

DCN HW-3

Date:- 17-nov-2024

Name: Basil Khawaja Bk08432

Section: L 1

Q1) Starting IP address: 192.10.10.0/24

Subnets = 15

$$A = \log_2(15) = 4$$

$$\text{total Prefix} = 24 + 4 = 28$$

Subnet mask = 255.255.255.240

$$2^{32-28} = 2^4 = 16$$

hence each subnet will have 16 addresses

\Rightarrow first subnet:

① network id:

Starting ip = 192.10.10.0

11000000 . 00001010 . 00001010 . 00000000

11111111 . 11111111 . 11111111 . 11110000

And

11000000 . 00001010 . 00001010 . 00000000

② Broadcast id:

↳ ① complement of the mask

↳ ② then OR operation

Complement:-

Compl → 00000000 . 00000000 . 00000000 . 00001111

netid → 11000000 . 00001010 . 00001010 . 00000000

OR

↳ [11000000 . 00001010 . 00001010 . 00001111]

Broadcast id = [192 . 10 . 10 . 15]

Range :-

first; network id + 1

11000000 . 00001010 . 00001010 . 00000000

+

1

11000000 . 00001010 . 00001010 . 00000001

↓

192 . 10 . 10 . 1

Last:- Broadcast - 1

11000000. 00001010. 00001010. 00001111

- 1

11000000. 00001010. 00001010. 00001110



192. 10. 10. 14

⇒ Second Subnet:-

① net id: Previous broadcast was
192. 10. 10. 15, so this
Subnet will Start from 192. 10. 10. 16

In binary:-

11000000. 00001010. 00001010. 00010000

1111111. 1111111. 1111111. 11110000

Ano

11000000. 00001010. 00001010. 00010000



192. 10. 10. 16

② broadcast id:-

Complement of Subnet mask :-

11111111 · 11111111 · 11111111 · 11110000



complement



00000000 · 00000000 · 00000000 · 00001111

netid 11000000 · 00001010 · 00001010 · 00010000

OR

11000000 · 00001010 · 00001010 · 00011111



192 · 10 · 10 · 31

\Rightarrow Subnet 14 :-

1st ip of Subnet 14



192 · 10 · 10 · 0 + (13 × 16)



192 · 10 · 10 · 208

Network id:-

IP \rightarrow 11000000 · 00001010 · 00001010 · 11010000

Sub \rightarrow 11111111 · 11111111 · 11111111 · 11110000

Ans \rightarrow 11000000 · 00001010 · 00001010 · 11010000

\downarrow
192 · 10 · 10 · 208 Ans //

Broadcast id:

① Complement of Subnet mask :-

00000000 · 00000000 · 00000000 · 00001111

② OR:

net \rightarrow 11000000 · 00001010 · 00001010 · 11010000

comp \rightarrow 00000000 · 00000000 · 00000000 · 00001111

OR

11000000 · 00001010 · 00001010 · 11011111

~~~~~  
192 · 10 · 10 · 223      Ans

$\Rightarrow$  Subnet 15 :-

Start = 192 · 10 · 10 · 0 + (14 × 16)

Start = 192 · 10 · 10 · 224

Net id:

IP  $\rightarrow$  11000000. 00001010. 00001010. 11100000

Sub  $\rightarrow$  11111111. 11111111. 11111111. 11110000

And

11000000. 00001010. 00001010. 11100000

~~~~~

192. 10. 10. 224 Any

Broadcast id:

net \rightarrow 11000000. 00001010. 00001010. 11100000

comp \rightarrow 00000000. 00000000. 00000000. 00001111

or

11000000. 00001010. 00001010. 11101111

~~~~~

192. 10. 10. 239

Random Subnets:

Subnet ~ 8:

Start = 192. 10. 10. 0 + (7  $\times$  16)

Start  $\rightarrow$  192. 10. 10. 112

Network id :

IP → 11000000 · 0000lolo · 0000lolo · 01110000

Sub → 1111111 · 1111111 · 1111111 · 11110000

And

11000000 · 0000lolo · 0000lolo · 01110000

