Classful Addressing

netid	hostid
← n bits →	← (32 − n bits) →

Class A : n = 8
Class B : n = 16
Class C : n = 24

1. No. of addresses in the block = $N = 2^{32-n}$
2. First address in the block
   - We keep the n leftmost bits as it is and set the rest (32 − n) rightmost bits all to 0s.
3. To find the last address in the block
   - We keep the n leftmost bits as it is and set the rest (32 − n) rightmost bits all to 1s.

Problem 1

Address : 73.22.17.25

∴ It is a class A block, so, n = 8.

∴ $N = 2^{32-8} = 2^{24}$

First address = Network address = 73.0.0.0/8
↳ not assigned to any host.

Last address = 73.255.255.255. (Special address)

Problem 2

Address in a block = 180.8.17.9

- It is a class B address, so, n = 16.

∴ First address = 180.8.0.0/16
Last address = 180.8.255.255/16

Problem (3)

Address → 200.11.8.45

~~Address = 180.8.17.9~~

class C → $n = 24$.

~~class B → n=16~~

First address → 200.11.0.0

Last address → 200.11.255.255.

$N = 2^{32-24} = 2^{8} = 256$

Network Mask / Default Mask:

- A 32-bit number with n leftmost bits all set to 1s, and $(32-n)$ rightmost bits all set to 0s.

class A → 255.0.0.0
class B → 255.255.0.0
class C → 255.255.255.0

To extract the network address from the destination address, the router uses the $\boxed{\text{AND operation}}$.

Problem (4)

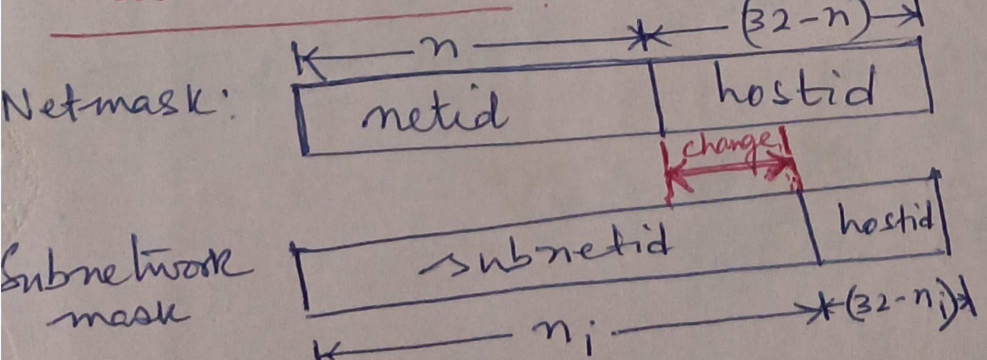
Destination address 201.24.67.32.

To find the network address :-

$$
\begin{array}{r}
201.24.67.32 \\
\text{AND} \quad 255.255.255.0 \\
\hline
201.24.67.0
\end{array}
$$

AND ed

Subnet mask



Subnetting increases the length of the netid and decreases the length of the hostid.

Illustration & Formulation

A network is divided into (s) no. of subnets, each of equal no. of hosts. The ~~the~~ subnetid for each subnetwork is –

$$\boxed{n_{sub} = n + \log_2 s}$$

where, n = length of the netid
n_{sub} = length of each subnetid
s = no. of subnets in the power of 2.

Problem 5

Network = 141.14.0.0/16

Suppose we need to divide into 4 subnets. Design the subnets.

$\therefore\ n = 16$
$s = 4$

length of each subnet $= n_{sub} = 16 + \log_2 4$
$= 16 + 2\log_2 2 = 18$

$\therefore\ n_1 = n_2 = n_3 = n_4 = 18$

$\therefore$ The subnetmask must have 18 1's and 14 0s, which is equal to which is 255.255.11000000.0,

255.255.192.0

Finding the subnet address

Given [An address in the subnetwork = 141.14.120.77
Subnet mask = 255.255.192.0

To find the subnet address → AND operation is done.

141.14.120.77
AND 255.255.192.0
141.14.64.0

01111000 → 120
AND 11000000 → 192
01000000 → 2^6 → 64

2|120
2|60 – 0
2|30 – 0
2|15 – 0
2|7 – 1
2|3 – 1
1 – 1

2|192
2|96 – 0
2|48 – 0
2|24 – 0
2|12 – 0
2|6 – 0
2|3 – 0
1 – 1

2|120
2|60 – 0
2|30 – 0
2|15 – 0
2|7 – 1
2|3 – 1
1 – 1

Problem 6

A company is granted an address 201.70.64.0. Design six subnets for the organization.

