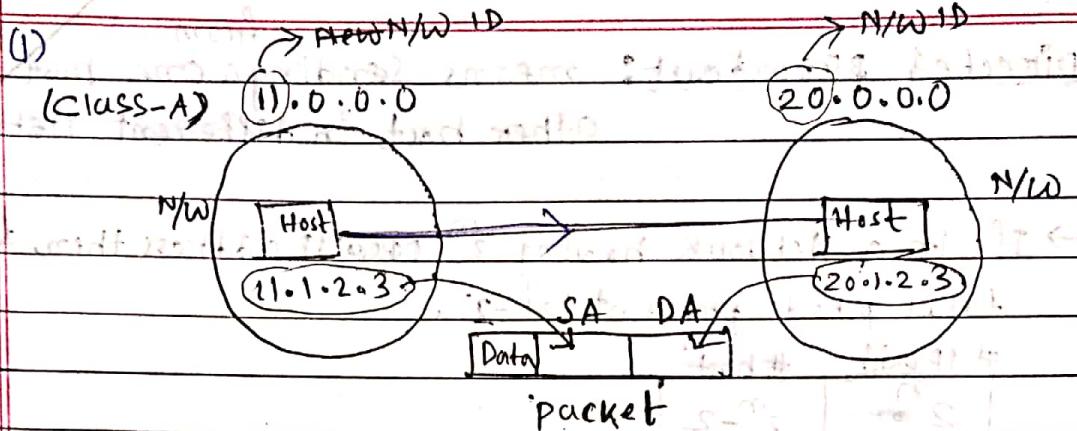
Range - A - (1 - 126)

C B - (127 - 191)

C C - (192 - 223)

C D - (224 - 239)

C E - (240 - 255)



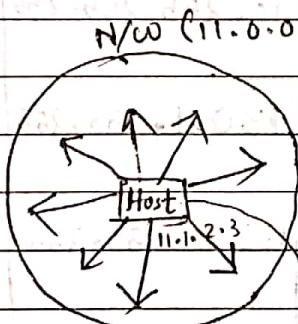
(I) Unicasting

(II)

Broadcasting

Limited BC

Directed BC



S-A DA  
Mess 11.1.2.3 255.255.255.255

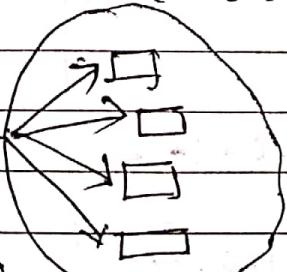
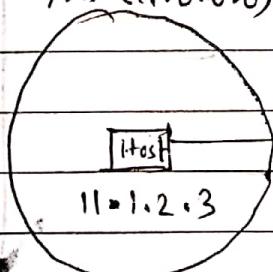
→ means sending to all the host.

this Host creat ↑ packet

Limited BC : sending from one host to many host in same N/W is called limited Broadcasting.

N/W ( $11 \cdot 0 \cdot 0 \cdot 0$ )

N/W ( $20 \cdot 0 \cdot 0 \cdot 0$ )



S-A DA  
Data 11.1.2.3 20.225.225.225 → packet

from  
 • Directed Broadcast: means sending one host to many other host in others network.

→ If in a Network having  $2^n$  IP address then, ~~2<sup>n</sup>-1~~ host.  
 total host present ( $2^n - 2$ )

# IP add # host

	$2^m$	$2^n - 2$
CA →	$2^{24}$	$2^{24} - 2$
CB →	$2^{16}$	$2^{16} - 2$
CC →	$2^8$	$2^8 - 2$

$$CA = (1-126), CB = (128-191), CC = (192-223)$$

	IP address	N/W ID	Direct Broadcast Address	Limited Broadcast Address
CA -	<u>1.2.3.4</u>	1.0.0.0	1.2.55.255.255	255.255.255.255
	<u>10.15.20.60</u>	10.0.0.0	10.255.255.255	255.255.255.255
CB -	<u>130.1.0.0</u>	130.1.0.0	130.1.255.255	"
	<u>150.0.0.0</u>	150.0.0.0	150.1.255.255	"
CC -	<u>200.1.10.100</u>	200.1.10.0	200.1.10.255	"
	<u>220.15.1.10</u>	220.15.1.0	220.15.1.255	"
CE	250.0.1.2	X	X	X
	360.1.2.3X			
	X not valid			

## • Subnets, Subnet Mask, Routing:

### Subnetting:

→ Dividing a big network in to many small network, is called subnetting.

### Adv:

(i) Maintenance of smallest network  
is easy as compare to big network.

(ii) security can be improved.

### disadv:

(i) Now 4 steps required to identification -

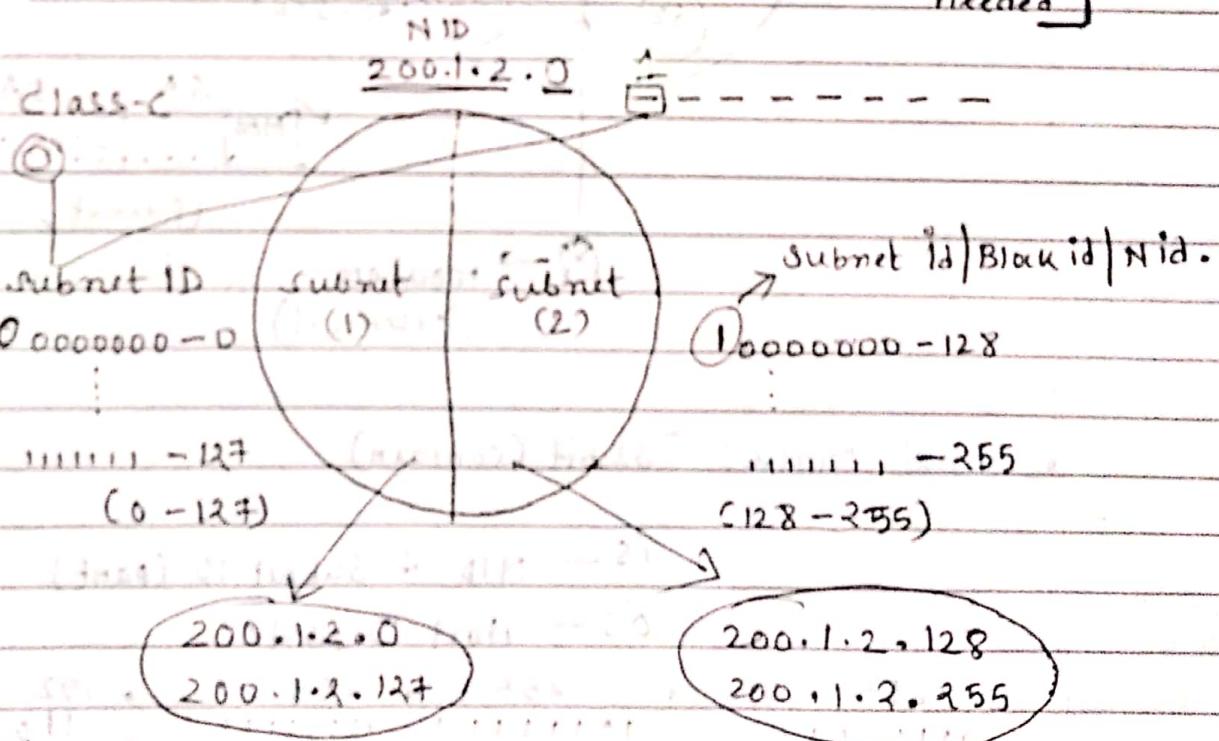
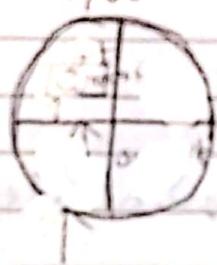
a. Identify network

b. " " subnet

c. " " host

d. " " process.

[normally 3 steps needed]



200.1.2.0

200.1.2.0 ---

0 0

range-(0-63)

S1

S4

1 1

→ already in subnetting

we are going to take  
(128-191) bits from the host id  
part.

0 1

S2

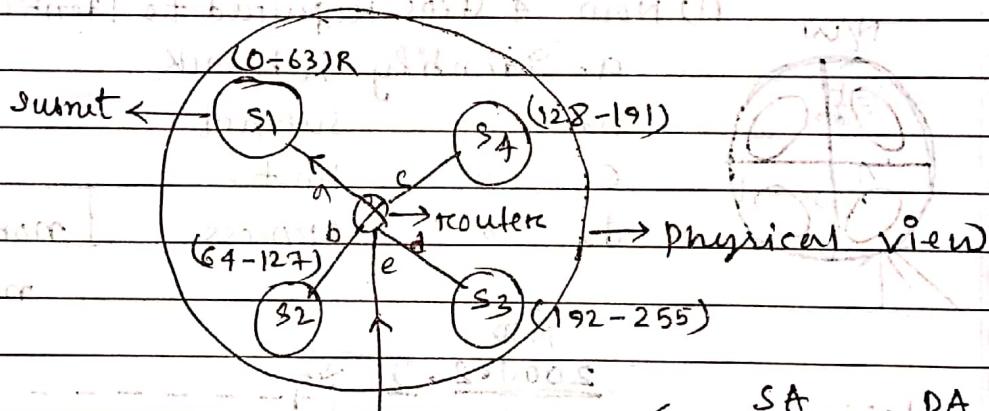
S3

1 0

(64-127)

(192-255)

Logical view.

→ here wasted  $2 \times 4 = 8$  IP addresses. (to 4 subnet)

SA DA

Mess 200.1.2.20

(Packet)

X → routetc  
(external)Subnet Mask: 32 bit (contain)

1's - NID &amp; Subnet ID (part)

0's - Host ID (part)

255.255.255.192

<u>11111111</u>	<u>11111111</u>	<u>11111111</u>	<u>11000000</u>
Network ID	SID	Host ID	

200.1.2.130

255

255 . 255 . 192

Subnet mask - 11111111 . 11111111 . 111111 . 11000000

IP add - 11001000 . 00000001 . 00000010 . 10000000

11001000 . 00000001 . 00000010 . 10000000

terminal 22.21.9.612, host 260 . 1 . 2 . 128

(0.2.1.2) 1st octet of IP

terminal prompt 200&gt; [200 . 1 . 2 . 128]

→ 11001000 . 00000001 . 00000010 . 10000000

given an IP add and Subnet mask we can find out  
 the network id of network to which the IP address  
 belongs.

Ex - Subnet mask : 255.255.255.192

IP add : 200 . 1 . 2 . 10

[200 . 0 . 1 . 8 . 12 . 0]

→ It belongs to subnet ( $S_1$ )

→ Router will use the subnet mask in order  
 to find out what is the interface we should  
 forward the packet to.

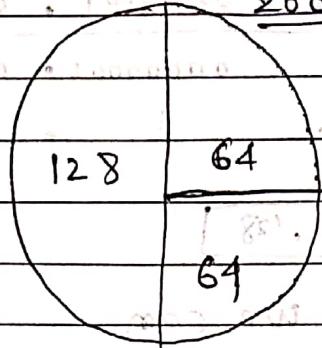
### Routing table

N ID	Subnet M	Interface
200 . 1 . 2 . 0	255 . 255 . 255 . 192	a
200 . 1 . 2 . 64	255 . 255 . 255 . 192	b
200 . 1 . 2 . 128	255 . 255 . 255 . 192	c
200 . 1 . 2 . 192	"	d
0 . 0 . 0 . 0	0 . 0 . 0 . 0	e

If coming packet-(IP add + subnet mask) is match with any  
 row N ID then the packet send over (a,b,c,d).  
 If doesn't match then next packet sent out (Default  
 entry)

variable length subnet masking →

CCW → 200.1.2.0



→ subnet size is different  
it is called (VLSM)

variable length subnet  
masking.

first 2 bits of the above family form NID and last 2 bits

form HID → 200.1.2.0 → NID → HID

choose 1 bit.

3 bit remaining

SM [255.255.255.192]

SNID  
 $(2^7 = 128)$

64

128

64

128

64

128

64

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128

## Subnet mask

255.255.255.192

11111111.11111111.11111111.11000000

here, 26 is  
 $(NID + SID)$

Class-A,  $8 + SID = 26$

$SID = 18$

#subnets =  $2^{18}$

6 SID - 00000001  
 $(NID)$  - 11111111  
 $\downarrow$   
 $2^6 = 64$  IP/SN

C-B,  $16 + SID = 26$

$SID = 10$

#subnets =  $2^{10}$

C-C,  $24 + SID = 26$

$SID = 2$

#SN =  $2^2 = 4$

(Question) — given 1225.255.255.15 (SM), how many subnet, possible. If it is class-C.



