CS & IT ENGINEERING

COMPUTER NETWORKS

IPv4 Addressing

Lecture No-22

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TOPICS TO BE COVERED

- Classless Addressing
- IPv4 Addressing PYQ

Q.3

Consider routing table of an organization's router shown below:

GATE-2022 $\boxed{\text{MSQ}}$

Subnet number	Subnet Mask	Next Hop
12.20.164.0	255.255.252.0	R1
12.20.170.0	255.255.254.0	R2
12.20.168.0	255.255.254.0	Interface 0
12.20.166.0	255.255.254.0	Interface 1
Default		R3

Which of the following prefixes in CIDR notation can be collectively used to correctly aggregate all of the subnets in the routing table?

(A) 12.20.164.0/21

(B) 12.20.164.0/22

(C) 12.20.168.0/22

(D) 12.20.164.0/20

I 12.20.164.0|22

II 12.20.170.0|23

III 12.20.168.0|23

IV 12.20.166.0|23

(164.0 – 167.255)

(170.0 – 171.255)

(168.0 – 169.255)

(166.0 – 167.255) X

Sol^n: I: 12.20.101001|00.00000000

$\underbrace{8+8+6}_{\text{NID}}$ | $\underbrace{}_{\text{HID}}$

$\underline{12.20.101001}$ 00.00000000 → 12.20.164.0

⋮

$\underbrace{12.20.101001}_{\text{NID}}$ 11.11111111 → 12.20.167.255

II $\underbrace{12.20.1010101}_{\substack{8+8+7 \\ NID}}\,\underbrace{0.00000000}_{HID}$

$\underline{12.20.1010101}\,0.00000000 \rightarrow 12.20.170.0$

$\vdots$

$\underline{12.20.1010101}\,1.11111111 \rightarrow 12.20.171.255$

III $\underbrace{12.20.1010100}_{\substack{8+8+7 \\ NID}}\,\underbrace{0.00000000}_{HID}$

$\underline{12.20.1010100}\,0.00000000 \rightarrow 12.20.168.0$

$\vdots$

$12.20.1010100\,1.11111111 \rightarrow 12.20.169.255$

IV $12 \cdot 20 \cdot \underbrace{10100110}$ | $\cdot$ 00000000

$\underbrace{8 + 8 + 7}_{NID}$ | HID

$\underline{12 \cdot 20 \cdot 1010011}\ 0 \cdot 00000000 \rightarrow 12 \cdot 20 \cdot 166 \cdot 0$

$\vdots \qquad \vdots$

$\underline{12 \cdot 20 \cdot 1010011}\ 1 \cdot 11111111 \rightarrow 12 \cdot 20 \cdot 167 \cdot 255$

Network IV is the Part of Network I so we can just ignore Network IV

I 12.20.164.0/22

II 12.20.170.0/23

III 12.20.168.0/23

12.20.164.0/22
12.20.168.0/23
12.20.170.0/23

① Contiguous (True)

② same size = 2^9 & No. of n/w's = 2 = 2^1

③ total size of supernet = $2^9 + 2^9 = 2^{10}$

12.20.101010$\underbrace{\boxed{00.00000000}}_{\text{Rem or HID}}$ /2^{10} (True)

supernet id = 12.20.168.0

12.20.168.0/22
12.20.164.0/22

⇓

12.20.164.0/22

12.20.168.0/22

① Contiguous (True)

② Same size = 2^{10} ⟵ No. of n/w's = 2

③ total size of supernet = $2^{10} + 2^{10} = 2^{11}$

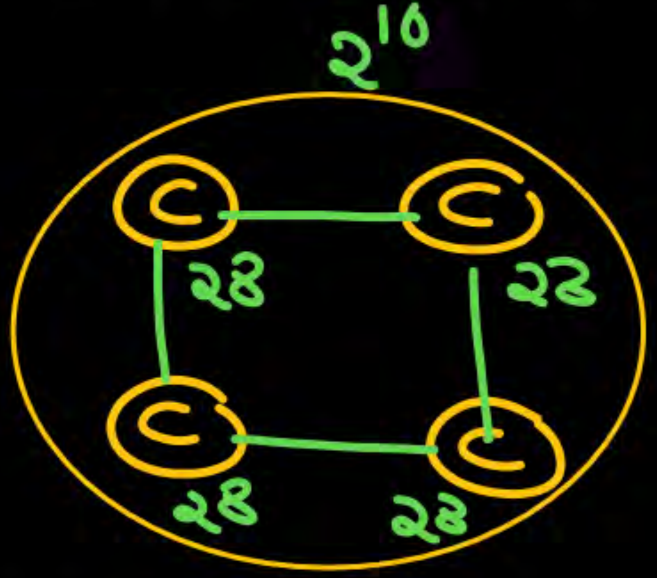
12.20. 10100 $\boxed{100.00000000}$ / 2^{11} (False)

