1500 byte.

ROLL NO.

Unit-3

N/W Layer. (Switch, Router, firewall).

↳ using packet / Datagram.

- (1) Host to Host / machine to machine / Source to Destn.
- (2) logical address (IP address)
- (3) | N/w address | Host add. | – IP address
- (4) Routing algorithm
  - RIP
  - OSPF
- (5) Fragmentation (If packet is not able to accept the full pkt).
- (6) Congestion control. (Leaky Bucket method) Token Bucket method.

ICMP, IGMP. (Router sends the ack. that pkt speed should be slow).

2nd topic – Network Addressing / IP Addressing.

Classfull addressing

Class A   Octet   ← HOST ID →

prefix → 0

← N/W ID → 32 bit (2^{32}) (IPV4)

2^{32} no. of IP addresses

N/w no.   ~~Host no~~ 2^{24}

8   32

7 bit

2^7 (combination) (no. of n/w's in class A = 2^7 = 128)

(0 - 127)

(n/w) 64.0.0.0

(broadcast) ~~255.0.0.0~~ 64.255.255.255

0 ~~0000000~~ 0000000 → not assigned (null address)

0000001 → to any organisation.

(loopback)

128 - 2 = 126

no. of Host possible in every n/w = $2^{24} - 2$

127 01111111

(0-127) class A.

eg- first 64.0.0.0. ← IP address.
last 64.255.255.255

Directed broadcast address.

64.0.0.1 - 1st Host
64.0.0.8 - कौनसा IP address के अंदर आता है।

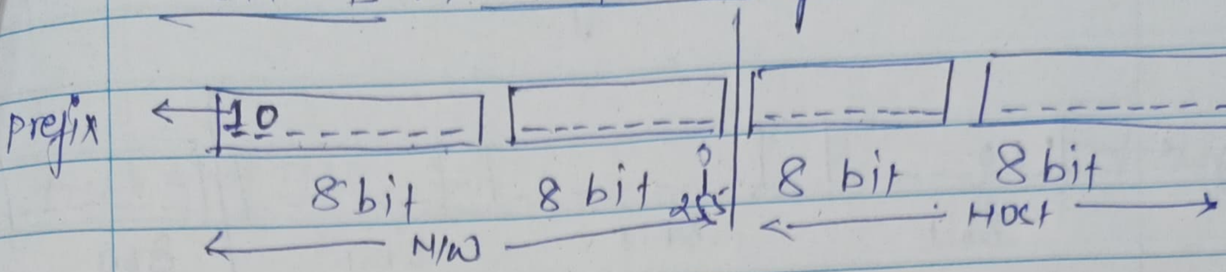
Default mask - 255.0.0.0.
AND Operation

1&1=1

01000000 . 0 . 0 . 00001000
11111111 . 0 . 0 . 00000000
01000000 . 0 . 0 . 00000000
64.0.0.0.

ROLL NO.

Class B in IP Addressing



10000000 First = 128] total
10111111 Last = 191] 64 values.

Range: 128 - 191 eg - 130.2.3.4

No. of networks: $2^{14} = 16384$ ($64 \times 256 = 2^{14}$)

No. of Addresses: 2^{30}

No. of Host: $2^{16} = 65536 - 2$
$= 65534$

eg. 128.0.0.0 – N/W representatn.
128.0.255.255 – broadcast

eg – 130.2.3.4 IP address given
belongs to class B & this host comes in which n/w.

130.2.3.4
default mask: 255.255.0.0

First 130.2.0.0 → N/w. belongs to some university.
last 130.2.255.255
65536 - 2 = 65534

ROLL NO.

Class C IP addressing

prefix ← 110 - - - - -	- - - - - - - - -	- - - - - - -	- - - - - - -
8 bit	8 bit	8 bit	8 bit

Range! 192 - 223

No. of networks: ~~2^{24}~~ 2^{21}

No. of Hosts in each n/w! ~~2^8~~ $2^8 = 256 - 2$
$= 254$

First ← 110 00000 first - 192
last ← 110 11111 last - 223] 32 values.

No. of IP Addresses :- $2^{29} =$

eg- 194.2.3.4

default subnet = 255.255.255.0

AND operation = 194.2.3.4
255.255.255.0

N/w ID ← $\boxed{194.2.3.0}$

ROLL NO.