1225.225.255.15

11111111.11111111.11111111.11111111

15

$2^{7-1}$

$2^{6-1}$

$2^{5-1}$

$0-1$

Network ID + subnet = 28



$24 + SID = 28$

$SID = 2^4$

$= 2^4$  (subnets)

Some Fundas

Questions on Subnet masking:

00000000 - 0

10000000 - 128

11000000 - 192

11100000 - 224

11110000 - 240

11111000 - 248

11111100 - 252

11111110 - 254

11111111 - 255

2<sup>8</sup> = 256 sub

(128+64)

2<sup>8</sup> = 256 = 128 + 642<sup>8</sup> = 256

Sub = 256 sub

2<sup>8</sup> = 256 sub for the given subnetmask how many  
subnets possible

Subnet mask	No of Hosts	Subnet in class A	Subnet in class B	Subnet in class C	NID is 10 bit
255.0.0.0	2 <sup>4</sup> -2	2 <sup>0</sup>	—	—	X
255.128.0.0	2 <sup>7</sup> -2	2 <sup>1</sup>	—	—	X
255.192.0.0	2 <sup>6</sup> -2	2 <sup>2</sup>	—	—	2 <sup>0</sup>
255.240.0.0	2 <sup>5</sup> -2	2 <sup>3</sup>	—	—	2 <sup>2</sup>
255.255.0.0	2 <sup>16</sup> -2	2 <sup>8</sup>	2 <sup>8</sup>	2 <sup>0</sup>	2 <sup>6</sup>
255.255.254.0	2 <sup>9</sup> -2	2 <sup>5</sup>	2 <sup>3</sup>	2 <sup>1</sup>	2 <sup>3</sup>
255.255.255.0	2 <sup>8</sup> -2	2 <sup>6</sup>	2 <sup>2</sup>	2 <sup>0</sup>	2 <sup>4</sup>
255.255.255.224	2 <sup>5</sup> -2	2 <sup>19</sup>	2 <sup>11</sup>	2 <sup>5</sup>	2 <sup>7</sup>
255.255.255.240	2 <sup>4</sup> -2	2 <sup>20</sup>	2 <sup>12</sup>	2 <sup>4</sup>	2 <sup>8</sup>

(a) 1's + 0's = 2<sup>8</sup>8 2<sup>8</sup>

$$\text{NID} + \text{S-ID} = 8$$

8                    8

$$\text{S-ID} = 0$$

Q. Given subnet mask as 255.255.255.192 and IP address PS: 200.1.2.3 ? find the Subnet ID and how many subnet there is.

SM - 255.255.255.192 ~~255.255.255.192~~

IP - 200. 1 . 2 . 3 ,

↳(class-c network)

SID = 200-1-2-0

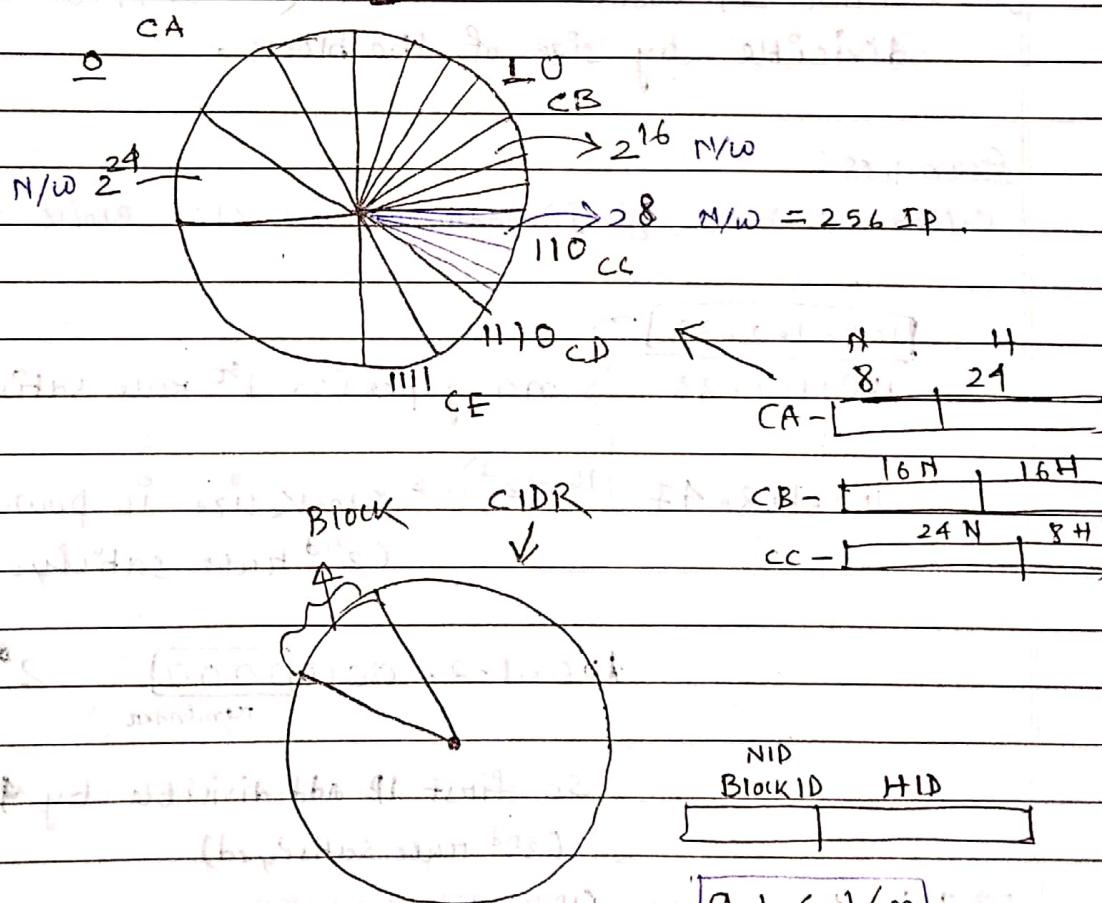
# mask of subnet  $\rightarrow$  11111111. 11111111. 11111111. 11000000  
mask NID SID SSID

$$\text{NID} + \text{SID} = 26$$

$$\# SID = 26 - 24 \Rightarrow 2 \text{ bit}$$

$$\text{So, no of subnet} = 2^2 \Rightarrow 4$$

## CLASSES INTER DOMAIN ROUTING (CIDR) :



→ here  $m$  represent what are the bits in Block ID (NID).

## CIDR representation

Ex- 20.10.50.100/20 $(m=20 \text{ bit in Network ID})$   
part

total bit = 32

NID = 20

HID =  $32 - 20$  $= 12$ contains  $2^{12}$  IP addresses  
 $= 2^{12} - 2$  host

## Rules for forming CIDR blocks

I) All IP Addresses should combine be contiguous.

II) The Block size should always be a power of 2. ( $2^n$ )  
(easy to divide IP add into NID and HID)

III) First IP address in the block should be evenly divisible by size of the block.

## Examples:

Given a block of IP addresses are CIDR Block or not?

100.1.2.32

100.1.2.33

no gaps (so 1<sup>st</sup> rule satisfied)

100.1.2.47

$16 = 2^4$

Block size is power of 2  
(2<sup>nd</sup> rule satisfied).

100.1.2.00100000

$2^4$

remained

So first IP add divisible by  $2^4$ .  
(3<sup>rd</sup> rule satisfied)

→ This block are CIDR Block.

### Example -

Whether this IP address form the CIDR Block or not.

<u>20. 30. 30. 32</u>	and $\rightarrow$ 25 blocks of size <u>20. 10. 30. 33</u>
<u>20. 10. 30. 34</u>	$32 = \textcircled{25}$ size of the block power of '2'.
<u>⋮</u>	<u>⋮</u>
<u>20. 10. 30. 63</u>	<u>20. 30. 30. 00100000</u>

→ this block also qualify to form GDR block.

$$\rightarrow \text{No of 1P add } 2^5, \text{ HID} = 5, \text{ BID} = 32 - 5 = 27 \quad [20, 10, 30, 32/2]$$

Example →  $\text{strides} = \text{None}$ ,  $\text{axis}=1$

find out whether ~~this~~ this block are EIDR or not.

$$150 \cdot 10 \cdot 20 \cdot 64$$

$$150 \cdot 10 \cdot 20 \cdot 65$$

$$150 \cdot 10 \cdot 20 \cdot 66$$

$$\vdots$$

$$150 \cdot 10 \cdot 20 \cdot 127$$

$$64 = 2^6 \quad (2^{\text{nd}} \text{ rule followed})$$

$$150 \cdot 10 \cdot 20 \cdot 128$$

$$150 \cdot 10 \cdot 20 \cdot 129$$

$$150 \cdot 10 \cdot 20 \cdot D1000000$$

→ Is this block also a CDR block?

→ In this block,  $2^6$  IP addresses and 6 host IDs.

HID = 6

$$HID + BID = 32$$

$$-BID = -28$$

Required CIDR representation, 150.10.20.64 /28

### Example -

~~B~~ CIDR Block given find the range.

100:1.2,35 / 20

BID size = 20 bits

BID

range -

100-1-0-0

100 + 15 = 265

~~32bit~~ 35bit

UNIVERSITY OF TORONTO LIBRARIES

—

1111111111

## Subnetting in CIDR -

example: In 20.30.40.10/25 → here NID = 25 and Host ID = 7 bit.

$$20.30.40.10/25 \rightarrow \text{here NID} = 25 \text{ and Host ID} = 7 \text{ bit.}$$

20.30.40.0 0001010

↓ NID

↓ 7 bit Host ID.

000001000000000000000000

We will choose bits from Host ID part for subnetting.

If we choose 1 bits from Host ID then we are going to divide the we will get 2 subnets.

20.30.40.0 0001010

NID ↓ 0000000

↓ 1111111

00001010 - 25 to 63

20.30.40.0 0001010

NID ↓ 1100000

↓ 0000000

00001010 - 64 to 127

20.30.40.0 0001010

0000000 - 0

0000001 - 1

0000100 - 2

0000111 - 7

0001000 - 8

0001001 - 9

0001010 - 10

0001011 - 11

0001100 - 12

0001101 - 13

0001110 - 14

0001111 - 15

0010000 - 16

0010001 - 17

0010010 - 18

0010011 - 19

0010100 - 20

0010101 - 21

0010110 - 22

0010111 - 23

0011000 - 24

0011001 - 25

0011010 - 26

0011011 - 27

0011100 - 28

0011101 - 29

0011110 - 30

0011111 - 31

0100000 - 32

0100001 - 33

0100010 - 34

0100011 - 35

0100100 - 36

0100101 - 37

0100110 - 38

0100111 - 39

0101000 - 40

0101001 - 41

0101010 - 42

0101011 - 43

0101100 - 44

0101101 - 45

0101110 - 46

0101111 - 47

0110000 - 48

0110001 - 49

0110010 - 50

0110011 - 51

0110100 - 52

0110101 - 53

0110110 - 54

0110111 - 55

0111000 - 56

0111001 - 57

0111010 - 58

0111011 - 59

0111100 - 60

0111101 - 61

0111110 - 62

0111111 - 63

Range,

Block ID 20.30.40.0/26

to  
20.30.40.63

for one subnet.

Range,

20.30.40.64/26

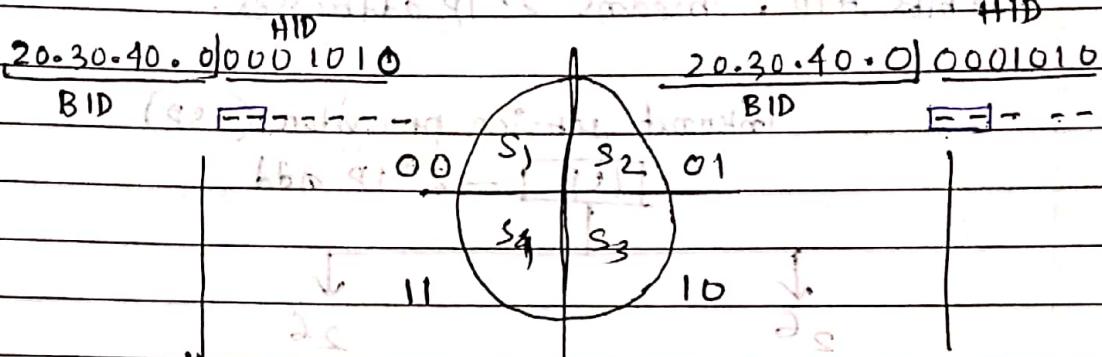
to  
20.30.40.127

for another subnet.

Example -

120.30.40.10/25

dividing the entire network into 4 subnets



If you choose 2 bits from HID part, then you get the entire network will be divide into 4 parts.

~~entire network will be divided into 4 parts~~

Subnet ID

First IP add

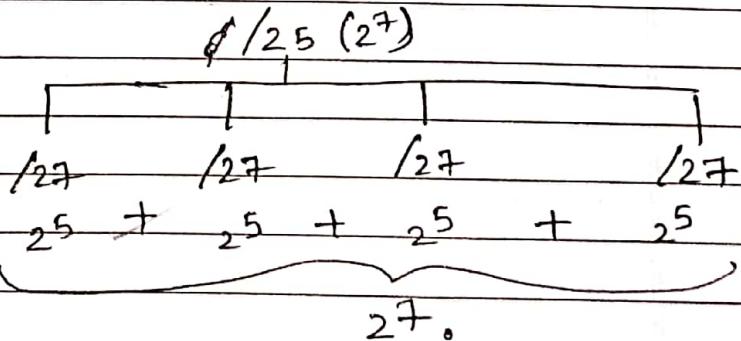
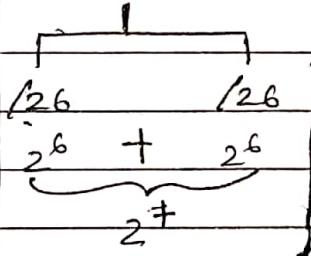
Last IP add

- |  |                 |
|--|-----------------|
| Subnet (S <sub>1</sub> ) ID → 20.30.40.0/27  | 20.30.40.31/27  |
| Subnet (S <sub>2</sub> ) ID → 20.30.40.32/27 | 20.30.40.63/27  |
| Subnet (S <sub>3</sub> ) ID → 20.30.40.64/27 | 20.30.40.95/27  |
| Subnet (S <sub>4</sub> ) ID → 20.30.40.96/27 | 20.30.40.127/27 |

NID

Directed Broadcast add

/25 - NID (HID = 7) ( $2^7$  IP address)



→ Variable length subnet masking.