Rom or HID

Supernetting
in
Classfull addressing

Q.1

A company needs 600 $\to 2^{10}$ addresses. Which of the following set of class C blocks can be used to form a supernet for this company?



(A) 198.47.32.0 198.47.33.0 198.47.50.0

(B) 198.47.32.0 198.47.42.0 198.47.52.0 198.47.62.0

(C) 198.47.31.0 198.47.32.0 198.47.33.0 198.47.52.0

(D) 198.47.32.0 198.47.33.0 198.47.34.0 198.47.35.0

① contiguous (True)

② same size $= 2^8$ & No. of n/w's $= 4 = 2^2$ (T)

③ total size of supernet $= 2^8 + 2^8 + 2^8 + 2^8 = 4 * 2^8 = 2^{10}$

198.47.32.0

198.47.001000$\boxed{00.00000000}$ | 2^{10} (T)

Rem or HID

Q.2

Consider 4 networks class-c

199,202.0.0,199.202.1.0, 199.202.2.0, 199.202.3.0 and perform aggregation to select one of the following supernet mask.

(A) 255.255.252.0

(B) 255.255.255.252

(C) 255.255.252.255

(D) None of these

① Contiguous (True)

② same size $= 2^8$ & No. of n/w's $= 4 = 2^2$ (T)

③ Total size of supernet

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

199.202.00000000.00000000 | 2^{10}

Rem or HID (T)

Total size of supernet $= 2^{10}$, HID = 10

NID = 22 bit

supernet mask: 11111111.11111111.11111100.00000000

255.255.252.0

Q.3

No. of 1's = 22

The mask is 255.255.252.0 can probably be used in class A, Class C, Class B respectively.

✓ Subnet Mask

supernet mask ✓

subnet mask ✓

(A) Subnet mask ,supernet mask ,subnet mask ✓

(B) Subnet mask ,subnet mask ,supernet mask

(C) Supernet mask ,subnetnet mask ,subnet mask

(D) Subnet mask ,subnet mask ,subnet mask

Q.4

In class C, if supernet mask is 255.255.224.0 then the number of class C networks combined to from supernet is

(A) 16

(B) 32

(C) 64

(D) 22

Supernet mask : $\overbrace{11111111 . 11111111 . 111\underbrace{00000}}^{NID} . \overbrace{00000000}^{HID}$

supernetid = 5 bit

No. of n/w's must be combined $= 2^5 = 32$

class-C

subnet Mask: $\overbrace{11111111 . 11111111 . 11111111}^{NID} . \overbrace{00000000}^{HID}$

Q.5 In class C, if supernet Mask is 255.255.252.0. How many number of networks that can be joined 4

Supernet Mask = $\overbrace{11111111.11111111.111111\underbrace{00}}^{NID}.\overbrace{00000000}^{HID}$

supernet id = 2 bit

No. of n/w's must be combined

$= 2^2 = 4$

Q.6 One of the address of a supernet is given as IP-201.99.89.113 and Supernet mask is 255.255.252.0

What will be the range of supernet?

class-c

(A) 201.99.88.0 - 201.99.91.255

(B) 201.99.81.0- 201.99.92.254

(C) 201.99.255.255- 201.99.0.0

(D) None of the Above

→ 64+16+8+1

IP Add = 201 . 99 . 89 . 113

AND AND

→ 128+64+32+16+8+4

Supernet mask = 255 . 255 . 252 . 0

supernet id = 201 . 99 . 88 . 0

Supernet Mask : $\overbrace{11111111 . 11111111 . 111111\underbrace{00}_{\text{Supernet id} = 2 \text{ bit}}}^{NID} . \overbrace{00000000}^{HID}$