~~~~~ | ~~~~~

192 · 10 · 10 · 112 → Ans//

Broadcast id :

IP → 11000000 · 0000lolo · 0000lolo · 01110000

Comp → 00000000 · 00000000 · 00000000 · 0000llll

OR

11000000 · 0000lolo · 0000lolo · 01111111

~~~~~ | ~~~~~

192 · 10 · 10 · 127 → Ans//

Subnet q :-

Start = 192 · 10 · 10 · 0 + (8 × 16)

Start = 192 · 10 · 10 · 128

Network id :

IP → 11000000 · 0000lolo · 0000lolo · 10000000

Sub → 1111111 · 1111111 · 1111111 · 11110000

And

11000000 . 00001010 . 00001010 . 10000000  
~~~~~ ~~~~~

192. 10. 10. 128

Broadcast id:-

net → 11000000 . 00001010 . 00001010 . 10000000

conf → 00000000 . 00000000 . 00000000 . 00001111

OR

11000000 . 00001010 . 00001010 . 10001111
~~~~~ ~~~~~

192. 10. 10. 143 → Ans //

⇒ no of addresses in each Subnet

$$\downarrow \\ 2^{(32-28)} = 2^4 = 16$$

$$\text{Usable addresses} = 16 - 2 = \textcircled{14}$$

↓  
because of network  
and broadcast

14 × 15 → Per Subnet usable = 210

20 employees will get internet connectivity.

$\Rightarrow$  unused addresses :-

$15 \times 16 \rightarrow$  including the network and broadcast for each Subnet

$15 \times 16 = 240$  addresses used by total 15 Subnets

$$256 - 240 = 16$$

16 address are still available for use and could be divided into a Subnet itself.

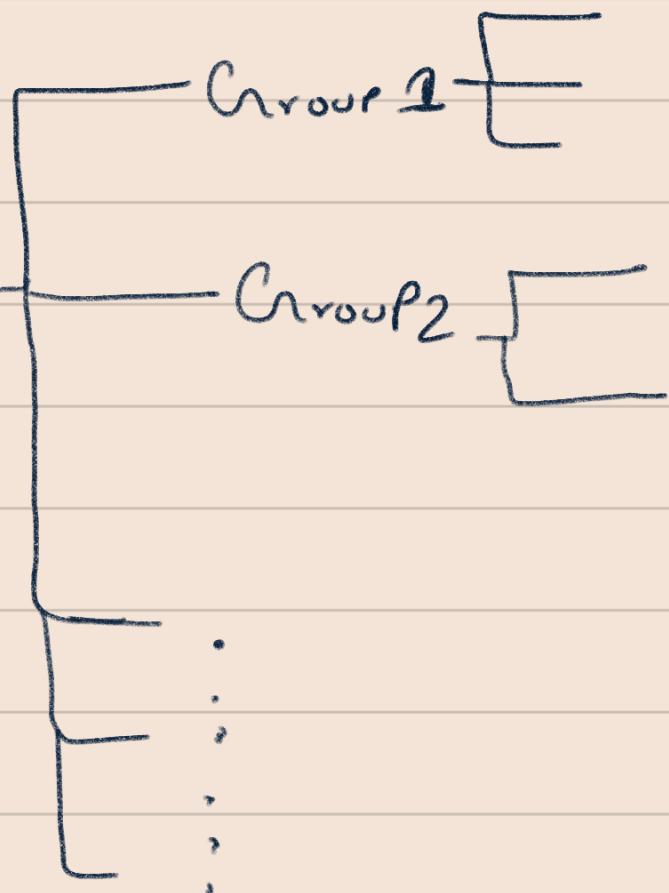
$\Rightarrow$  Subnet mask for each Subnet is same since every Subnet is being divided into equal length which is 255.255.255.240

OR

/28

Question 2:-

192.16.10.0/24



Crosses on till 13

Groups.

total Subnets now will be changed  
because we are creating 5  
additional Subnets :-

$$13 + 5 = 18 \text{ Subnets}$$

$$\text{bits} = \log_2(18) = 5$$

$$\text{Updated Subnet mask} = 24 + 5 = /29$$

192.16.10.248

Group 1 design:- (Subnet 1)

⇒ net id: 192.10.10.0

IP: 11000000. 00001010. 00001010. 00000000

Sub: 11111111. 11111111. 11111111. 11111000

And

11000000. 00001010. 00001010. 00000000

192.10.10.0

⇒ Broadcast id:-

if: 11000000. 00001010. 00001010. 00000000

Comp: 00000000. 00000000. 00000000. 00000111

OR

11000000. 00001010. 00001010. 00000111

192.10.10.7

IP's for users:

192.10.10.1 - 192.10.10.6

$\Rightarrow$  Subnet 2

network id:- 192.10.10.8

IP: 11000000. 00001010. 00001010. 00001000

mask :- 11111111. 11111111. 11111111. 11111000

And

11000000. 00001010. 00001010. 00001000



192.10.10.8

$\rightarrow$  net id

Broadcast id :-

IP: 11000000. 00001010. 00001010 . 00001000

compl: 00000000. 00000000. 00000000 . 00000111

or

11000000. 00001010 . 00001010 . 00001111