### VLSM in CIDR blocks:

Example

20.30.40.10/25

here in this block 25 bit Network ID and (32-25) = 7 bits HID, means  $2^7$  IP addresses.

00100010.00110000.01101010.00000000

Internet service provider (ISP)

[ISP] -  $2^7$  IP add

↓ ↓ ↓

2<sup>6</sup> 2<sup>6</sup>

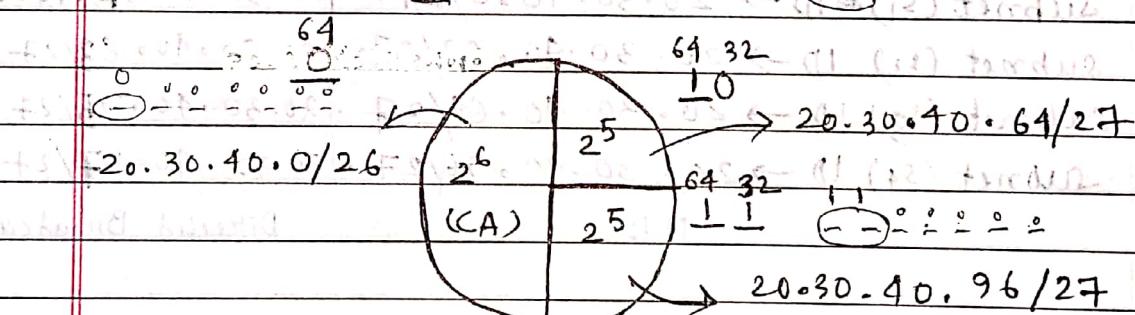
(for company A)

2<sup>5</sup> 2<sup>5</sup> (for company) (to individual customers)

B

25 bits NID HID

20.30.40.00000000



((S) 25))

.00

Example —  $\lim_{x \rightarrow 0} \frac{\sin x}{x}$  does not exist.

(MP) 40-30-10-10/20 2018 (MP) Vendo la casa

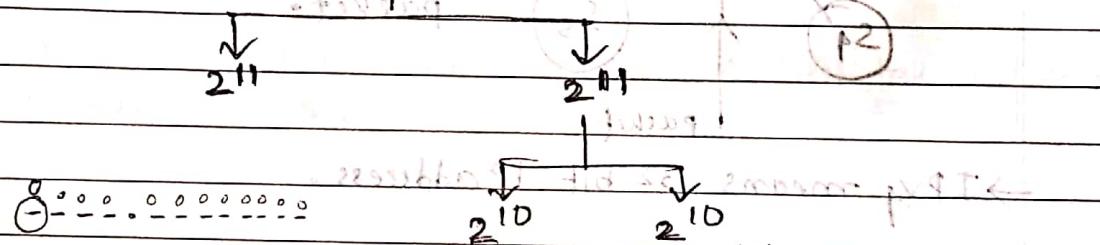
hence requires 20 bits BID(NID) and  $(32-20)$  bits = 12 bits Host ID (HID) so, total number of IP address possible  $2^{12}$ .

40.30.0.000|1010.00001010

20 bit Block ID      Host IP  
0000.0000.000 - 1<sup>st</sup> IP add (40.30.0.0)

~~with port 40.30.15.8225~~ — last IP add(40.30.15.8225)

~~The first edition of no. 12  
was first used at 15P.M.~~



$$\text{first} - (40 \cdot 30 \cdot 8 \cdot 0.01 / 22) \leftarrow \text{IP}$$

(b) ~~IP~~ ~~copyright~~ ~~material~~

$$\text{last}(P^c(40 \cdot 30 \cdot 15 \cdot 355), 1) = \frac{1}{1}$$

(40-30.11.255/22) - last

Last IP = (40-30-15-255)21) ⑤1 210 11

2)  $\frac{1}{2} \sin(2x) + C$

$$(40 \cdot 30 \cdot 12 \cdot 0, / 22) - 1^t$$

(40.30.15.255/22)

~~160-91~~ that current bloods may help. ~~for example~~ ~~infecting no other animal~~ ~~as well~~ ~~but~~ ~~not~~ ~~recommended~~

- Some problems on Subnet masking - ~~standard~~

→ subnet mask (sm) also called network mask (nm).

~~What is standard? If one (one) is also said to be standard.~~

~~The difference between SM is the number of bits in (0 or 1) at first.~~

IP

SID →

subnet ID of subnet <sup>to which</sup> where IP belongs to.



~~(S1-S4)~~ → Subnets.

~~(S1-S4)~~ → Subnet mask used by the

~~router. Router to which find out~~

~~which way direct to the~~

~~packet.~~

→ IPv4 means 32 bit IP address.

Internet service provider (ISP) provides - (i) IPv4

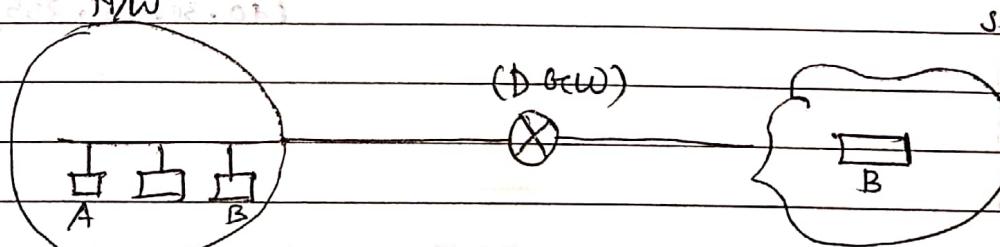
(ii) Dgw

(Default gateway IP add)

(iii) SM (subnet mask)

(iv) DNS (Domain name

server).



→ To send a packet, first you should know that IP add Destination and also DA are Inside or outside.

Example -

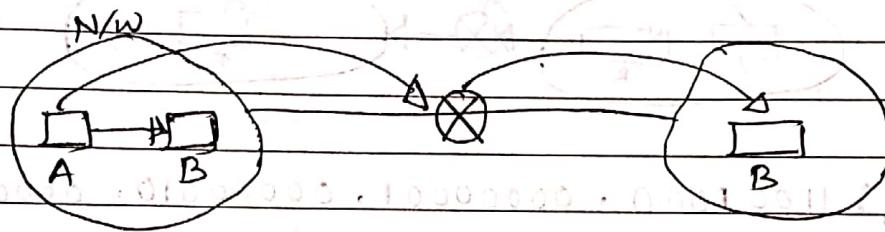
200.1.2.0

a host A : IP<sub>A</sub> : 200.1.2.10

SMA : 255.255.255.128. And a host

8.8.8.88. IP<sub>B</sub> : 200.1.2.130

(0.0.0.0) default route 200.1.2.128

B : IP<sub>B</sub> : 200.1.2.130 facing number

To send packet from host A, A first take its own IP add and SMA.

IP<sub>A</sub> : 11001000 . 00000001 . 00000010 . 00001010

SMA : 11111111 . 11111111 . 11111111 . 10000000

*(Network ID of A)* 11001000 . 00000001 . 00000010 . 00000000  
NID<sub>AA</sub> : 200 . 1 . 0 . 0

*(along with same broadcast address of bus A as)*

IP<sub>B</sub> : 11001000 . 00000001 . 00000010 . 10000010

SMA : 11111111 . 11111111 . 11111111 . 10000000

*(Network ID of B)* 11001000 . 00000001 . 00000010 . 10000000  
NID<sub>BA</sub> : 200 . 0 . 2 . 1 (8.8.8.88) . 128

*In this case,*

Here, Network ID of A and B are different so,

~~A can't send~~ A first send the packet to router ~~and~~ (Router know that where its Destination) and router send the packet to Destination address.

Example-

Q. 3.1.3.3

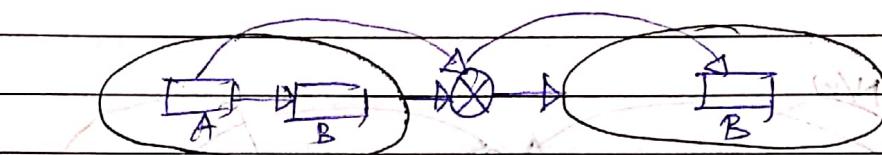
$(200 \cdot 1 \cdot 2 \cdot 0)$   $\rightarrow$  belongs to  $(200 \cdot 1 \cdot 2 \cdot 0)$

Ans: a host A:  $IP_A: 200 \cdot 1 \cdot 2 \cdot 10$

$SM_A: 255.255.255.128$

$7 \cdot 0 \cdot 1 \cdot 1 \rightarrow$  this IP belongs to  $(200 \cdot 1 \cdot 2 \cdot 0)$

another host B:  $IP_B: 200 \cdot 1 \cdot 2 \cdot 126$



$IP_A: 11001000 \cdot 00000001 \cdot 00000010 \cdot 00001010$

$SM_A: 1111111 \cdot 1111111 \cdot 1111111 \cdot 10000000$

$NID_A: 11001000 \cdot 00000001 \cdot 00000010 \cdot 00000000$

AA

200 . 1 . 2 . 0

$IP_B: 11001000 \cdot 00000001 \cdot 00000010 \cdot 00001010$

$SM_B: 1111111 \cdot 1111111 \cdot 1111111 \cdot 10000000$

$NID_B: 11001000 \cdot 00000001 \cdot 00000010 \cdot 00000000$

200 . 1 . 2 . 0

so, A and B both are in <sup>in</sup> network  $\rightarrow$  so, A send the packet

Diffrctly to B  $\rightarrow$   $IP_B: 200 \cdot 1 \cdot 2 \cdot 126$

Ex.

$SM (Subnet mask) : 255.255.255.255$

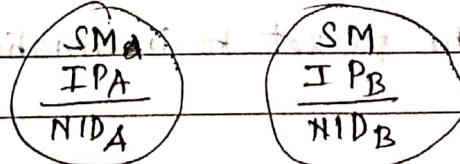
here, no of  $1$ 's (32), means  $(NID + SID) = 32$ .

so transmit from A to: no of  $0$ 's (0), means  $HID = 0$ .



Combining all subnet fields (HID, NID, SID) we get

number  
(1)



~~Explain how to find network ID & subnet mask.~~

given a Directed Broadcast Address (DBA) can you find out network ID and subnet mask.



DBA: 200.1.15.255 (if in host ID part put all 1's then it is DBA)

~~11001000.00000001.00001111.11111111  
8 bit 8 bit Host ID~~

many NID =  $2^{20-15} = 2^5 = 32$  (Because all 1's are in this part)

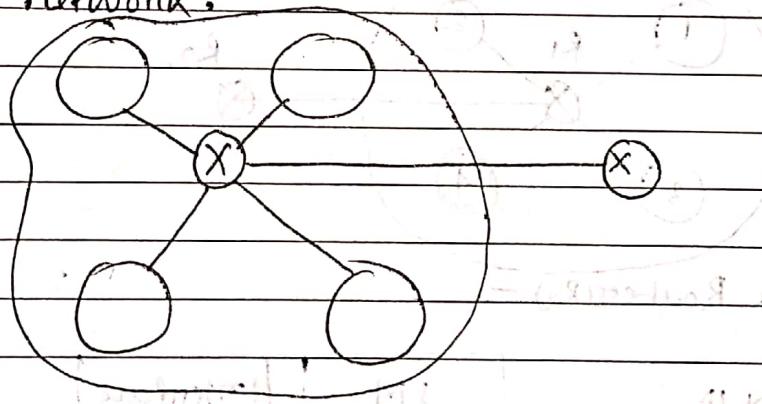
$$\text{CID} = 122$$

$$= 11 \quad 0.0.1100$$

~~192.168.1.0 - 192.168.1.31~~

Super netting or aggregation

→ Combining many small networks into one big network.



rules: (to aggregation)

- 1) all the network should be contiguous. (means NID)
- 2) size of all network same ( $2^n$ )
- 3) First network ID should divisible by ( $2^n$ )

Example - How Aggregate all this 4 network.

- ① 200.1.0.0 /24
- ② 200.1.1.0 /24
- ③ 200.1.2.0 /24
- ④ 200.1.3.0 /24

→ (possible)

(Aggregation point)

→ (i) all the addresses are contiguous form.

(ii) here, size of all network is same ( $2^8, 2^8, 2^8, 2^8$ )

(iii) first IP address should be divisible by size of the total supernet.

$$(4 \times 2^8 = 2^{10})$$

200.1.0.0

200.1.00000000, 00000000

so, When you divisible the 1<sup>st</sup> network then remainder will be '0'.