No. of Networks Combined $= 2^2 = 4$

$201 . 99 . 010110\underbrace{\_\ \_}_{\text{Supernet id}} . \underbrace{\_\ \_\ \_\ \_\ \_\ \_\ \_\ \_}_{HID}$

N_1 : 00

N_2 : 01

N_3 : 10

N_4 : 11

N_1: 201.99.010110 $\underline{00}$.00000000 → 201.99.88.0

201.99.010110 $\underline{00}$.11111111 → 201.99.88.255

N_2: 201.99.010110 $\underline{01}$.00000000 → 201.99.89.0

201.99.010110 $\underline{01}$.11111111 → 201.99.89.255

N_3: 201.99.010110 $\underline{10}$.00000000 → 201.99.90.0

201.99.010110 $\underline{10}$.11111111 → 201.99.90.255

N_4: 201 · 99 · 010110 $\underline{11}$ · 00000000 → 201 · 99 · 91 · 0

201 · 99 · 010110 $\underline{11}$ · 11111111 → 201 · 99 · 91 · 255

Range → (201 · 99 · 88 · 0 – 201 · 99 · 91 · 255)

21 HID

$201.99.\underbrace{010110}_{88}\,00.\boxed{8\text{bit}}$

21

$01.\boxed{8\text{bit}}$

HID

21

$10.\boxed{8\text{bit}}$

HID

21

$11.\boxed{8\text{bit}}$

HID

Q.7 If default subnet mask for a network is 255.255.255.0 and if 'm' bits are borrowed from the Network ID (NID), then what could be its supernet mask?

(A) $255.255.\underbrace{(2^{8-m}-1) \times 2^m}.0$

(B) $255.255.\underbrace{(2^{8-m}) \times 2^m}.0$

(C) $255.255.\underbrace{(2^{8-m-1}) \times 2^{m-1}}.0$

(D) $255.255.\underbrace{(2^{8-m}) \times 2^{m-1}}.0$

$SM = \overbrace{11111111.11111111.11111111}^{NID}.\overbrace{00000000}^{HID}$

$m=4$

Supernet Mask: $11111111.11111111.1111\underbrace{0000}_{\text{supernet id} = 4\text{ bit}}.00000000$

Supernet Mask = 255.255.240.0

(a) $(2^{8-m}-1) * 2^{m}$

$(2^{8-4}-1) * 2^{4}$

$15 * 16 = 240$

~~(b)~~ $(2^{8-m}) * 2^{m}$

$(2^{8-4}) * 2^{4}$

$2^{4} * 2^{4} = 2^{8} = 256$

~~(c)~~ $2^{(8-m-1)} * 2^{m-1}$

$2^{(8-4-1)} * 2^{4-1}$

$2^{3} * 2^{3} = 2^{6} = 64$

~~(d)~~ $2^{(8-m)} * 2^{(m-1)}$

$2^{(8-4)} * 2^{(4-1)}$

$2^{4} * 2^{3} = 2^{7} = 128$

MCQ

An organization requires a range of IP addresses to assign one to each of its 1500 computers. The organization has approached an Internet Service Provider (ISP) for this task. The ISP uses CIDR and serves the requests from the available IP address space $\boxed{202.61.0.0/17}$. The ISP wants to assign an address space to the organization, which will minimize the number of routing entries in the ISP's router using route aggregation. Which of the following address spaces are potential candidates from which the ISP can allot any one to the organization?

I. 202.61.84.0/21

II. 202.61.104.0/21

III. 202.61.64.0/21

IV. 202.61.144.0/21

[GATE-2020-CN: 2M]

(A) I and II only

(B) II and III only

15

(C) III and IV only

(D) I and IV only

202.61.0.0/17

NID = 17 bit, HID = 32 - 17 = 15 bit

$\underbrace{202.61.0}_{\substack{8+8+1 \\ \text{NID}}}\ \underbrace{\text{-------.--------}}_{\text{HID} = 15\text{ bit}}$

$\underline{202.61.0}$ 0000000.00000000 → 202.61.0.0

⋮

$\underline{202.61.0}$ 1111111.11111111 → 202.61.127.255

× I 202.61.84.0/21

NID = 21 bit, HID = 11 bit

1500 Computer's

HID = 11 bit

202.61.01010 $\boxed{100.00000000}$ | 2^{11} (No)