Soln: The company can have 8 subnets since $8 = 2^3$ whereas $6 \neq 2^3$ exactly.

Since, it is a class C address, so, default mask is 255.255.255.0.

Now, here $n = 24$, since class C.

$s = 8$

∴ No. of address in each subnet $= 2^5 = 32$

$$\therefore n_{sub} = n + \log_2 s$$
$$= 24 + 3 \log_2 2 = 27$$

∴ subnetmask = 11111111.11111111.11111111.11100000
= 255.255.255.224

$2^7 + 2^6 + 2^5$
$= 128 + 64 + 32$
$= 224$

The subnets are :-

201.70.64.0 1st — 201.70.64.31
201.70.64.32 2nd — 201.70.64.63
.64 3rd
.96 4th
⋮
201.70.64.224 8th — 201.70.64.255

Problem 7

A company is granted the site address 181.56.0.0. The company needs 1000 subnets. Design the subnets.

Soln:

The company can have 1024, not 1000, since, $2^x \neq 1000$

but $2^{10} = 1024$.

Since, it is a class B address, $n = 16$.

$\therefore n_{sub} = 16 + \log_2 1024 = 16 + 10 = 26$.

$\therefore$ subnetmask = 11111111.11111111.11111111.11000000

= 255.255.255.192

$\therefore$ No. of address in each subnet = $2^6 - 1 = 63$

$\therefore$ The subnets are :-

181.56.0.0 —— 181.56.0.63

181.56.0.64 —— 181.56.0.127

181.56.0.128 —— 181.56.0.191

181.56.0.192 —— 181.56.0.255

⋮

181.56.255.192

~~Supernetting~~

Supernetting

- An organization can combine several class C blocks to create a larger no of addresses.
- By doing this an organization can apply for several class C blocks instead of one.
- For 1000 addresses, the organization will be granted four blocks.

Illustration : Dividing 1 class C block into eight subblocks

Subnet mask: 11111111 11111111 11111111 11100000 — $n_{sub} = 24+3 = 27$

Default mask: 11111111 11111111 11111111 00000000 — $n = 24$

Supernet mask: 11111111 11111111 11111000 00000000 — $n_{super} = 24-3 = 21$

No. of sub-block $= 8 = 2^3 = s$

Subnet mask:

$$n_{sub} = n + \log_2 s$$
$$n_{sub} = 24 + 3 = 27$$

Supernet mask:

$$\boxed{n_{super} = n - \log_2 s}$$
$$= 24 - 3$$
$$= 21$$

where, n_{super} = length of supernet id

∴ 3rd byte must have m 0s

i.e. 2^m = no. of blocks.

P.T.O.

The 3rd byte of the first address must be divisible by no. of blocks (s).

ob-8

A company needs 1000 addresses. Which of the following set of class C blocks can be used to form a supernet for this company?

198.47.32.0 198.47.33.0 198.47.34.0

198.47.32.0 198.47.42.0 198.47.52.0 198.47.62.0

198.47.31.0 198.47.32.0 198.47.33.0 198.47.52.0

~~198.47~~.32.0 198.47.33.0 198.47.34.0. 198.47.35

soln:

Since 1000 addresses are required, so,

- four blocks are required (i.e. $2^{10}=1024$)
- Must be consecutive blocks.
- 3rd byte must be divisible by 4.

So, the 4th set.

Prob-9

We need to make a supernet out of 16 class C blocks. What is the supernet mask?

soln: $n = 24$

$S = 16$

11111111.11111111.11110000.00000000

$\underline{240}$

$n_{super} = 24 - 4 = 20$

i.e. in the ~~3rd byte of the~~ default mask, from the left, there must be 20 1s and rest (12) 0s.

Problem - 8 (Supernet)

First Address — 205.16.32.0
Supernet mask — 255.255.248.0
A router receives three packets with the following destination addresses:-

AND → third byte 248.

~~20~~5.16.37.44
205.16.42.56
207.17.33.76 ← This IP will not be even checked because its 2nd byte doesn't even matches with 16 in the 2nd byte of the given first address.