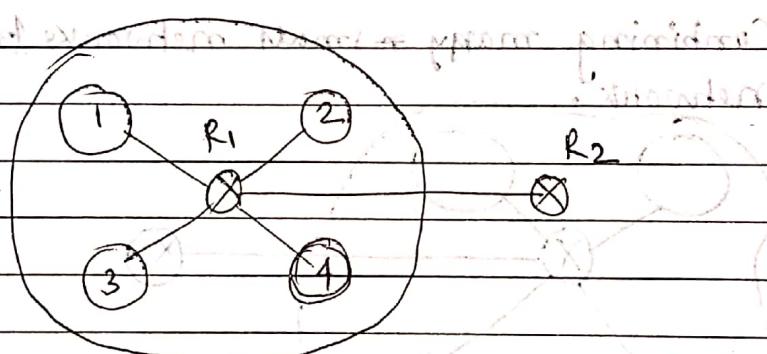


Table for Router (R2) -

N ID	S M	Interface
200.1.0.0	255.255.255.0	a.1
200.1.1.0	255.255.255.0	a.2
200.1.2.0	255.255.255.0	a.3
200.1.3.0	255.255.255.0	a.4

Subnet mask:

~~Subnet~~ → If we change mask then it becomes supernet.

SuperNet Mask: - 32 bit number.

→ In superNet mask 1's represent fixed part and no. of 0's represent variable part.

fixed fixed fixed variable  
~~200.1.00000000.00000000~~

~~200.1.00000001.00000000~~

~~200.1.00000010.00000000~~

~~200.1.00000011.00000000~~

~~255.255.255.00000000~~

~~255.255.255.11111100.00000000~~

$255 \cdot 255 \cdot 252 \cdot 0$  → SuperNet mask. For this.

→ To find NID enter SuperNet.

SuperNet ID:  $\frac{IP}{SM}$  = SuperNet ID

NID

~~200.1.0.0~~ → SuperNet ID

~~255.255.252.0~~

~~200.1.0.0~~ → SuperNet ID.

Routing Table.

NID	SM	Interface
200.1.0.0	255.255.252.0	a

→ by the one

entry, it represents all '9' networks.

→ Router part: (1) Loop (2) source routing and filtering.

→ Forwarding logic after SR.

Example - How aggregate all this network.

It's possible or not to give given block.

Four	$200 \cdot 1 \cdot 32 \cdot 0 / 24$	→ valid networks for super-
	$200 \cdot 1 \cdot 33 \cdot 0 / 24$	networking.
	:	
	$200 \cdot 1 \cdot 47 \cdot 0 / 24$	

(i) contiguous.

(ii) size of all networks ( $2^8$ ) same. ( $2^8$ )

(iii)  $200 \cdot 1 \cdot 32 \cdot 0$  should be divisible by ( $2^8 \cdot 2^4 = 2^{12}$ )

$200 \cdot 1 \cdot 00100000 \cdot 00000000$

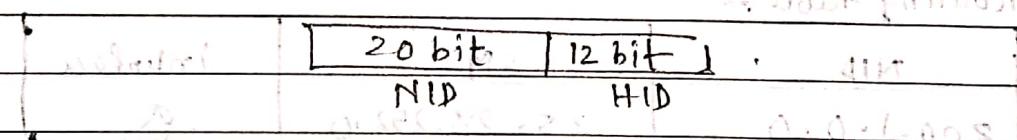
~~$200 \cdot 1 \cdot 32 \cdot 00000000$~~

Yes, it's possible to convert into ~~make~~ supernet.

Total Network =  $16$  ~~4~~  $\cdot$   $HID = 2^8$

So, ~~the~~ size of the entire Network =  $2^4 \times 2^8$   
~~size of each network~~  
 $= 2^{12}$

→ If all '3' networks are satisfied then, 1st HID will be Supernet ID. =  $200 \cdot 1 \cdot 32 \cdot 0 / 20$



Supernet mask:  $255.255.240.0$

Example - (many possible  $2, 4, 8, 16, 32 \dots$ )

①  $100 \cdot 1 \cdot 2 \cdot 0 / 25$

②  $100 \cdot 1 \cdot 3 \cdot 128 / 26$

③  $100 \cdot 1 \cdot 2 \cdot 192 / 26$

→ In this case first merge ② and ③ then merge ① with new supernet.

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Date \_\_\_\_\_

Page \_\_\_\_\_

## FLOW CONTROL METHOD

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Date \_\_\_\_\_

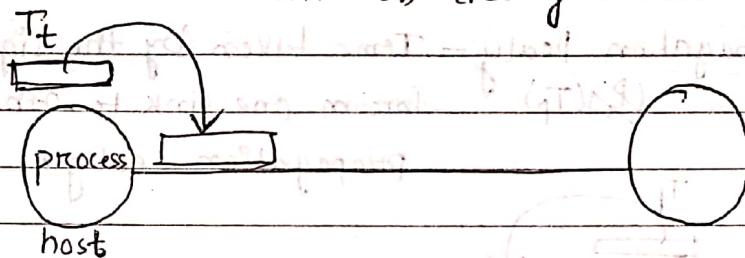
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[www.GateNotes.in](http://www.GateNotes.in)

- DELAYS in Computer network:

Transmission delay: ( $T_f$ )

The time taken to transmit a data packet from a host on to an outgoing link is called transmission delay.



Ex-  $BW = 1 \text{ bps}$

Data size = 1 bit

so, what is the transmission delay of the data.

$\rightarrow 1 \text{ sec} - 1 \text{ bit}$

$10 \text{ bit} - 10 \text{ sec}$

If the size of Data packet = 1 bits and BW is 'B' bps.

then time taken to transmit this data 1 is,

$$T_f = (1/B) \text{ sec.}$$

Ex-  $L$  (length of the data) is 1000 bits

$BW = 1 \text{ Kbps}$

What is the transmission delay of the data.

$$\rightarrow T_f = \frac{1}{B} \Rightarrow \frac{1000 \text{ bits}}{1000} = 1 \text{ sec.}$$

Ex-  $L = 1 \text{ Kbytes}$ ,  $BW = 1 \text{ Kbps}$

$$T_f = ?$$

$$\rightarrow T_f = \frac{1024}{1000} = 1.024 \text{ sec.}$$

✓ Data → powers of 2 | BW → powers of 10.

$$K = 1024$$

$$M = 1024 \times 1024$$

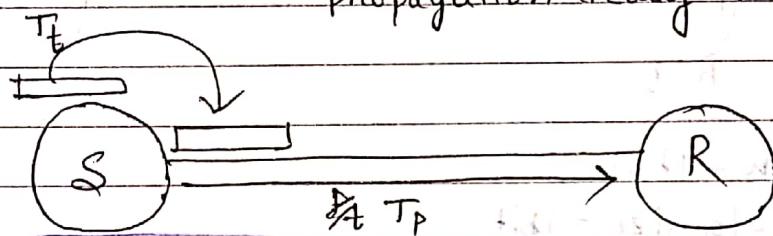
$$Gc = 1024 \times 1024 \times 1024$$

$$K = 1000$$

$$M = 10^6$$

$$Gc = 10^9$$

propagation delay — Time taken by the signal to reach from one link to other link is called propagation delay.



$$T_p = \frac{d}{v} = \frac{\text{distance}}{\text{velocity}}$$

$$\begin{aligned} v &= 3 \times 10^8 \times 0.7 \\ &= 2.1 \times 10^8 \text{ m/s} \end{aligned}$$

Ex-

$$d = 2.1 \text{ km}$$

$$v = 2.1 \times 10^8 \text{ m/s}$$

What is  $T_p = ?$

$$\rightarrow T_p = \frac{d}{v} \Rightarrow \frac{2.1 \text{ km}}{2.1 \times 10^8 \text{ m/s}}$$

$$\Rightarrow \frac{2.1 \times 10^3 \text{ m}}{2.1 \times 10^8 \text{ m/s}}$$

$$1 \text{ micro sec} = 10^{-6}$$

$$T_p \Rightarrow 10^{-5} \text{ [long] second}$$

$$1 \text{ msec} = 10^3 \text{ [mili sec]}$$

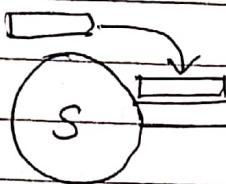
$$\checkmark \text{ Convert into msec} = \frac{10^{-5} \times 10^3}{10^{-3}}$$

$$= 10^{-2} \text{ msec}$$

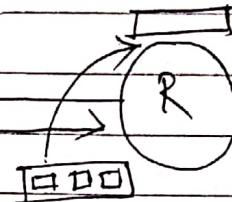
$$\checkmark \text{ convert micro sec} = \frac{(10^{-5}) \times 10^6}{10^6}$$

$$= 10 \mu \text{sec}$$

$$T_f = \frac{1}{B}$$



$$T_p = \frac{d}{N}$$



queuing delay

Queuing delay — The amount of time any packet sits in the buffer and wait before being process is called queuing delay.

Packet

processing delay — The will be taken by the machine and then it will be processed that is called processing delay.

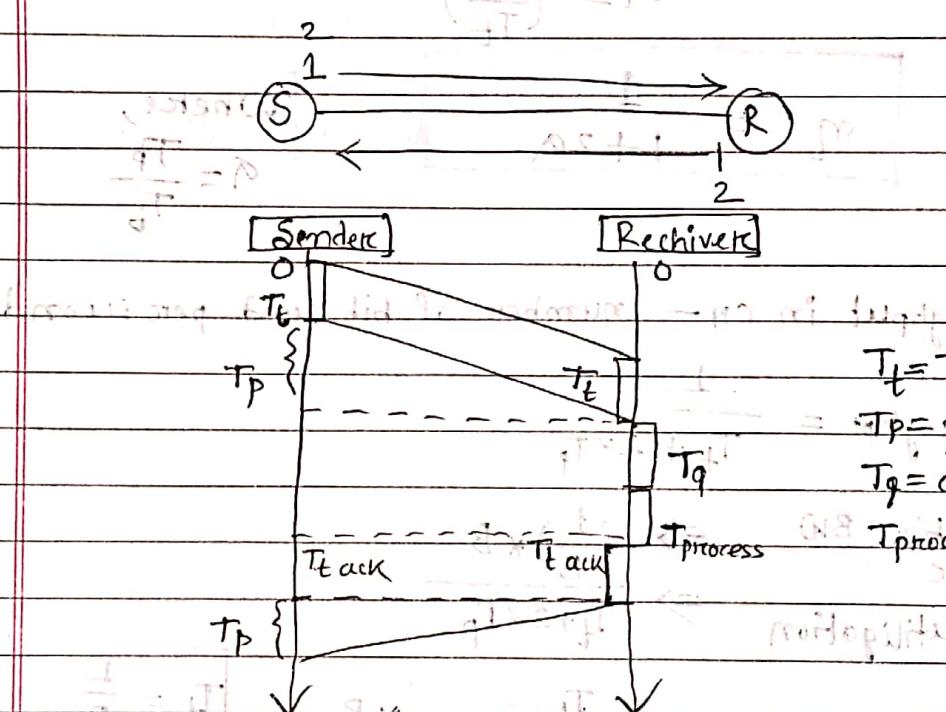
the best time of year to travel and plan a  
weekend trip has varied over  
the past few years.

Now we want to attend a set of  $\mathbb{R}^n$ -functions which are bounded and differentiable at all points.

- Flow Control methods:

- Flow control is the management of data flow b/w computers or devices or flow b/w nodes in a network so that the data can be handled at an efficient pace. Too much data arriving before a device can handle it causes data overflow, meaning the data is either lost or must be retransmitted.

[Stop and wait] —



$T_f$  = Transmission delay

$T_p$  = propagation delay.

$T_q$  = queuing delay.

$T_{process}$  = processing delay.

~~The total time taken to send 1 packet~~

The total time taken to send 1 packet =  $T_f + T_p + T_q + T_{process}$

$$= [T_f + T_p + 2 \times T_p + T_f]$$

$$= [T_f + 2 \times T_p]$$

$T_q$  and  $T_{process}$  taken as '0'.  
 $T_{ack}$  taken as '0' as  
 $ack$  is very small as  
compared to data

$$\eta(\text{efficiency}) = \frac{\text{useful time}}{\text{total cycle time}}$$

$$\text{useful time} = \frac{T_f}{T_f + 2 \times T_p}$$

$$\text{useful time} = \frac{T_f / T_f}{T_f / T_f + 2 \times T_p / T_f} \quad \text{divide by } T_f \text{ (Nw & De)}$$

$$= \frac{1}{1 + 2 \times \left( \frac{T_p}{T_f} \right)} \quad \rightarrow \text{final form ans}$$

$$\boxed{\eta = \frac{1}{1 + 2\alpha}}$$

$$\text{where, } \alpha = \frac{T_p}{T_f}$$

Throughput in CN - number of bits send per second.

$$\text{Throughput} = \frac{1}{T_f + 2 \times T_p}$$

$$\text{effective BW} \Rightarrow \left( \frac{1}{B} \right) * B$$

$$\text{BW utilization} \Rightarrow \frac{1}{T_f + 2 \times T_p}$$

$$\Rightarrow \frac{T_f}{T_f + 2 \times T_p} * B$$

$$\boxed{T_f = \frac{1}{B}}$$

$$\Rightarrow \left( \frac{1}{1 + 2\alpha} \right) * B$$

$$\boxed{\text{Throughput} \Rightarrow \eta * B}$$

Q. Given,  $T_f = 1\text{ msec}$  and  $T_p = 1\text{ msec}$ .

What is efficiency ( $\eta$ ) = ?

$$\rightarrow \eta = \frac{1}{1+2a} \times 100\% =$$

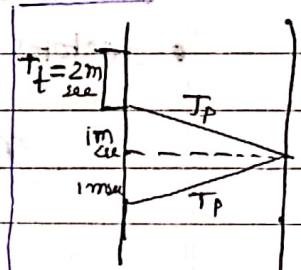
$$\Rightarrow \frac{1}{1+2 \times \frac{1}{2}} \times 100\% = \boxed{a = \frac{T_p}{T_f}}$$

$$\Rightarrow \frac{1}{3} \times 100\% =$$

Q. Given,  $T_f = 2\text{ msec}$ ,  $T_p = 1\text{ msec}$ .

$$\eta = ?$$

$$\eta = \frac{1}{1+2a} \Rightarrow \frac{1}{1+2 \times \frac{1}{2}} = \frac{1}{2}$$



$$\text{Total} = 4\text{ msec}$$

50% of ~~total~~ time.