192.10.10.15

$\rightarrow$  Broadcast id

$\Rightarrow$  Subnet 3 :-

$\Rightarrow$  net id: 192.10.10.16

IP: 11000000. 00001010 . 00001010. 00010000

mask: 11111111. 11111111 . 11111111. 11111000

And

11000000 . 0000 lolo . 0000 lolo . 0001000

192 . 10 . 10 . 16

⇒ Broadcast id :-

net id : 110 . 0000 . 0000 lolo . 0000 lolo . 0001000

comp : 00000000 . 00000000 . 00000000 . 00000111

OR:

11000000 . 0000 lolo . 0000 lolo . 00010111

192 . 10 . 10 . 23 → Broad id

Group 2 :

⇒ Subnet 1 :-

⇒ network Id = 192 . 10 . 10 . 24

IP : 11000000 . 0000 lolo . 0000 lolo . 00011000

Sub : 11111111 . 11111111 . 11111111 . 11111000

Ans:

11000000 . 0000 lolo . 0000 lolo . 00011000

192 . 10 . 10 . 24

$\Rightarrow$  Broadcast id :-

ip : 11000000 . 00001010 . 00001010 . 00011000

mask : 00000000 . 00000000 . 00000000 . 00000111

OR

11000000 . 00001010 . 00001010 . 00011111

192 . 10 . 10 . 31

ip's for users : 192 . 10 . 10 . 25 - 192 . 10 . 10 . 30

$\Rightarrow$  Subnet 2 :-

$\hookrightarrow$  net id = 192 . 10 . 10 . 32

net : 11000000 . 00001010 . 00001010 . 00100000

mask : 11111111 . 11111111 . 11111111 . 11111000

And :

11000000 . 00001010 . 00001010 . 00100000

$\hookrightarrow$  192 . 10 . 10 . 32  $\rightarrow$  net id

$\hookrightarrow$  Broadcast id :

net : 11000000 . 00001010 . 00001010 . 00100000

mask : 00000000 . 00000000 . 00000000 . 00000111

OR 11000000 . 00001010 . 00001010 . 00100111

192.10.10.39 → Broad id

usable IP's for users

↳ 192.10.10.33 - 192.10.10.38

⇒ Now after this the remaining 13 Subnets will have similar ranges (in terms of IP's they can accommodate) and will start from 192.10.10.40 and so on.

Question 3)

Given IP : 191.10.10.0/16

no of Subnets to be made = 100

no of IP's from this

$$2^{(32-16)}$$

$$= 65536$$

⇒ no of bits to borrow from the network address bits for making 100 Subnets

$$= \log_2 (100)$$

$$= 7$$

Updated Subnet mask =  $16 + 7$

$$= 23$$



255.255.254.0

no of ip's for each Subnet



$$2^{32-23} = 2^9 = 512$$

$$512 - 2 = 500$$



usable

⇒ Subnet 1 :-

Start: 191.10.10.0, mask  $\leq 23$

network id:

ip: 1011111. 00001010. 00001010. 00000000

mask: 1111111. 1111111. 1111110. 00000000

And

1011111. 00001010. 00001010. 00000000



191.10.10.0 → net id

$\Rightarrow$  Broadcast id:

comp of mask



00000000 . 00000000 . 00000001 . 11111111

net: 10111111 . 00001010 . 00001010 . 00000000

comp : 00000000 . 00000000 . 00000001 . 11111111

or

10111111 . 00001010 . 00001011 . 11111111