11001101.00010000.00100101.00101100
1111 1111.11111111.11111000.00000000

11001101.00010000.00100000.0

205.16.32.0

205.16.40.0

00101010
11111000

00101000
7 6 5 4 3 2 1 0

Problem - 9

First address — 205.16.32.0
Supernet mask - 255.255.248.0
m=3
11111000

$\therefore$ No. of blocks $= 2^m = 2^3 = 8$

2 | 248
2 | 124 — 0
2 | 62 — 0
2 | 31 — 0
2 | 15 — 1
2 | 7 — 1
2 | 3 — 1
1 — 1

~~32+8~~
~~= 40~~

$2^5+1+2+4$
$= 32+7 = 39$

By "NOT"ing the supernet mask = result
1st add (OR) Result = last address

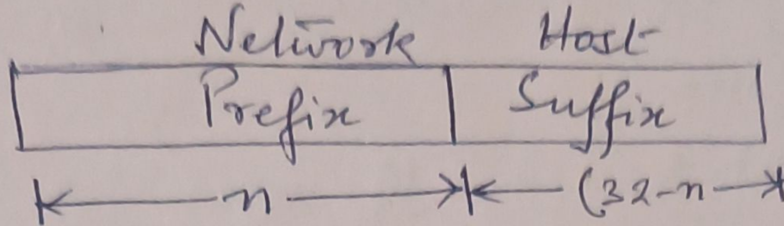
$1+2+4+32 = 39$

OR
205.16.00100000.0
0.0.00000111.255

⇒ 205.16.00100111.255
⇒ 205.16.39.255

and the range is 205.16.32.0 to 205.16.39.0

Problems on Class~~ful~~less Addressing



230.8.24.56/24 ⟶ n = 24 = prefix length

↓

slash(/) notation is called CIDR

167.199.170.82/27

⟶ means 27 1s and five 0s.

prefix = n = 27
suffix = 5
⟶ netmask = 255.255.255.224

$N = 2^{(32-n)}$

First Add. = (any address) AND (netmask)

Last Add. = (any address) OR [NOT(netmask)]

Prob 1:

One of the address in a block = 167.199.170.82/27

Find the 1st and the last address and also the number of addresses in the network? $= 2^{32-n} = 2^{32-n} = 2^5 = 3$

Ans: 1st Add. = 167.199.170.64/27
2nd Add. = 167.199.170.95/27

Prob 2:

One of the address = 17.63.110.114/24

N = 256, 1st Add. = 17.63.110.0/24
last add. = 17.63.110.255/24

Block Allocation (For assigning large block of addresses to ISPs)

Restrictions on CIDR :-

1. No. of addresses (N) must be a power of 2.

2. $N = 2^{32-n}$

$\therefore n = \log_2(2^{32}/N) = 32 - \log_2 N$

That is why N needs to be a power of 2.

3. Beginning address = $x \times 2^{32-n} \Rightarrow x \times N$, where $x = n$ in decimal decimal.

Designing the subnets

N = Total no. of address granted.

n = prefix length

N_{sub} = no. of addresses in each subnet

n_{sub} = subnetid / prefix length for each subnet.

s = total no. of subnets.

$$\boxed{n_{sub} = n + \log_2 (N/N_{sub})}$$

P.T.O

Prob-3:

Which of the following can be the beginning address of a block that contains 16 addresses?

205.16.37.32
190.16.42.44
17.17.33.80
123.45.24.52

192.168.5.30
40.

Soln: 205.16.37.32 ⇒ because 32 is divisible by 16.
17.17.33.80 ⇒ because 80 is divisible by 16.

Prob-4:

Which of the following can be the beginning address of a block that contains 1024 addresses?

Soln:
To be divisible by 1024, the rightmost byte must be 0 and the second rightmost byte must be divisible by

So, the address
205.16.37.32
190.16.42.0
17.17.32.0
123.45.24.52

meets this condition

Prob-5:

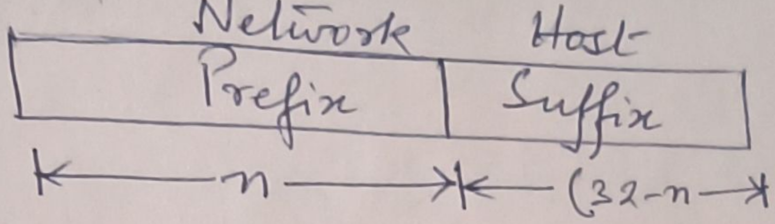
A small company is given a block with the beginning address 205.16.37.24/29. What is the range of the block

Soln: 11001111 00010000 00100101 00011000 ← Beginning ad
11001111 00010000 00100101 00011111 ← End addre

∴ The range is from 205.16.37.24/29 to
205.16.37.31/29

i.e. There are 8 addresses in the range.