Rem or HID

First IP Address of the block must be divisible by size of the Block

✓ II 202.61.104.0/21, NID = 21 bit, HID = 11 bit

202.61.0110 1 $\boxed{000.00000000}$ | 2^{11} (True)

III 202.61.64.0/21, NID = 21 bit, HID = 11 bit

$202.61.01000\boxed{000.00000000}/2^{11}$ (True)

Rem or HID

IV

Q. An internet service provider (ISP) is granted a block of addresses starting with 162.72.0.0/16. The ISP needs to distribute these addresses to three groups of customers as follows:

1. The first group has 128 customers; each needs 256 addresses.
2. The second group has 128 customers; each needs 64 addresses.
3. The third group has 64 customers; each needs 128 addresses.
4. Find the last address of 6^{th} customer of the 2^{nd} group and how many addresses are still available with ISP after these allocations.

162.72.0.0/16

NID = 16 bit, HID = 16 bit

No. of IP Addresses Available in this block $= 2^{16} = 65,536$

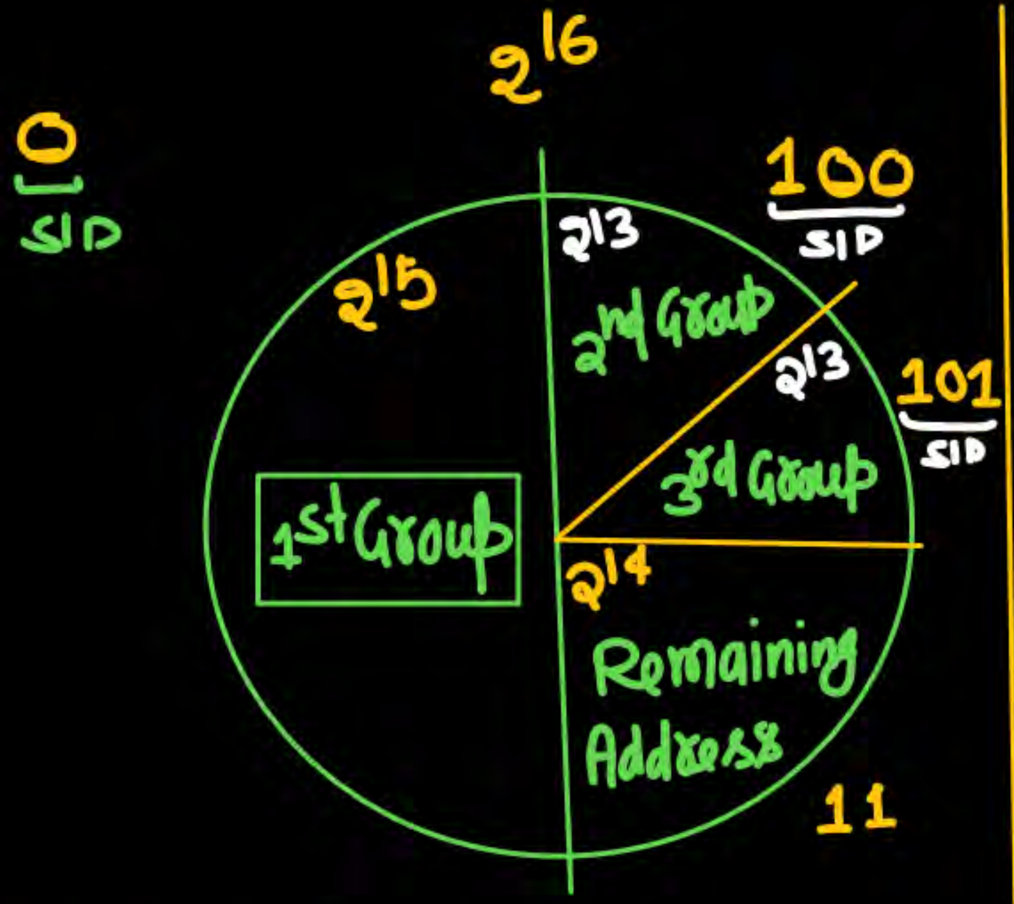
I First Group: 128 customer each Need 256 Addresses