~~~~~

191 . 10 . 11 . 255 \rightarrow Broadcast id

\Rightarrow Subnet mask : 255 . 255 . 254 . 0

\Rightarrow Subnet 2 :-

Start : 191 . 10 . 11 . 255 + 1

Start : 191 . 10 . 12 . 0

ip: 10111111 . 00001010 . 00001100 . 00000000

mask: 11111111 . 11111111 . 11111110 . 00000000

And:

10111111 . 00001010 . 00001100 . 00000000

~~~~~

192 . 10 . 12 . 0

 $\Rightarrow$  network id

$\Rightarrow$  Broadcast id:

IP: 10111111. 00001010. 00001100. 000 000 00

OR: 100000000. 00000000. 00000000. 111 111 11

OR

10111111. 00001010. 00001101. 11111111

191. 10. 13. 255  $\rightarrow$  Broadcast id

$\Rightarrow$  Subnet mask :- 255. 255. 254. 0

$\Rightarrow$  Subnet 99:

$$512 \times (99-1) = 512 \times 98$$

= 50176  $\Rightarrow$  offset

Base: 10111111. 00001010. 00001010. 000 000 00

50176: 00000000. 00000000. 11000100. 000 000 00

+

10111111. 00001010. 1100110. 000 000 00

192. 10. 206. 0

Network id:

1011111. 00001010 . 11001110 . 00000000

1111111. 11111111 . 11111110 . 00000000

And

1011111. 00001010 . 11001110 . 00000000

~~~~~

191. 10. 206 . 0 → net id

Broadcast id:-

1011111. 00001010 . 11001110 . 00000000

0000000 . 0000000 . 00000001 . 1111111

OR

1011111. 00001010 . 11001111 . 11111111

~~~~~

191. 10. 207 . 255 Any

Subnet mask = 255 . 255 . 255 - 0

$\Rightarrow$  Subnet 100:

$$512 \times 99 = 50688$$

Base: 10111111. 00001010. 00001010. 00000000

50688: 00000000. 00000000. 11000110. 00000000

+

10111111. 00001010. 11010000. 00000000

Start = 191. 10. 208. 0

$\Rightarrow$  Network id:

10111111. 00001010. 11010000. 00000000

11111111. 11111111. 11111110. 00000000

And

10111111. 00001010. 11010000. 00000000

net id: 191. 10. 208. 0

$\Rightarrow$  Broadcast id:

10111111. 00001010. 11010000. 00000000

00000000. 00000000. 00000001. 11111111

or

10111111. 00001010. 11010001. 11111111

$\hookrightarrow$  191. 10. 209. 255

Subnet mask : 255.255.254.0

Subnet 80:

$$49 \times 512 = 25088$$

Base: 1011111. 00001010. 00001010. 00000000

25088; 00000000. 00000000. 01100010. 00000000

+

1011111. 00001010. 01101100. 00000000

~~~~~

Start = 191.10.108.0

Network id;

1011111. 00001010. 01101100. 00000000

1111111. 1111111. 11111110. 00000000

And

1011111. 00001010. 01101100. 00000000

~~~~~

191.10.108.0  $\Rightarrow$  Ans//

Broadcast id;

1011111. 00001010. 01101100. 00000000

00000000. 00000000. 00000001. 1111111 OR

1011111. 00001010. 01101101. 1111111



191.10.109.255  $\Rightarrow$  Ans

$\Rightarrow$  Subnet mask: 255.255.254.0

Subnet S1:  
~~~~~

$$50 \times 512 = 25600$$

Ans: 10111111. 00001010. 00001010. 00000000

25600: 00000000. 00000000. 01100100. 00000000

+

10111111. 00001010. 01101110. 00000000
~~~~~

191.10.110.0

Network id:-

10111111. 00001010. 01101110. 00000000

11111111. 11111111. 11111110. 00000000

And

10111111. 00001010. 01101110. 00000000  
~~~~~