Q. Given,  $B = 4\text{ Mbps}$ ,  $T_p = 1\text{ msec}$ , then

what will be the length of packet so that efficiency is at least 50%.

$$L \geq 2 \times T_p \times B$$

$$L \geq 2 \times 10^{-3} \times 4 \times 10^6$$

$$L \geq 8 \times 10^3 \text{ bits}$$

$$\eta \geq 0.5$$

$$\frac{T_f}{T_f + 2 \times T_p} \geq \frac{1}{2}$$

$$\Rightarrow 2T_f \geq T_f + 2T_p$$

$$\Rightarrow T_f \geq 2T_p$$

$$\Rightarrow \frac{1}{B} \geq 2 \times T_p$$

$$\Rightarrow L \geq 2 \times T_p \times B$$

So, the length of the packet should be

at least 8000 bit, so that we get

50% of efficiency.

Q. Given,  $\eta = \frac{1}{2}$  and  $B = 4 \text{ Mbps}$ .  $\rightarrow$   $\boxed{\text{BW} = \text{bandwidth}}$   
 $E_B$  or throughput = ?

$$\begin{aligned}\text{effective BW} &= \eta \times B \\ &= \frac{1}{2} \times 4 \text{ Mbps} \\ &= 2 \text{ Mbps} \quad (\because \eta \text{ is } 50\%) \end{aligned}$$

- factors which affect stop-and-wait efficiency -

$$\begin{aligned}\eta &= \frac{1}{1+2\alpha} \\ &= \frac{1}{1+2 \times \frac{T_p}{T}}\end{aligned}$$

$$\eta = \frac{1}{1+2 \times \frac{d}{V} \times \frac{B}{L}}$$

So, Bandwidth(B) Increases  
efficiency decrease.

$$\boxed{B \uparrow \quad \eta \downarrow - \text{LAN} \quad \text{WAN}}$$

Where, both

velocity and bandwidth  
are not going to change

$L$  = length of the packet

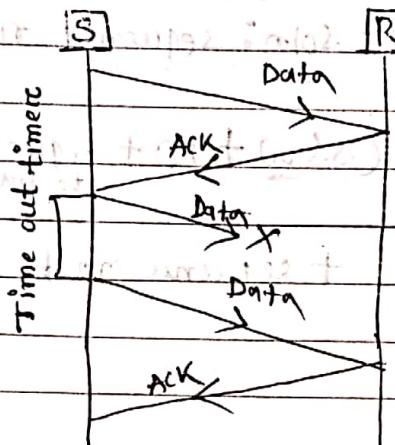
$T_p < L < T \Rightarrow$  standard framing not possible

so,  $L$  has to be increased to

$L > T_p & L < T$

- problem in stop and wait -

### ① Data Packet loss - (problem)



→ S & R wait forever  
S (Wait for ack)  
R (Wait for data)

Deadlock

Soln: Time out timer

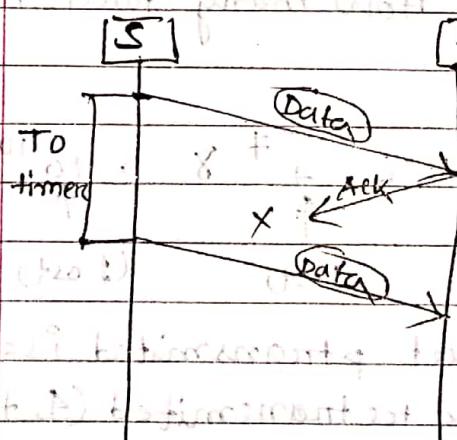
(Stop & wait + TO)  
(Stop & wait + ARQ)

= Stop & wait + ARQ.

(Automatic

→ timer triggers to retransmit with repeat request)

### ② ACK lost - (problem)



(Duplicate packet problem)

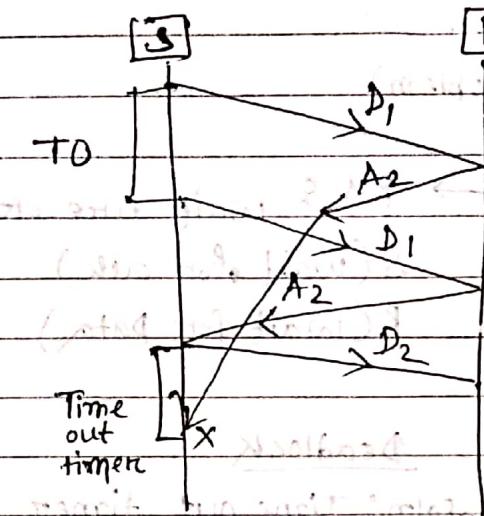
Soln: sequence numbers for data.

• (stop and wait + timeout timer + sequence number to the data)

• (stop and wait + sequence number to the data)

• (stop and wait + sequence number to the data)

③ Delayed ACK - (problem)



→ Soln: sequence no. to ACK.

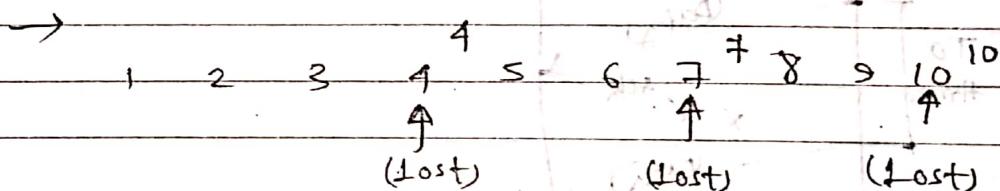
(S&W + TO + sequence no. of  
to Data.  
+ sequence no to ACK )

(missing packet)

→ ACK no. is always the no. of next expected data  
packet.

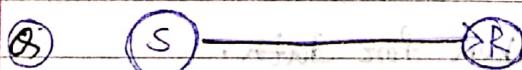
- Increase the efficiency of stop and wait -

④ In stop & wait, sender is sending 10 packets in which every 4<sup>th</sup> packet is lost. How many total transmissions are required.



Total number of packet transmitted is = 13.

and packets which are retransmitted (4, 8, 10)



error probability in this channel is 20%. If send 400 packets on this link. how many packet transmitted in total.

$$\rightarrow 1466 \text{ packets}$$

$$\rightarrow 1460 / 180 \rightarrow 14880$$

$$\Rightarrow 400 + 400 \times 20\% + 80 \times 20\% + 16 \times 20\% + \dots \dots$$

\* If send 'n' packet which have error probability of  $p$ ,

$$\begin{aligned} & n + np + np^2 + np^3 + \dots \\ &= n(1 + p + p^2 + p^3 + \dots) \\ &= \boxed{n \left( \frac{1}{1-p} \right)} \end{aligned}$$

this many packet send totally.

$$\Rightarrow 400 \left( \frac{1}{1-0.2} \right)$$

$$\Rightarrow \frac{400}{0.8} \Rightarrow 500 \text{ Packet}$$

• Capacity of channel / wire / link —

atmosphere + crust + mantle

solid + liquid + gas + plasma

Earth's crust

(+ 150 + 100 + 100)

(+ 100)

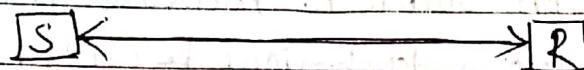
solid + liquid + plasma

(+ 100)

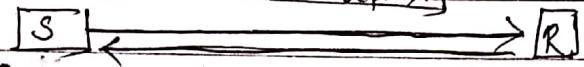
(+ 100)

solid + liquid + plasma

- Capacity of a channel/link/wire =



Half-duplex



Full-duplex

example-

(i) a 'walkie-talkie' is half-duplex device because only one party can talk at a time.

(ii) a telephone is full-duplex device because both parties can talk simultaneously.

• In case of half duplex, capacity of the channel =  $[BW \times T_p]$

• In case of full duplex, capacity of the channel =  $[2 \times BW \times T_p]$

$BW$  = Bandwidth

$T_p$  = Propagation delay

→ If the channel capacity is very high is called Thick pipe.

→ If the channel capacity not very high is called Thin pipe.

→ Efficiency of stop and wait is less in Thick pipe.  
Efficiency of stop and wait is more in Thin pipe.

$$\eta = \frac{1}{2 + 2\alpha} \Rightarrow \frac{1}{1 + 2 \frac{T_p}{T_t}} \Rightarrow \frac{1}{1 + 2 \cancel{\times} T_p \times B} \rightarrow \text{When this part is increased}$$

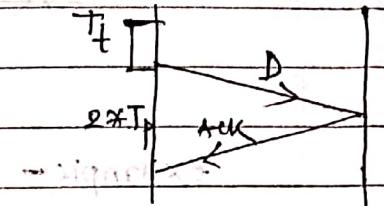
then efficiency of stop and wait will be less.

• Pipelining = ~~using network resources for pipelining~~

In order to increase the  $\eta$ , we use a technique called pipeline.

$$T_t \text{ see } - 1 \text{ packet}$$

$$1 \text{ sec } - \frac{1}{T_t} \text{ packet.}$$



$$(T_t + 2T_p) = \frac{T_t + 2T_p}{T_t}$$

$$= 1 + 2a \text{ packet.}$$

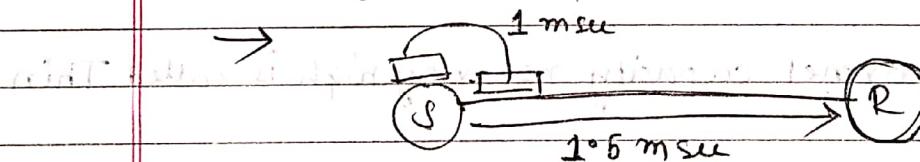
→ When sending more than one packet is called window.

~~Latency = becomes all the distance except the last node~~

~~Tt + 2Tp = distance with the distance except last node~~

~~distance between S and R~~

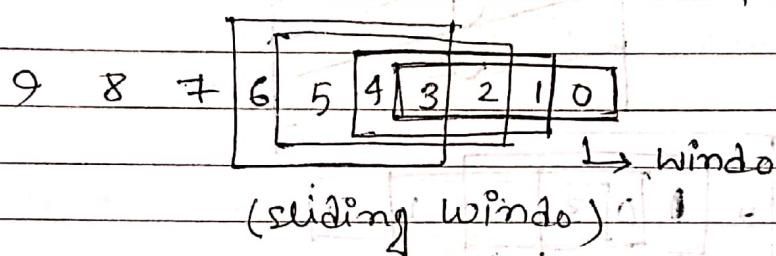
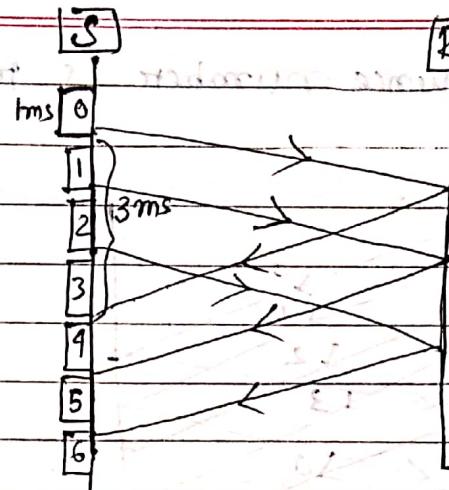
- ③ If  $T_p = 1.5$  millisecond and  $T_t = 1$  millisecond, then how many packets can be transmitted before waiting for acknowledgement of first packets.



Round trip time (RTT)
$= 2 * T_p$

$$\eta = \frac{1}{1 + 2a} \Rightarrow \frac{1}{1 + 2 * \frac{1.5}{1}} \Rightarrow \frac{1}{4}$$

to increase the efficiency of  $\eta$ .



9 8 7 6 5 4 3 2 1 0

→ which are present  
what the packet ^ Right side of windo ts are already  
transmitted and they are acknowledged.

→ packets which are present inside the windo  
are just being transmitted but they are not acknow-  
ledged.

→ packets which are present left side of windo  
are add to be transmitted.