Problems on Class~~ful~~less Addressing



230.8.24.56/24 → n = 24 = prefix length

↓

slash(/) notation is called CIDR

167.199.170.82/27

→ means 27 1s and five 0s.

prefix = n = 27
suffix = 5
→ netmask = 255.255.255.224

$N = 2^{(32-n)}$

First Add. = (any address) AND (netmask)

Last Add. = (any address) OR [NOT(netmask)]

Prob 1:

One of the address in a block = 167.199.170.82/27

Find the 1st and the last address and also the number of addresses in the network? $= 2^{32-n} = 2^{32-n} = 2^5 = 32$

Ans: 1st Add. = 167.199.170.64/27

2nd Add. = 167.199.170.95/27

Prob 2:

One of the address = 17.63.110.114/24

N = 256, 1st Add. = 17.63.110.0/24

Last add. = 17.63.110.255/24

(11)

Prob-3:

Which of the following can be the beginning address of a block that contains 16 addresses?

205.16.37.32
190.16.42.44
17.17.33.80
123.45.24.52

192.168.5.30
40

Soln: 205.16.37.32 ⇒ because 32 is divisible by 16.
17.17.33.80 ⇒ because 80 is divisible by 16.

Prob-4:

Which of the following can be the beginning address of a block that contains 1024 addresses?

Soln:
To be divisible by 1024, the rightmost byte must be 0 and the second rightmost byte must be divisible by 4.

So, the address
205.16.37.32
190.16.42.0
17.17.32.0 meets this condition.
123.45.24.52

Prob-5:

A small company is given a block with the beginning address 205.16.37.24/29. What is the range of the block?

Soln:
11001111 00010000 00100101 00011000 ← Beginning addr.
11001111 00010000 00100101 00011111 ← End address.

∴ The range is from 205.16.37.24/29 to
205.16.37.31/29

i.e. There are 8 addresses in the range.

Prob-6:

What is the network address if one of the address is $167.199.170.82/27$

2	82
2	41 – 0
2	20 – 1
2	10 – 0
2	5 – 0
2	2 – 1
	1 – 0

01010010

∴ The last byte : 01000000

i.e. $167.199.170.64/27$ (Ans)

Prob-7:

A company is granted the block $130.34.12.64/26$. The company needs four subnets, each with equal number of hosts. Design the subnets.

Soln: $n = 26$

$N = 2^{32-26} = 64 \rightarrow$ to be divided into four equal subnets.

∴ $N_{sub} = 64/4 = 16$

$s = 4$

$n_{sub} = 26 + \log_2 (64/16) = 28.$

∴ Subnet mask = $\underbrace{255.255.255.1111}_{28\ 1s}0000 \Rightarrow$

Performing AND operation :-

130.34.12.01000000

$\boxed{AND}$ 255.255.255.11110000

130.34.12.01000000

↓

$\Rightarrow$ ~~255.255.255~~.64/26

∴ The four subnets are :-

1st subnet : 130.34.12.64 ⟶ 130.34.12.79

2nd " 130.34.12.80 ⟶ –.–.–.95

3rd " 130.34.12.96 ⟶ –.–.–.111

4th " 130.34.12.112 ⟶ –.–.–.127

Prob-8 : (13)

An organization is granted a block with beginning address 14.24.74.0/24. It needs to have 3 subblocks as:-

1. One subblock → 120 addresses
2. One sub-block → 60 addresses
3. One sub-block → 10 addresses

Soln : $n = 24$

$N = 2^{32-24} = 256$

sub-blocks = 3

First part: Since, 120 is not a power of 2, therefore we take 128 addresses.

i.e. $N_{sub} = 128$

$\therefore n_{sub} = 24 + \log_2(256/128) = 25$

$\therefore$ subnet mask = 255.255.255.10000000

NOT : 0.0.0.01111111

14.24.74.00000000

OR 0.0.0.01111111

14.24.74.01111111

$2^6+2^5+2^4+2^3+2^2+2^1+2^0$

⇒ 14.24.74.127/25

$\therefore$ 1st sub-block → 14.24.74.0/25 — 14.24.74.127/25

2nd part: Since, 60 is not a power of 2, therefore we take 64 addresses

i.e. $N_{sub} = 64$, $n = 24$, $N = 256$

$\therefore n_{sub} = 24 + \log_2\left(\frac{256}{64}\right) = 26$

$\therefore$ subnet mask = 255.255.255.11000000

NOT : 0.0.0.00111111

First address

14.24.74.128/26

OR 0.0.0.00111111

14.24.74.10111111

14.24.74.191/26