Class D IP Address

prefix ← 1110----			
8 bit	8 bit	8 bit	8 bit

11100000 224
⋮
11101111 239

No. of IP Addresses in class D = 2^{28}

no n/w, no host, It is reserved for multicasting & group for research & organisation.

Class E (Reserved for military purpose)

1111----			
8 bit	8 bit	8 bit	8 bit

No. of IP Addresses in class E = 2^{28}

1111 0000 - 240
⋮
11111111 = 256

no n/w, no host.

eg. 245.0.1.2 → class E

ROLL NO.

Q. IP address = 201.20.30.40

Calculate :- N/W ID = 201.20.30.0

4th Host ID = 201.20.30.4

Last Host ID = 201.20.30.254

Broadcast Address = 201.20.30.255

limited Direct

Class C = 192 - 223 (255.255.255.255) (201.20.30.255)

(Inside) (~~Inside~~ outside organization)

(1) 201.20.30.40 → belongs to class C Range.

default mask = 255.255.255.0

perform AND = 201.20.30.0

(2) In class C no. of hosts = 256 but First & last is not used. So

201.20.30.0 – reserved.

201.20.30.1 – First

:2 – 2nd

:3 – 3rd

$\boxed{201.20.30.4}$ – 4th

(3) 201.20.30.255 → last IP address reserved,

201.20.30.254 → so this is last

ROLL NO.

Disadvantage of Classful Addressing

- Wastage of IP addresses (less flexibility)
- Maintenance is time consuming
- More prone to errors. (S/W failure) Security

CA = 2^{24} = 1 Crore ✓ which is very huge (HOST) but N/W is less

CB = 2^{16} = 65K

CC = 2^{8} = 256 ✓ Host is very less

Classless Addressing (Blocks)

IEANA (Internet assigned number authority)

→ No classes

→ only blocks

→ Notation

(IPV4)

← 32 →

BLOCKS ID	HOST ID

octet

eg: x.y.z.w/n — mask or no. of bits represent block → N/W ID part

200.10.20.40/28

↓

28 no. of 1's

200.10.20.40 — one of the IP

N/WID-?

32
28 N/W ID
—
4 — HOST ID

← 32 →

28	4
BLOCK ID	HOST ID

2^4 = no. of host = 16

11111111.11111111.11111111.11110000

Convert into mask

$\boxed{255.255.255.240}$ mask of this n/w.

15

ROLL NO.

To find in which n/w this IP address belongs

$\boxed{200.10.20.40}$ - IP address.

1st method

200. 10. 20. 00101000

|← 28 bit →| Host bit

00100000

$\boxed{200.10.20.32/28}$ - N/W

2nd method

AND with mask value

255.255.255.240 → 11110000

200.10.20.40 → 00101000

$\boxed{200.10.20.32}$ 00100000

Interdomain Routing.

CIDR (Classless ~~Addressing concept~~)

Rules - (1) Addresses should be contiguous.

(2) N. of addresses in a block must be in Power of 2

(3) First address of every block must be evenly divisible by size of the block.

$$\frac{200.10.20.32}{16} \qquad \frac{00100000}{2^4}$$

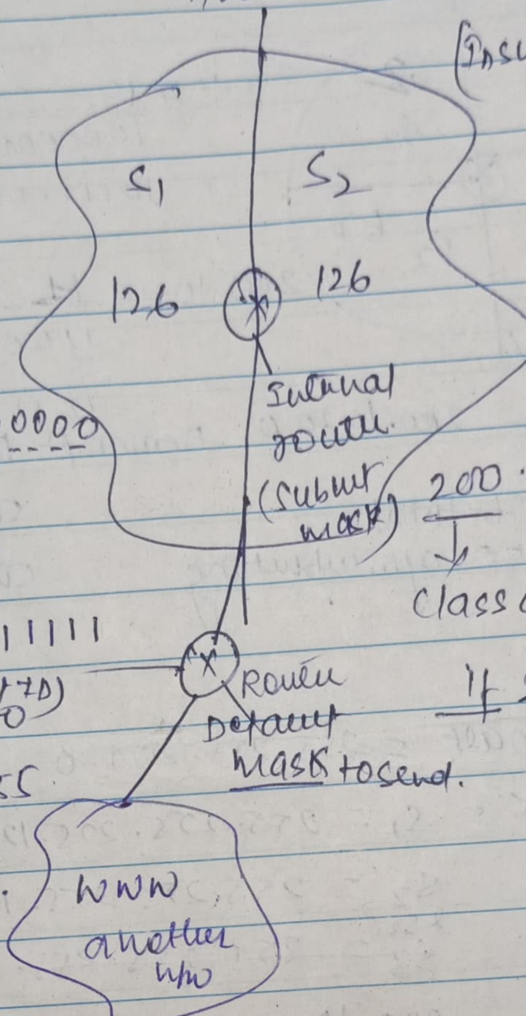
$\frac{1}{33}$ = 00100001

not

ROLL NO.