191.10.110.0 \Rightarrow net id

Broadcast id:

10111111. 00001010. 01101110. 00000000

00000000. 00000000. 00000001. 11111111

OR



1011111 · 00001010 · 01101111 · 11111111

~~~~~

191 · 10 · 111 · 255 → Brad id

Subnet mask = 255 · 255 · 254 · 0

⇒ Since each Subnet has 510  
usable addresses

$$100 \times 510 = 51000$$

⇒ 51000 employees will get  
connectivity

⇒ total addresses = 65536

actually used addresses =  $(510+2) \times 100$

$$4 = 51200$$

remaining unused =  $65536 - 51200$

$$= 14336$$



available

for future use

Q4) no of IP addresses required

$$120 + 2 = 122$$

$$A = \log_2 [122] = 7$$

$$2^7 = 128 \text{ IP's / Subnet}$$

$$\text{CIDR} = 32 - 7 = 25$$

Updated Subnet mask = 255.255.255.128

$\Rightarrow$  Subnet 1:

Start : 191.10.10.0

Network id:

10111111. 00001010. 00001010. 00000000

11111111. 11111111. 11111111. 10000000

And

10111111. 00001010. 00001010. 00000000



191.10.10.0  $\Rightarrow$  net id

$\Rightarrow$  Broadcast id:-

comp: 00000000. 00000000. 00000000. 01111111

net: 10111111. 00001010. 00001010. 00000000

comp: 00000000. 00000000. 00000000. 01111111

OR

1011111.0000lolo.0000lolo.0111111

191.10.10.127

Subnet mask : 255.255.255.128

Subnet 2:

Start = Base + 128

$$= 191 \cdot 10 \cdot 10 \cdot 0 + 128$$

$$= 191 \cdot 10 \cdot 10 \cdot 128$$

Network id:

1011111.0000lolo.0000lolo.10000000

1111111.1111111.1111111.10000000

And

1011111.0000lolo.0000lolo.10000000

~~~~~

191.10.10.128

Broadcast id:

1011111.0000lolo.0000lolo.10000000

00000000.00000000.00000000.01111111

OR

1011111.0000lolo.0000lolo.11111111



191.10.10.255

⇒ Subnet mask : 255.255.255.128

⇒ Subnet %:

$$= \text{base} + (2^9 \times 128)$$



which is network of 1st

$$= 191 \cdot 10 \cdot 10 \cdot 0 + 2712$$

$$2712 / 256 = 14 \cdot 5$$

$$= 191 \cdot 10 \cdot 24 \cdot 128$$

⇒ Network id :-

10111111 · 00001010 · 00011000 · 10000000

11111111 · 1111 1111 · 1111 1111 · 10000000

And

10111111 · 00001010 · 00011000 · 10000000

~~~~~

$$191 \cdot 10 \cdot 24 \cdot 128$$

⇒ Broadcast id :-

10111111 · 00001010 · 00011000 · 10000000

00000000 · 00000000 · 0000 0000 · 01111111 OR

10111111 · 00001010 · 00011000 · 11111111



191.10.24.255

⇒ Subnet 31 :-

base +  $(30 \times 128)$

191.10.10.0 + 3840

$3840 / 256 = 15$

191.10.25.0

Network id:

10111111.00001010.00011001.00000000

11111111.11111111.11111111.10000000

And

10111111.00001010.00011001.00000000

~~~~~

191.10.25.0 ⇒ net id

Broadcast id:

10111111.00001010.00011001.00000000

00000000.00000000.00000000.01111111 OR

10111111.00001010.00011001.01111111

~~~~~

191.10.25.127 ⇒ Broad id

⇒ Subnet 99:-

base + (98 × 128)

191.10.10.0 + 12544

$12544 / 256 = 49$

191.10.59.0

network id:

10111111.00001010.00111011.00000000

11111111.11111111.11111111.10000000

And

10111111.00001010.00111011.00000000

191.10.59.0

Broadcast id:

10111111.00001010.00111011.00000000

00000000.00000000.00000000.01111111 OR

10111111.00001010.00111011.01111111

191.10.59.127

Subnet 60:

$$\text{base} + (99 \times 128)$$

$$191 \cdot 10 \cdot 10 \cdot 0 + 12672$$

$$= 12672 = 4905$$

$$191 \cdot 10 \cdot 59 \cdot 128$$

Network id:

$$10111111 \cdot 00001010 \cdot 00111011 \cdot 00000000$$

$$\underline{11110111 \cdot 11111111 \cdot 11111111 \cdot 10000000} \quad \text{And}$$

$$10111111 \cdot 00001010 \cdot 00111011 \cdot 10000000$$

$$191 \cdot 10 \cdot 59 \cdot 128$$

Broadcast id:

$$10111111 \cdot 00001010 \cdot 00111011 \cdot 10000000$$

$$\underline{00000000 \cdot 00000000 \cdot 00000000 \cdot 01111111} \quad \text{or}$$

$$10111111 \cdot 00001010 \cdot 00111011 \cdot 11111111$$

$$191 \cdot 10 \cdot 59 \cdot 255$$

120 addresses for each floor

$$120 \times 100 = 12000$$

each floor has 128 addresses

$$\text{IP's allocated} = 120 + 2 \\ = 122$$

$$128 - 122 = 6 \\ 6 \times 100 = 600 \Rightarrow \text{no of IP's wasted}$$

$$512 - 100 = 412 \Rightarrow \text{Subnets available still}$$

$$412 \times 128 = 52736 \text{ addresses available for future use.}$$

Q5) Given : 80.70.56.0/21

$$2^{72-21} = 2^{11} = 2048 \text{ available addresses}$$

$\Rightarrow$  organisation 1 and 2 need 500 addresses b.th.

$$\log_2(500) \approx 9 \\ 2^9 = 512$$

$$32 - 9 = 23$$

$\Rightarrow$  Start of organisation 1  
↳ 80.70.56.0

→ organisation 18-

Start: 01010000 . 01000110 . 00111000 . 00000000

mask: 11111111 . 11111111 . 11111110 . 00000000 /23

And

01010000 . 01000110 . 00111000 . 00000000

~~~~~

80.70.56.0 ⇒ net id

Broadcast id:-

complement of mask OR net id

01010000 . 01000110 . 00111000 . 00000000

00000000 . 00000000 . 00000001 . 11111111 OR

01010000 . 01000110 . 00111001 . 11111111

~~~~~

80.70.57.255 ⇒ Broadcast id

Subnet mask s/23, Range: 80.70.56.1

80.70.57.255

Organisation 28

Subnet mask : /23

Starting :- 80.70.58.0

01010000 . 01000110 . 00111010 . 00000000

And 11111111 . 11111111 . 11111110 . 00000000

↓

01010000.01000110.00111010.00000000

~~~~~

80.70.58.0 \Rightarrow net id

\Rightarrow Broadcast id:-

01010000.01000110.00111010.00000000

00000000.00000000.00000001.11111111 OR

01010000.01000110.00111011.11111111

~~~~~

80.70.59.255

$\Rightarrow$  Organisation 3<sup>rd</sup> (needs 250 addresses)

$$\log_2(250) \approx 8$$

$$\text{mask} = 32 - 8 = /24$$

Start : 80.70.60.0

01010000.01000110.00111000.00000000

11111111.11111111.11111111.00000000 And

01010000.01000110.00111000.00000000

~~~~~

80.70.60.0 \Rightarrow net id

\Rightarrow Broadcast id:-

01010000.01000110.00111000.00000000

00000000.00000000.00000000.11111111 OR



01010000 . 01000110 . 00111100 = 11111111

80 . 70 . 60 . 255 \Rightarrow Broadcast id

\Rightarrow Organisation 4 :- (needs 250)

$$\log_2(250) \approx 8$$

$$\text{Subnet mask} = 32 - 8 = /24$$

Start : 80 . 70 . 61 . 0

01010000 . 01000110 . 00111101 . 00000000

11111111 . 11111111 . 11111111 . 00000000 And

01010000 . 01000110 . 00111101 . 00000000 00

80 . 70 . 61 . 0 \Rightarrow net id

\Rightarrow Broadcast id:

01010000 . 01000110 . 00111101 . 00000000 00

00000000 . 00000000 . 00000000 . 11111111 OR

01010000 . 01000110 . 00111101 . 11111111

80 . 70 . 61 . 255 \Rightarrow Broadcast

\Rightarrow organisation 5: (needs 50)

$$\log_2(50) \approx 6$$

$$\text{Subnet} = 32 - 6 = /26$$

Start: 80.70.62.0

01010000 . 01000110 . 00111110 . 00000000

1111111 . 1111111 . 1111111 . 11000000 And

01010000 . 01000110 . 00111110 . 00000000

80.70.62.0 \Rightarrow net id

Broadcast id:

00000000 . 00000000 . 00000000 . 00111111

01010000 . 01000110 . 00111110 . 00000000 OR

01010000 . 01000110 . 00111110 . 00111111

80.70.62.63 \Rightarrow Broad id

\Rightarrow organisation 6 : needs 50

Subnet : /26

Start: 80.70.62.64

01010000 . 01000110 . 00111110 . 01000000

1111111 . 1111111 . 1111111 . 11000000 And

01010000 . 01000110 . 00111110 . 01000000



80.70.62.64 \Rightarrow net id

\Rightarrow Broadcast id:-

00000000. 00000000. 00000000. 00111111
01010000. 01000110. 00111110. 01000000 or
01010000. 01000110. 00111110. 01111111

80.70.62.127

\Rightarrow Organisation 7 & 8 - needs 50

Subnet: /26

Start:- 80.70.62.128

01010000. 01000110. 00111110. 10000000
1111111. 111111. 1111111. 11000000 And
01010000. 01000110. 00111110. 10000000



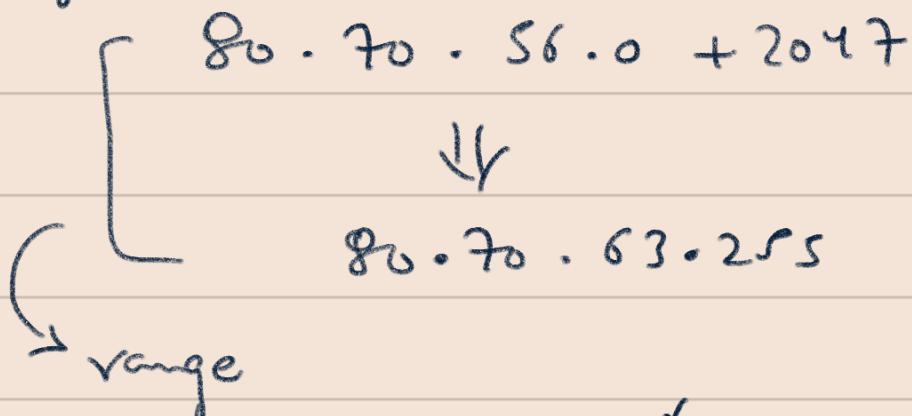
80.70.62.128 \Rightarrow net id

\Rightarrow Broadcast id:-

00000000. 00000000. 00000000. 00111111
01010000. 01000110. 00111110. 10000000 or
01010000. 01000110. 00111110. 10111111

80.70.62.191

Range of addresses :-



no of addresses was found earlier

↳ 2048

usable ranges :-

org 1: 80.70.56.1 - 80.70.57.254

org 2: 80.70.58.1 - 80.70.59.254

org 3: 80.70.60.1 - 80.70.60.254

org 4: 80.70.61.1 - 80.70.61.254

org 5: 80.70.62.1 - 80.70.62.62

org 6: 80.70.62.65 - 80.70.62.126

org 7: 80.70.62.129 - 80.70.62.190

remaining ↳ 2048 - 512 - 512 - 256

- 256 - 64 - 64 - 64

= 320