In this question,

no of packets are transmitting rate =  $(1+2a)$

In sliding window,

$(1+2a)$  are max utilization

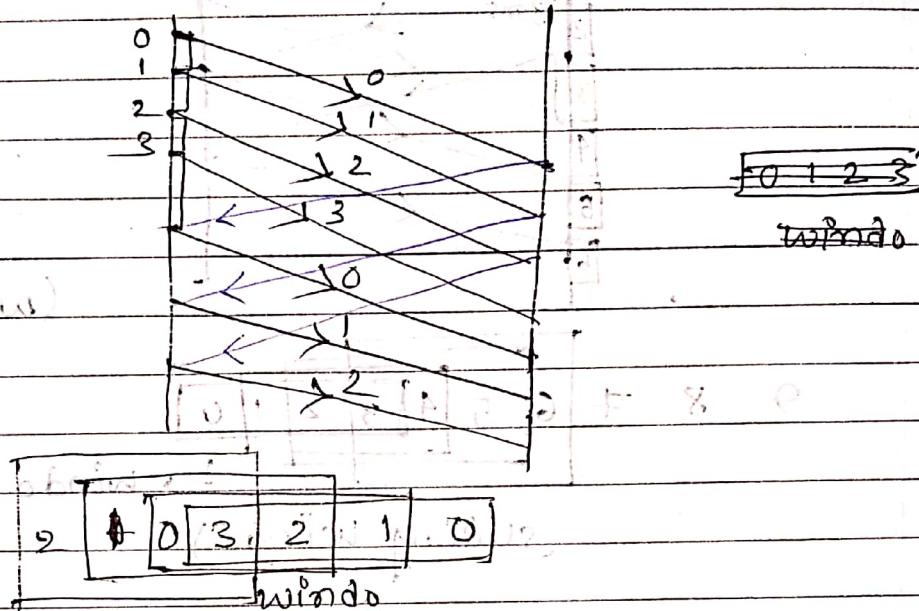
In sender side

$$= 1 + 2 * 1.5$$

$$= 4$$

$$W_s = 1 + 2a$$

How many sequence numbers is required in this case:-

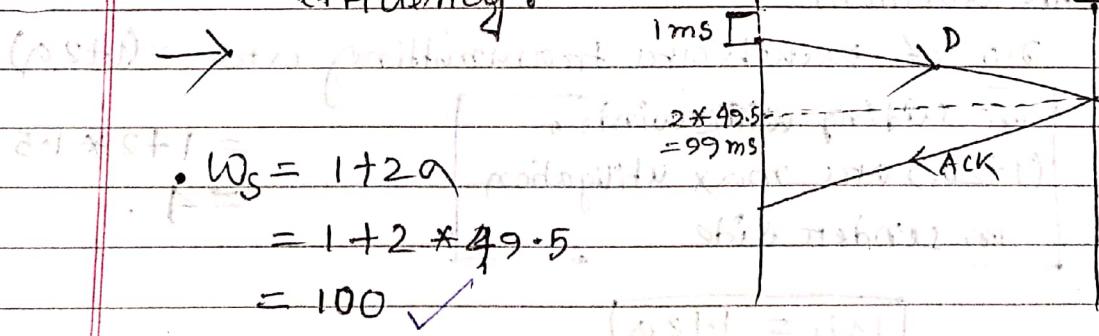


With Sliding Window protocol -

$$\alpha = \frac{T_p}{T_f}$$

- \* ① max sender window size =  $1 + 2\alpha$
- \* ② minimum number of sequence required =  $1 + 2\alpha$
- \* ③ minimum no. of files required in sequence field =  $\lceil \log_2(1 + 2\alpha) \rceil$

Q) If,  $T_f = 1 \text{ ms}$  and  $T_p = 49.5 \text{ msec}$   
find out the maximum what should be  
sender window size to get the maximum  
efficiency.



- minimum no. of sequence required =  $1 + 2^a$   
 $= 100 \checkmark$

- what should be the minimum no. of bits in sequence number field should be =  $\lceil \log_2 100 \rceil$   
 $\lceil \log_2 100 \rceil = \lceil 6.67 \rceil = 7 \checkmark$

$2^7 = 128$ , In 128 seq no, we get 100 sequence no. and remaining 28 no sequence no not used.

- (Q) If,  $T_f = 1\text{ msec}$  and  $T_p = 99.5\text{ msec}$ . What will be the sender window size in order to increase efficiency. What are the minimum sequence no. required. and how many bits are required in seq no. field.

→ •  $W_s = 1 + 2^a$

$$\begin{aligned}
 &= 1 + 2 * 199 \\
 &= 200 \text{ packet}
 \end{aligned}$$

• Sequence no. required,  
 $= 200$

• how many bits do need in seq no field,  
 $\lceil \log_2 (200) \rceil$   
 $= \lceil 7.8 \rceil \Rightarrow 8 \text{ bit} \text{ (required to send 200 seq)}$

(8 bit required in seq no field to send 200 packet)

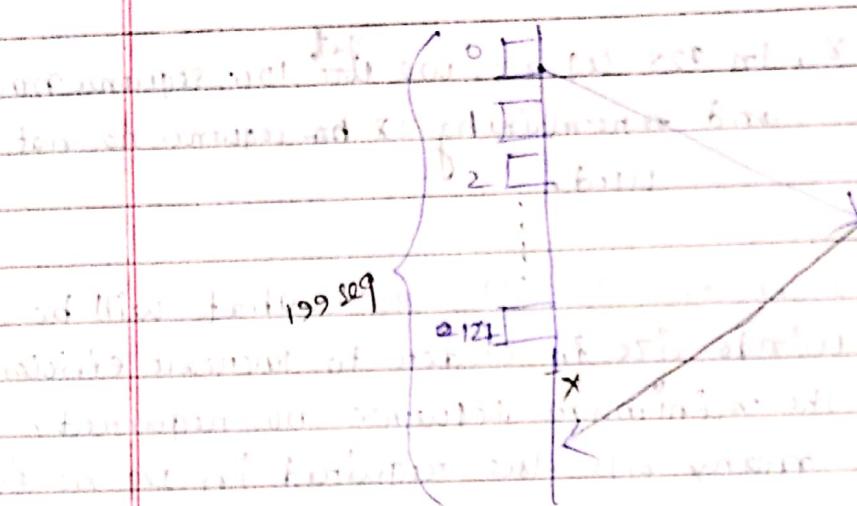
→ assume that, given,  $[N=7]$ , means 7 bit in seq no field.

$N = \boxed{\text{number of sequence no.}}$

Step 8:  $2^7 = 128$  seg no. in one window.

$$\eta = \frac{128}{200} = 64\% \text{ (efficiency)}$$

met no 200 seg and have 128 seg no. thus that seg n efficiency will be 64 %.



$$\begin{aligned} \text{Window size } w_{\text{size}} &= \min(2a+1, 2^b) \\ &= \min(200, 128) \end{aligned}$$

First segment have no window size which is 128.

last segment have no window size which is 128.

for maximum window size it is 128. Both window size is 128.

→ Sliding window protocol is a theoretical concept.  
practically it is implement in two way—

(1) GBN (Go Back N)      (2) SR (Selective Repeat)

(1) Go Back N =

(i) Sender window size in Go Back N is N.

Sender window size greater than '1'. ( $N > 1$ )

Ex:  $T_f = 1 \text{ msec}$ ,  $T_p = 49.5 \text{ ms}$ ,  $\eta$  (efficiency) = ?,  
GBN.



$$W_s = 1 + 2a = 100$$

$$N = 10$$

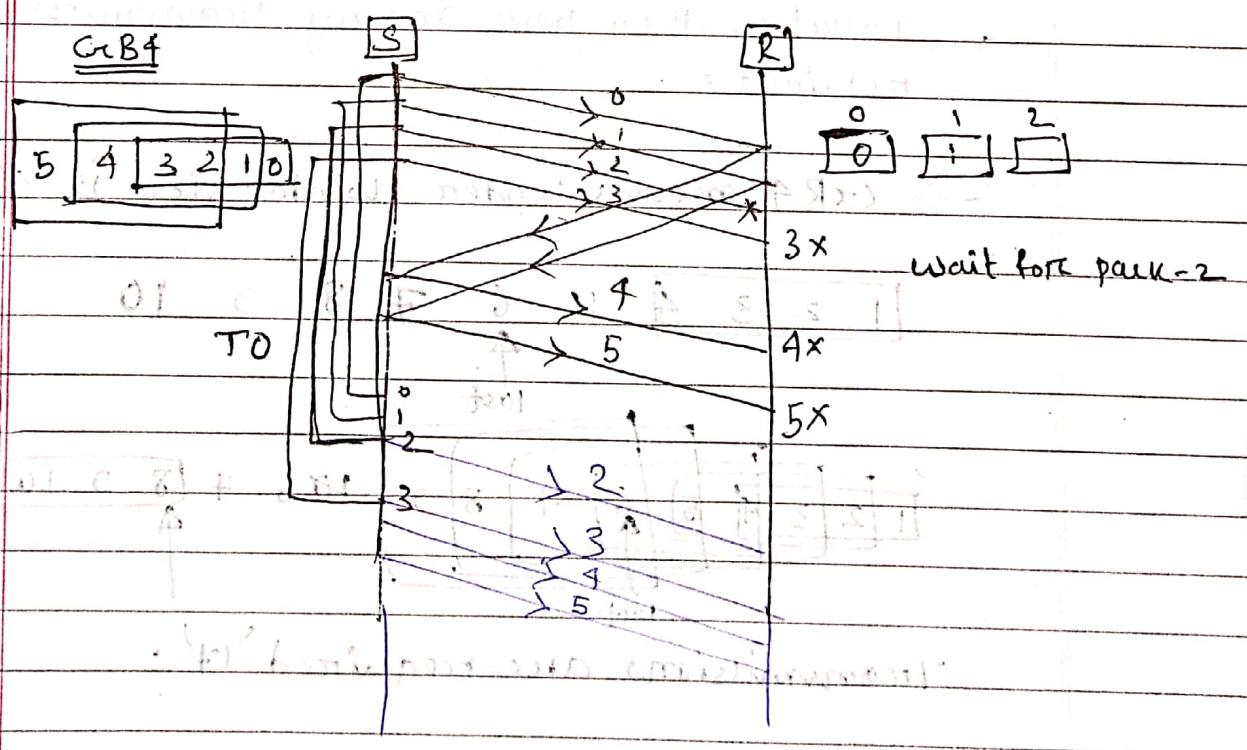
$$\eta = \frac{10}{100} = 10\%$$

$W$  = sender window size.

$N$  = no. of pack send.

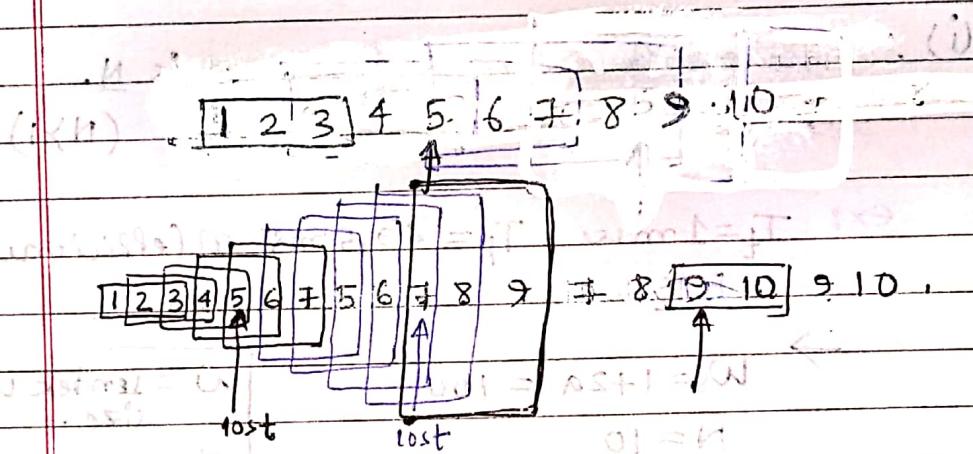
$\eta$  = efficiency

(ii) Receiver window size = 1.



Ex - In GIB 3, if every 5<sup>th</sup> packet that is being transmitted is lost and if we have to send 10 packets, then how many transmissions are required.

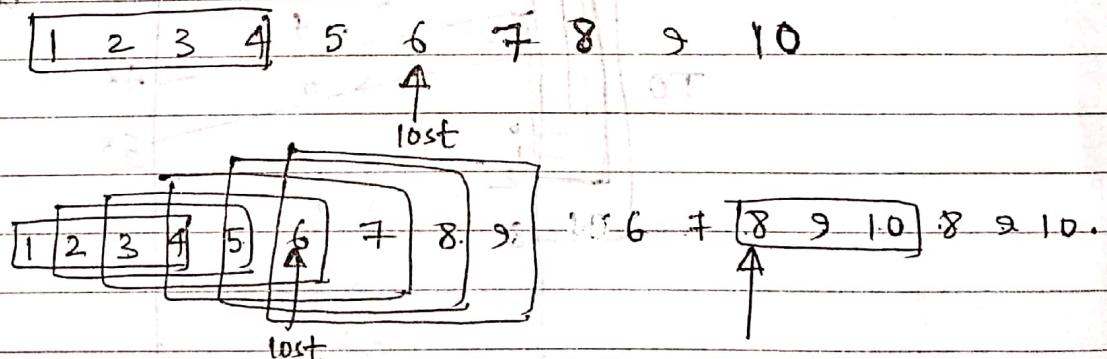
→ GIB 3 means sender window size '3'.