Subnetting Dividing the big n/w into small n/ws. enhancing Security

class A, B, C



(In subnet N/w bit should be same)

200.10.20.0 0000000
↑ fix

0 1111111

N/w ID 200.10.20.0 to
200.10.20.127 (broadcast)

Host = 128 - 2 = 126

200.10.20.1 0000000
↑ Fix

1 1111111

(N/w ID/subnet ID)
200.10.20.128 to
200.10.20.255

total Host IP Add.
126

200.10.20.0
↓
Class C total host = 256 - 2 = 254

If 2 subnet

Subnet mask - $\boxed{255.255.255.128}$ which decide IP add. belongs to which subnet ID

1.0000000 = 128
reserve bit 1, rest of the 7 bit will be zero.

Ex 32, 64, 128

N/w | Host IP | port IP
N/w | SID | HID | PID

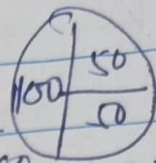
200.10.20.15, 200.10.20.130

S1

ROLL NO.

variable length subnet masking (VLSM)

256 total

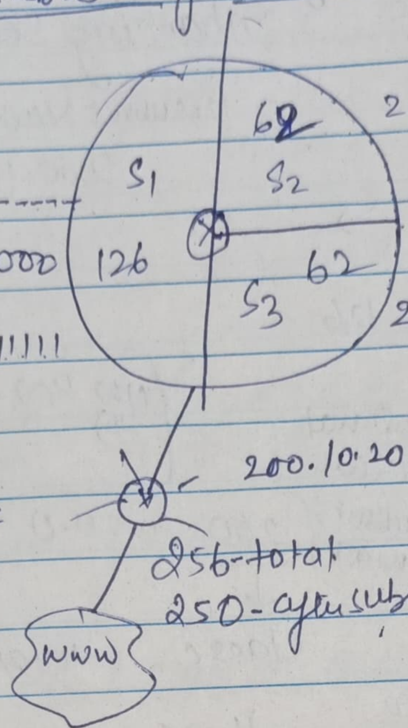


0] 254
255

200.10.20.10 ------
10000000
10111111

128 to 191
(64) − 2

200.10.20.0 -------
0000000
0111111



200.10.20.11 ------
11000000
11111111

192] 64-2
255

200.10.20.0
to
200.10.20.127

128−2=126

200.10.20.0

256-total
250-after subnetting

Demand- 100 Host in 1 subnet
50 Host in 2 subnet
50 Host in 2 subnet

Default mask = 255.255.255.0

Subnet mask = S1 = 255.255.255.128 ✓

S2 = 255.255.255.192 ✓

~~S3 = 255.255.255.~~ & S3

200.10.20.10

10000000

2^7 = 128 ✓S1

2^7 2^6

11000000

128+64 = 192 } S2 & S3

ROLL NO.

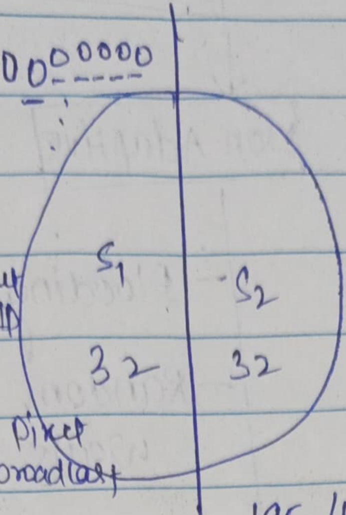
Subnetting in classless Addressing (CIDR)