$128 * 256 = 2^7 * 2^8 = 2^{15}$ Addresses

II 2nd Group: $128 * 64 = 2^7 * 2^6 = 2^{13}$ Addresses

III 3rd Group: $64 * 128 = 2^6 * 2^7 = 2^{13}$ Addresses

$$
\begin{aligned}
\text{IP Address still Available} &= 2^{16} - (2^{15} + 2^{13} + 2^{13}) \\
&= 2^{16} - (2^{15} + 2^{14}) \\
&= 2^{16} - 2^{14}(2^{1} + 1) \\
&= 2^{16} - 3 \times 2^{14} \\
&= 2^{2} \times 2^{14} - 3 \times 2^{14} \\
&= 4 \times 2^{14} - 3 \times 2^{14} \\
&= 2^{14}
\end{aligned}
$$



162.72.0.0/16

NID	HID
16	16

First Group:

SID	HID
1	15

$\underbrace{162.72}_{8+8}.\underbrace{0}_{SID}\underbrace{\text{-------.--------}}_{HID}$

162.72.0 0000000.00000000 → 162.72.0.0/17

⋮

162.72.0 1111111.11111111 → 162.72.127.255/17

162.72.0.0/17

NID	HID
17	15

$\boxed{\text{128 customer or subnet}}$

NID	SID	HID
17	7	8

$$\underbrace{162.72.0}_{NID}\ \underbrace{\text{- - - - - - -}}_{SID}.\underbrace{\text{- - - - - - - -}}_{HID}$$

1st Group: 1st customer

$$\underbrace{162.72.0}_{NID}\ \underbrace{0000000}_{SID}.00000000 \rightarrow 162.72.0.0|24$$

$$\vdots$$

$$\underbrace{162.72.0}_{NID}\ \underbrace{0000000}_{SID}.11111111 \rightarrow 162.72.0.255|24$$

1st Group → 2nd customer

$$\underbrace{162.72.0}_{NID}\ \underbrace{0000001}_{SID}.00000000 \rightarrow 162.72.1.0|24$$

$$\vdots$$

$$\underbrace{162.72.0}_{NID}\ \underbrace{0000001}_{SID}.11111111 \rightarrow 162.72.1.255|24$$

1st Group → 3rd customer

$$\underbrace{162.72.0}_{NID}\ \underbrace{0000010}_{SID}.\overbrace{00000000}^{HID} \rightarrow 162.72.2.0/24$$

⋮

$$\underbrace{162.72.0}_{NID}\ \underbrace{0000010}_{SID}.11111111 \rightarrow 162.72.2.255/24$$

⋮

1st Group: 128th customer

$$\underbrace{162.72.0}_{NID}\ \underbrace{1111111}_{SID}.\overbrace{00000000}^{HID} \rightarrow 162.72.127.0/24$$

⋮

$$\underbrace{162.72.0}_{NID}\ \underbrace{1111111}_{SID}.11111111 \rightarrow 162.72.127.255/24$$

2nd Group

$\underbrace{162.72}_{NID}.\underbrace{100}_{SID}\underbrace{\text{-----.----------}}_{HID}$

$\underbrace{162.72}_{NID}.\underbrace{100}_{SID}00000.00000000 \rightarrow 162.72.128.0/19$

$\vdots$

$\underbrace{162.72}_{NID}.\underbrace{100}_{SID}11111.11111111 \rightarrow 162.72.159.255/19$

$\Downarrow$

162.72.128.0/19

NID	HID
19	13

$\boxed{\text{128 customer or 128 subnet}}$

19	7	6
NID	SID	HID

2nd Group → 1st customer

$\underbrace{162.72.100}_{NID}\ \underbrace{-----}_{SID}\ .\ \underbrace{--}_{SID}\ \underbrace{------}_{HID}$

$\underbrace{162.72.100}_{NID}\ \underbrace{00000.00}_{SID}\ 000000 \rightarrow 162.72.128.0/26$

⋮

$\underbrace{162.72.100}_{NID}.\underbrace{00000.00}_{SID}\ 111111 \rightarrow 162.72.128.63/26$

2nd Group : 2nd customer

$\underbrace{162.72.100}_{NID}\ \underbrace{00000.01}_{SID}\ 000000 \rightarrow 162.72.128.64/26$

.
.
.

$\underbrace{162.72.100}\ \underbrace{00000.01}_{SID}\ 111111 \rightarrow 162.72.128.127/26$


THANK
YOU!