Transmissions are required '18'.

Ex - In GIB 4, if every 6<sup>th</sup> packet that is being transmitted is lost and if we have to send 10 packets, then how many transmissions are required.

→ GIB 4 means sender window size is '4'.

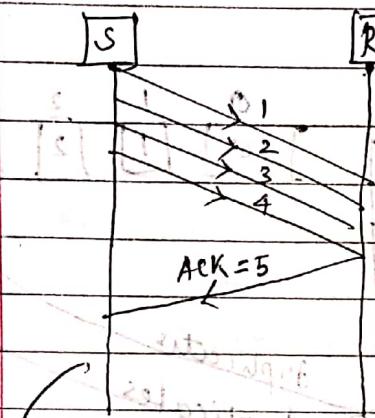


Transmissions are required '17'.

(iii) Acknowledgement - (ACK)

(Depending on what receiver is saying, sender is going to follow)

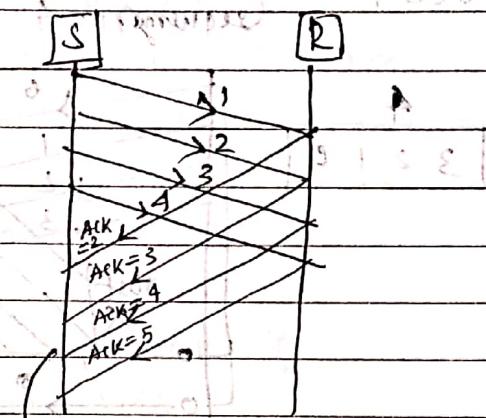
Cummulative ACK



Adv: Less traffic.

dis: less reliable.

Independent ACK

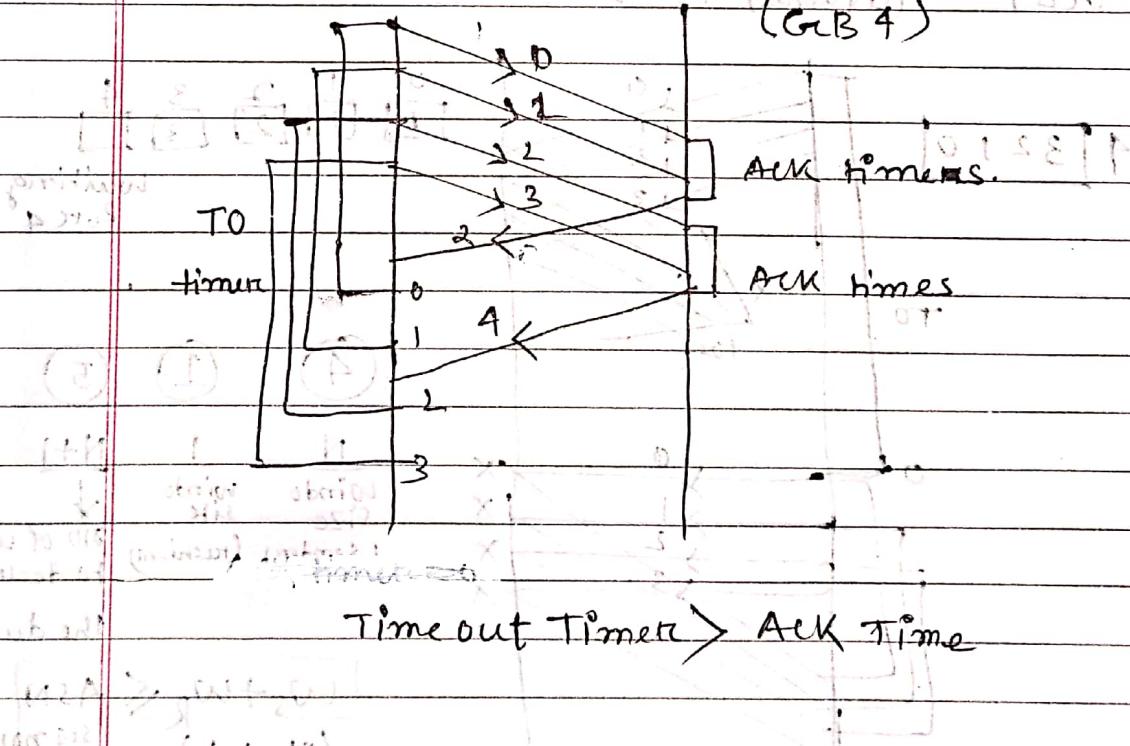


Adv: Reliability is high.

dis: Traffic is high.

→ Go Back N use Cummulative acknowledgement.

(GBN)



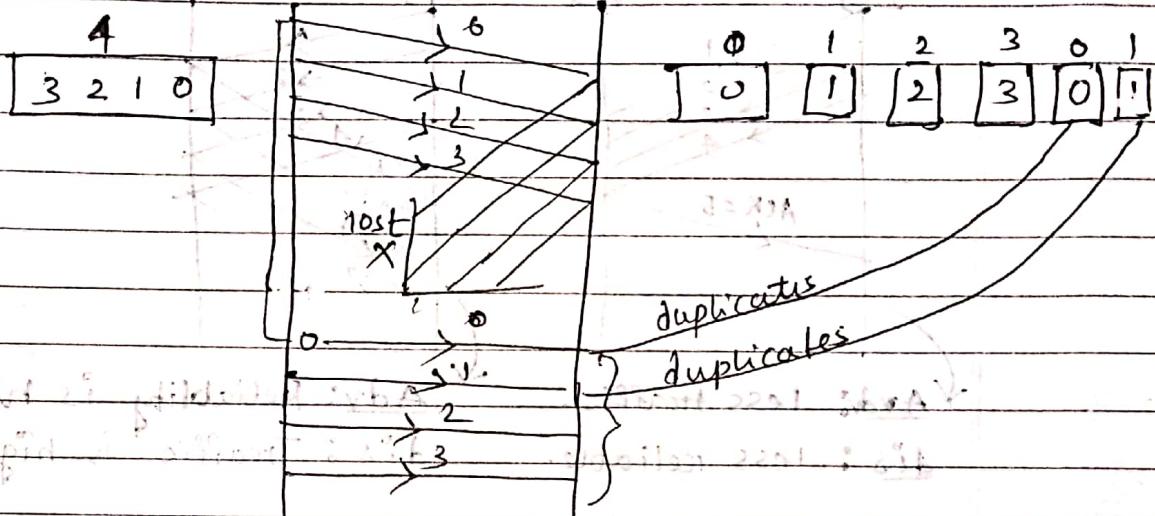
Time out Timer > ACK Time

GCB(N)  $\rightarrow$  window sizes = frame numbers + 1

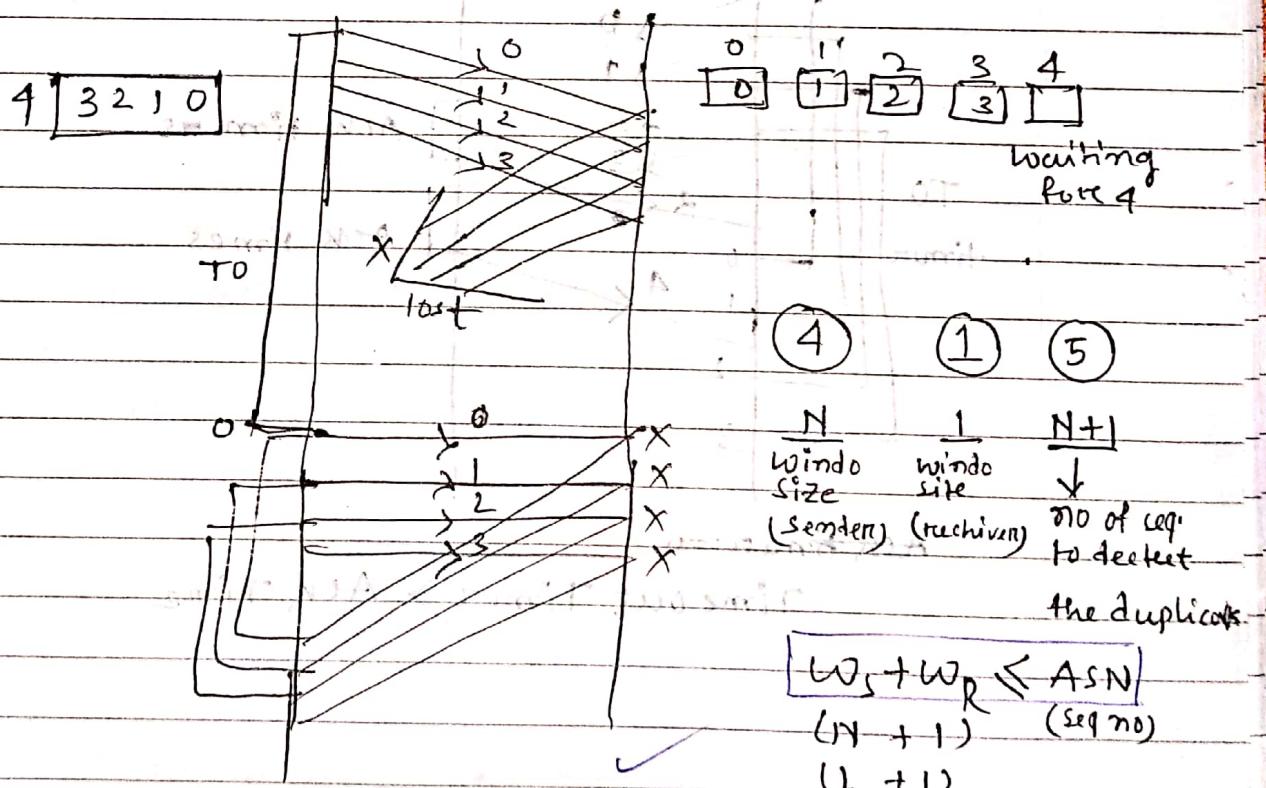
Relationship b/w window size sizes and sequence numbers.



GCB4

(sequence)  $n=4$ 

GCB4

(sequence)  $n=5$ 

## • Types of Question -

$$1) \text{ if } (\omega_s = N) \rightarrow (\omega_p = 1), s_{eq} = N+1$$

given

$$\text{bits} = \lceil \log_2 (N+1) \rceil$$

where,

$w_s \rightarrow$  sender window size.

WR → Rechiviert 2021 = FT 19 .

~~Seg → required seg no.~~

bits  $\rightarrow$  bit required to find  $(N+1)$  segno.

2) If  $\text{seq} = N$ ,  $w_s = N-1$ ,  $w_f = 1$

givén.

$$\text{Ex- Seg} = 4, w_s = w_p = ?$$

$$\omega_s = 4 - 1 = 3/2$$

$$W_R = 1 - (\cos \theta_1; \sin \theta_1)$$

3) If  $\text{bit} = K$ ,  $\text{seg} = 2^K$ ,  $w_s = 2^{K-1}$ ,  $w_r = 1$

given

$$QAD \times SP = dT \leftarrow$$

$$\rightarrow w_s + w_r \leq ASN_{\text{seg no.}}$$

~~whether nothing has changed~~

$$d\omega = g(\overline{w}) \cdot (ii) - g$$

(2) Selective Repeat (SR) :-

P(i)  $[W_s > 1]$

Send window size greater than '1'

$$\textcircled{B} \quad T_t = 1 \text{ ms}, T_p = 49.5 \text{ ms}$$

$\therefore W_s = 50$ , so, in SR protocol  $\eta(\text{efficiency}) = ?$ .