Intradomain Routing

195.10.20.100 00000

.10011111

195.10.20.128/27 Subnet N/W ID
to
195.10.20.159/27 Direct broadcast



195.10.20.10.1 00000

101 1111

195.10.20.160/27 N/W ID
to
195.10.20.191/27 Direct broadcast

195.10.20.128/26   32-26 = 6 bits Host

N/W bit   HOST ID

$\boxed{195.10.20.1\,|\,0000000}$

Fix

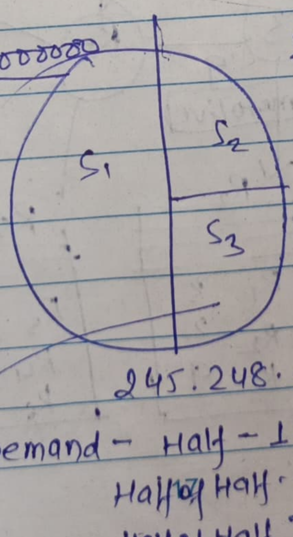
195.10.20.10.0

~~Q. CIDR~~ Variable length subnet masking in CIDR

8 8
$\boxed{245.248.1000\,|\,0000.00000000}$
NID   HID
Fix

245.248.128.0/21
to
245.248.135.255/21

256-2
= 254



245.248.1000 1000.00000000
245.248.1000 1000.00000000
245.248.136.0 to /22
245.248.139.255/22

245.248.128.0/20   32-20 = 12 bit host
2^{12} Host-2

Demand - Half - 1st
Half of Half - 2nd
Half of Half - 3rd

245.248.1000 1100.00000000
to
245.248.1000 1111.11111111
→ 245.248.140.0/22 to
245.248.143.255/22

Routing Algorithm

- Adaptive
  - Isolated
  - Centralized
  - Distributed
- Non-Adaptive
  - Flooding
  - Random walk
- Hybrid
  - Link state
  - Distance vector.

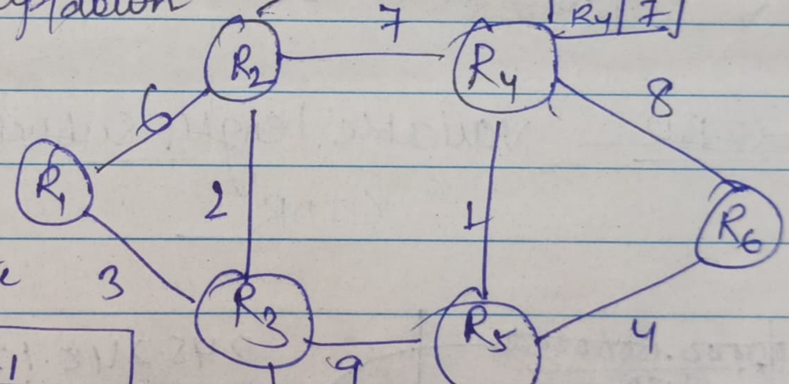
(1) Link state Routing Algorithm → to make Routing table.

edge. up/down

6 Router.

R2

R1	6
R3	2
R4	7



R6

R5	4
R4	8

linkstate table

R1

Sequence no. 1 | TTL (Time to Live)

R2	6
R3	3

bandwidth utilization but congestion is also high

using flooding

R3

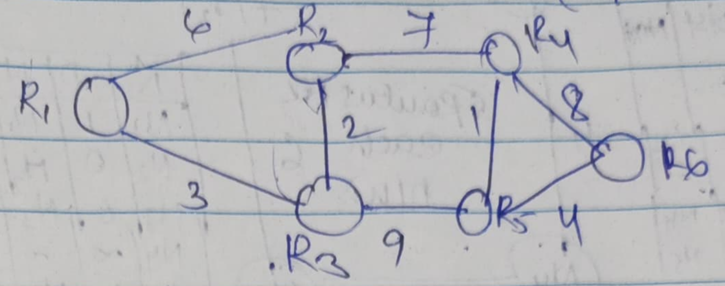
R1	3
R2	2
R5	9

R5

R3	9
R4	1
R6	4

ROLL NO.

(1) **Flooding** R_1 getting info of all nodes.
(Global knowledge)



(2) Dijkstra's algorithm. (single source shortest path)

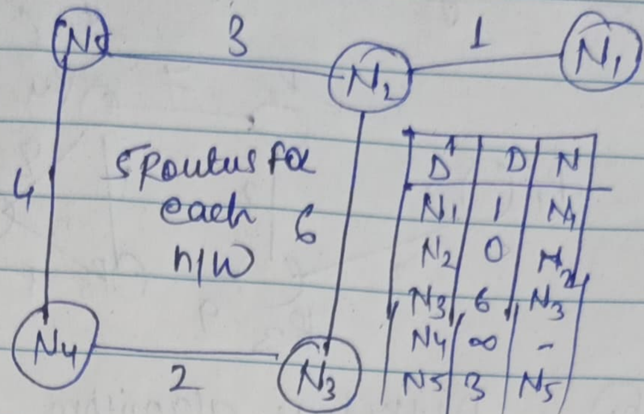
Source	dest R_2	R_3	R_4	R_5	R_6
R_1	6	3	∞	∞	∞
$R_1 R_3$	5	3	∞	12	∞
$R_1 R_3 R_2$			12	12	∞
$R_1 R_3 R_2 R_4$				12	21
$R_1 R_3 R_2 R_4 R_5$					16

		via
R_1 -	0	R_1
R_2 -	5	R_1
R_3	3	R_1
R_4	12	$R_3 R_2$
R_5	12	R_3
R_6	16	$R_3 R_5$

for Intranetwork.

(2) Distance vector Routing (DVR)

Destn	Dist	Next
N_1	∞	-
N_2	3	N_2
N_3	∞	-
N_4	4	N_4
N_5	0	N_5



D	D	N
N_1	1	N_1
N_2	0	N_2
N_3	6	N_3
N_4	∞	-
N_5	3	N_5

D	D	N
N_1	0	N_1
N_2	1	N_2
N_3	∞	-
N_4	∞	-
N_5	∞	-

D	D	N
N_1	∞	-
N_2	∞	-
N_3	2	N_3
N_4	0	N_4
N_5	4	N_5

D	D	N
N_1	∞	-
N_2	6	N_2
N_3	0	N_3
N_4	2	N_4
N_5	∞	-

local Routing tables.

→ All N/w knows ~~their~~ total no. of router & their local neighbour.

→ Share the local Routing table (only distance vector) to their n/w neighbour only.

eg- $N_1 \rightarrow N_2$

$N_2 \rightarrow N_5, N_1, N_3$

$N_4 \rightarrow N_3, N_5$. only share distance

(1) Now start to share the information of distance to their neighbour.

For N1

N_2

For N2

N1, N3, N5

For N3

N4, N2

For N4

N3, N5

For N5

N2, N5

(2) : For N1

$$N_2: \begin{bmatrix} 1 \\ 0 \\ 6 \\ \infty \\ 3 \end{bmatrix}$$

new routing table For N_1

D	D	N
N_1	0	N_1
N_2	1	N_2
N_3	7	N_2, N_3
N_4	∞	-
N_5	4	N_2, N_5

(1) $N_1 \to N_1 = 0$

(2) $N_1 \to N_2 + N_2 \to N_2$

$1 + 0 = 1$

(3) $N_1 \to N_2 + N_2 \to N_3$

$1 + 6 = 7$

(4) $N_1 \to N_2 + N_2 \to N_4$

$1 + \infty = \infty$

(5) $N_1 \to N_2 + N_2 \to N_5$

$1 + 3 = 4$

ROLL NO.

(5) For N5

N_2	N_4
1	∞
0	∞
6	2
∞	0
3	4

Distance vector of neighbour.

new Routing table for N5

D	D	Next
N_1	4	N_2
N_2	3	N_2
N3	6	N4
N4	4	N4
N5	0	N5

(1) $N_5 \to N_1$

$N_5 \to N_2$ and $N_2 \to N_1 \Rightarrow 3+1 = 4$

$N_5 \to N_4$ and $N_4 \to N_1 \Rightarrow 4+\infty = \infty$

(2) $N_5 \to N_2$

$N_5 \to N_2$ and $N_2 \to N_2 \Rightarrow 3+0 = 3$

$N_5 \to N_4$ and $N_4 \to N_2 \Rightarrow 4+\infty = \infty$

(3) $N_5 \to N_3$

$N_5 \to N_2$ and $N_2 \to N_3 \Rightarrow 3+6 = 9$

$N_5 \to N_4$ and $N_4 \to N_3 \Rightarrow 4+2 = 6$

(v) $N_5 \to N_4$

$N_5 \to N_4$ and $N_4 \to N_4 \Rightarrow 4 + 0 = 4$

$N_5 \to N_2$ and $N_2 \to N_4 = 3 + \infty = \infty$

~~Continuously~~

3-4 Pass for updated Routing table.

$\downarrow$

minimum Distance.