→ Packet can send

Max window capacity = 1 + 2A (always)

$$1 + 2A - 1 - 1 = 50 \quad = 1 + 2 \left( \frac{T_p}{T_t} \right) + 1$$

$$= 1 + 99$$

$$= 100$$

$$\eta(\text{efficiency}) = \frac{50}{100} = 50\%$$

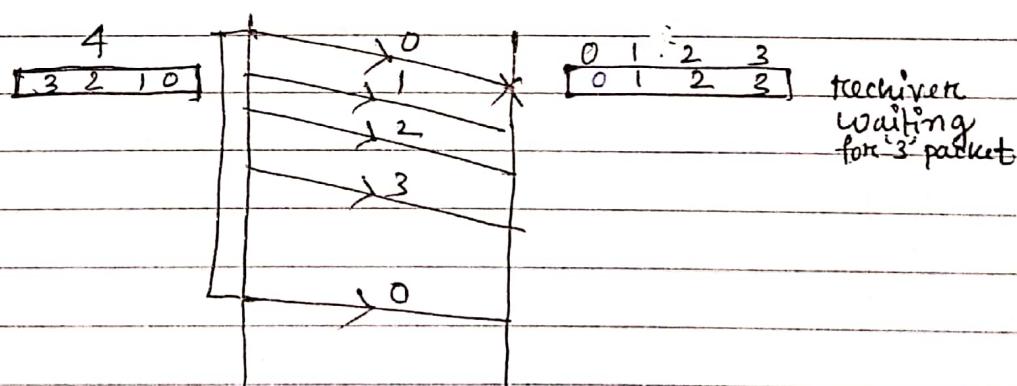
Then, they can give  $BW = 4 \text{ Mbps}$ , Throughput = ?

$$\rightarrow Th = \eta * BW$$

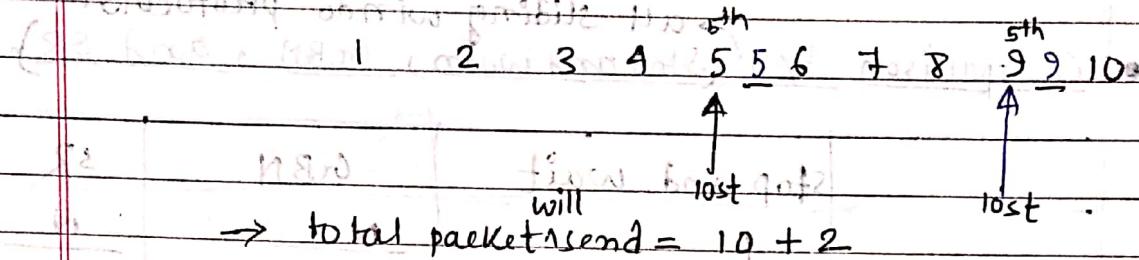
$$= 50\% * 4 = 2 \text{ Mbps}$$

P(ii)  $[W_R = W_s]$

Receiver and sender window size is same

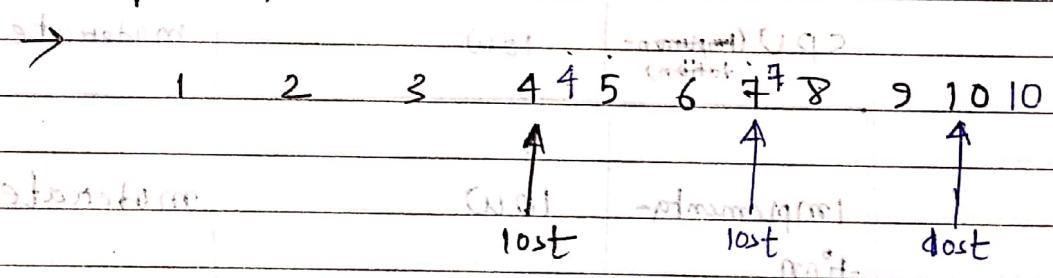


Ex -  $W_s = 3$ , 10 packet being send and out of which every 5<sup>th</sup> packet is lost, then how many packet will be send in total using SR protocol.

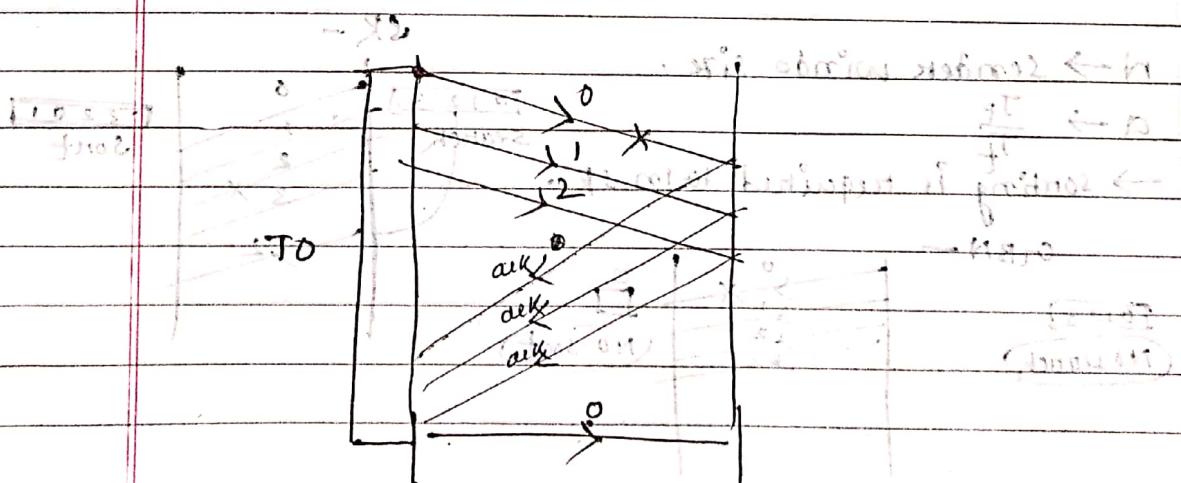


- (i)  $\rightarrow$  Number of retransmission in SR protocol is less compared.
- $\rightarrow$  Number of retransmission in GBN protocol is high.

Ex -  $W_s = 3$ ,  $W_p = 10$  i.e., 1<sup>st</sup> packet is lost, then how many packet will be send in total using SR protocol.



P-(ii) ACK and SR acknowledgement are independent)



→ both the case (GBN & SR) when packet lost they  
will have to retransmit same way.

→ In case of packet corrupted, GBN discard packet  
silently and SR produce Negative acknowledgement.

- Comparison b/w (Stop and wait, GBN, and SR).

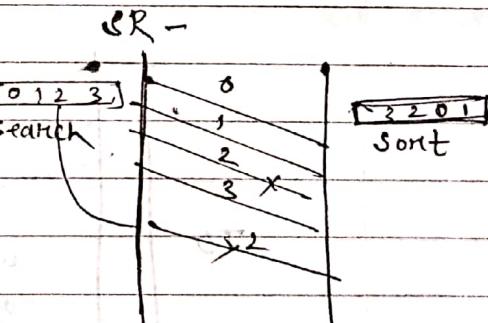
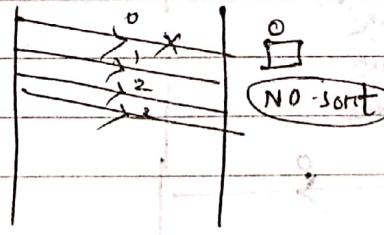
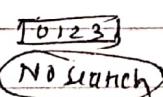
	Stop and wait	GBN	SR
efficiency	$\frac{1}{1+2a}$	$\frac{N}{1+2a}$	$\frac{N}{1+2a}$
Buffers	$(1+1)$	$(N+1)$	$(N+N)$
seq numbers	$(1+1)$	$(N+1)$	$(N+N)$
Retransmission	$(1 \text{ pack lost})$	$N$	1
BW	low	high	moderate
CPU (implementation)	low	moderate	high
Implementation	low	moderate	complex
ack	Independent ack	Cumulative ack	Independent ack

$w \rightarrow$  sender window size.

$$a \rightarrow \frac{T_p}{T_t}$$

→ sorting is required in SR.

GBN →



(8)

(S)

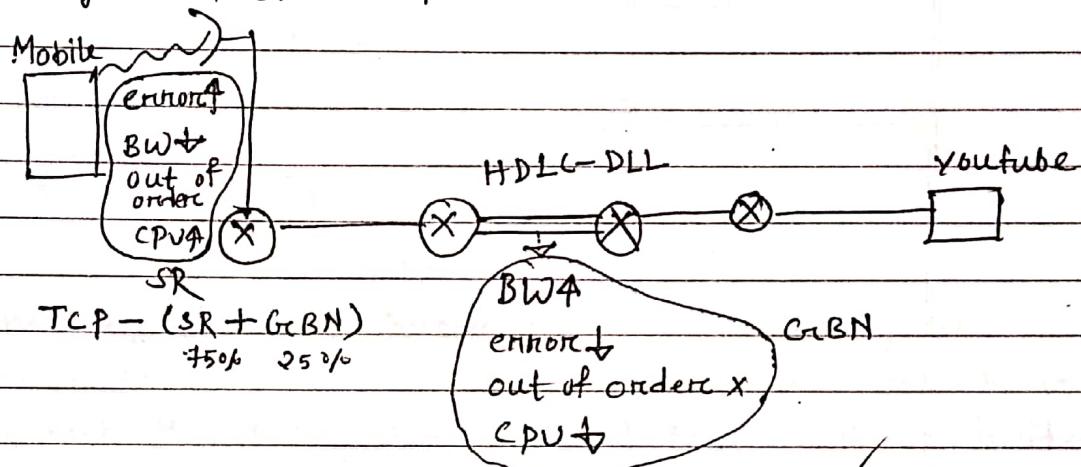
(R)

BW ↑ CPU ↓ Buffer ↓ — use GBN.

BW ↓ CPU ↑ Buffer ↑ — SR.

(9)

Utiligation of '2'- protocol.



(2)

(3)

• Head ant - Landed at 000 + 000

• 92 - Spotted near 1600

• Landing is to continue with (3)

Answers

100-100

L - O - B - S - (3)

100-100

Answers

100-100

100-100

Answers

(100+32)-900

+ 00 feet

Head ant -  
Spotted  
(X marks to the  
left of 000)

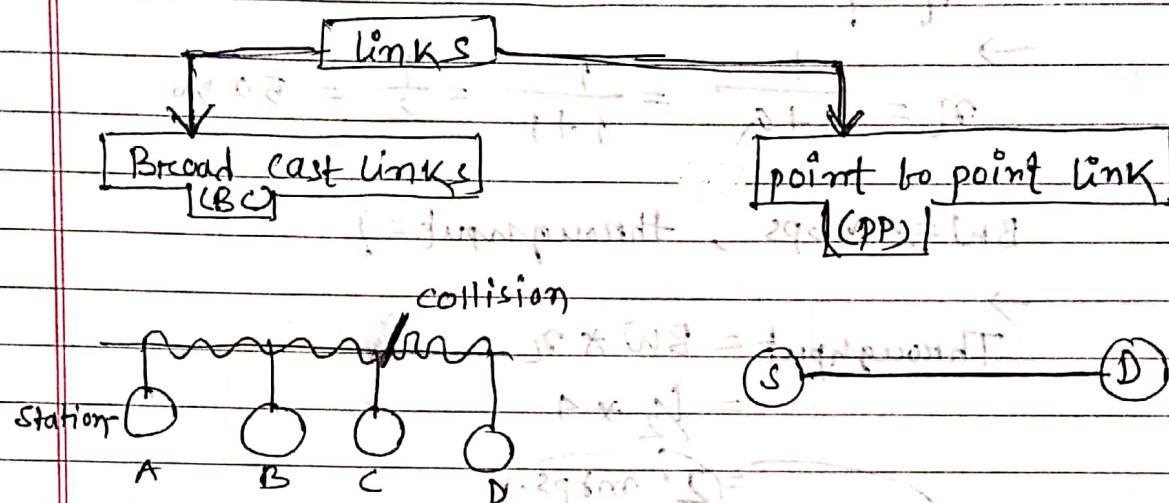
d-000

100-100

Answers

100-100

- Access Control methods

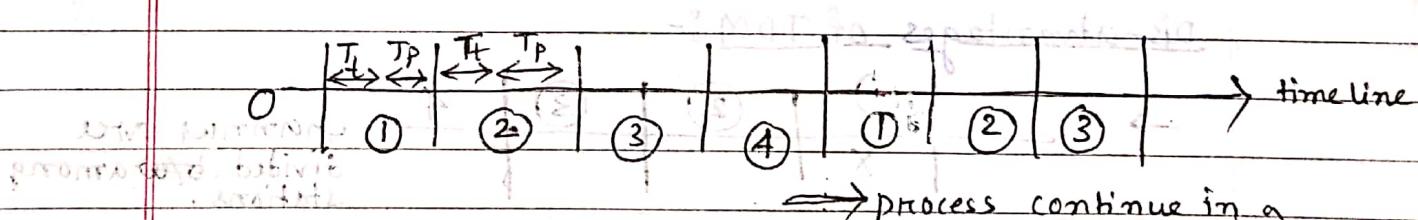


→ Whenever I have a broadcast channel, only one station should send the data or if more than one station starts sending the data, there should be no collision inside the channel. If you could some how make this happen is called access control method.

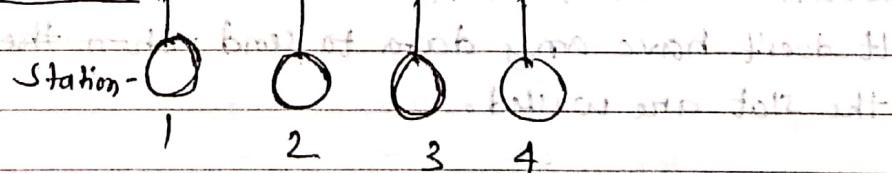
- Various ways to implementation of access control methods —

- TDM (time division multiplexing)

→ Simplest access control method.



BC channel, i.e., broadcast channel using Round Robin manner.



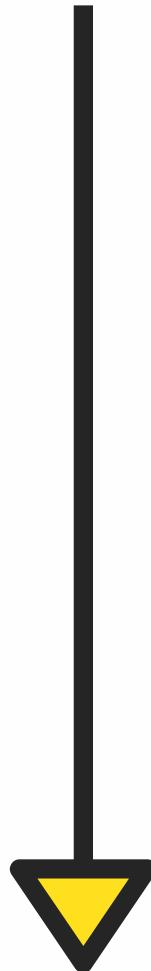
$$\text{total time taken} = T_t + \alpha T_p$$

$$(\alpha = \frac{T_p}{T_t})$$

$$\eta(\text{efficiency}) = \frac{\text{useful time}}{\text{cycle time}} = \frac{T_t}{T_t + T_p} = \frac{1}{1 + \alpha}$$

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