# CS & IT ENGINEERING

# COMPUTER NETWORKS

IPv4 Addressing

Lecture No-10

By- Ankit Doyla Sir

TOPICS TO BE COVERED

Subnetting Part-2

**Q.3**

$$\underset{157 \cdot 157}{\overset{NID}{\underbrace{\phantom{157 \cdot 157}}}} \quad \underset{0 \cdot 0}{\overset{HID}{\underbrace{\phantom{0 \cdot 0}}}}$$

**Class-B**

$$\frac{NID}{16} \quad \frac{HID}{16}$$

| 64 subnet |

$$\frac{16}{NID} \quad \frac{6}{SID} \quad \frac{10}{HID}$$

Sol Q.1 → 8<sup>th</sup> Subnet → Subnet id, DBA

157.157 $\underbrace{\text{---- ----}}_{\text{SID}}$ $\underbrace{\text{---------------}}_{\text{HID}}$

157.157. $\underline{00011100}$.00000000 → 157.157.28.0 ] SID

157.157. $\underline{000111}$11. 11111111 → 157.157.31.255 ] DBA

or

$\underbrace{128\ 64\ 32\ 16\ 8\ 4}_{0\ 0\ 0\ 1\ 1\ 1}$

$4 \times 256 = 2^2 \times 2^8 = 2^{10}$

<u>Sol<sup>n</sup> Q·2</u> : 17<sup>th</sup> subnet → Subnet id, DBA

$157 \cdot 157 \cdot$ ----------  ------------

                      SID          HID

$157 \cdot 157 \cdot \underline{01000000} \cdot 00000000 \rightarrow 157 \cdot 157 \cdot 64 \cdot 0 ]$ SID

$157 \cdot 157 \cdot 01000011 \cdot 11111111 \rightarrow 157 \cdot 157 \cdot 67 \cdot 255 ]$ DBA

$\underline{Sol^n}$ Q 3 → $28^{th}$ subnet → Subnet-id, DBA

157.157. 0110 1100.00000000 → 157.157.108.0 ] SID

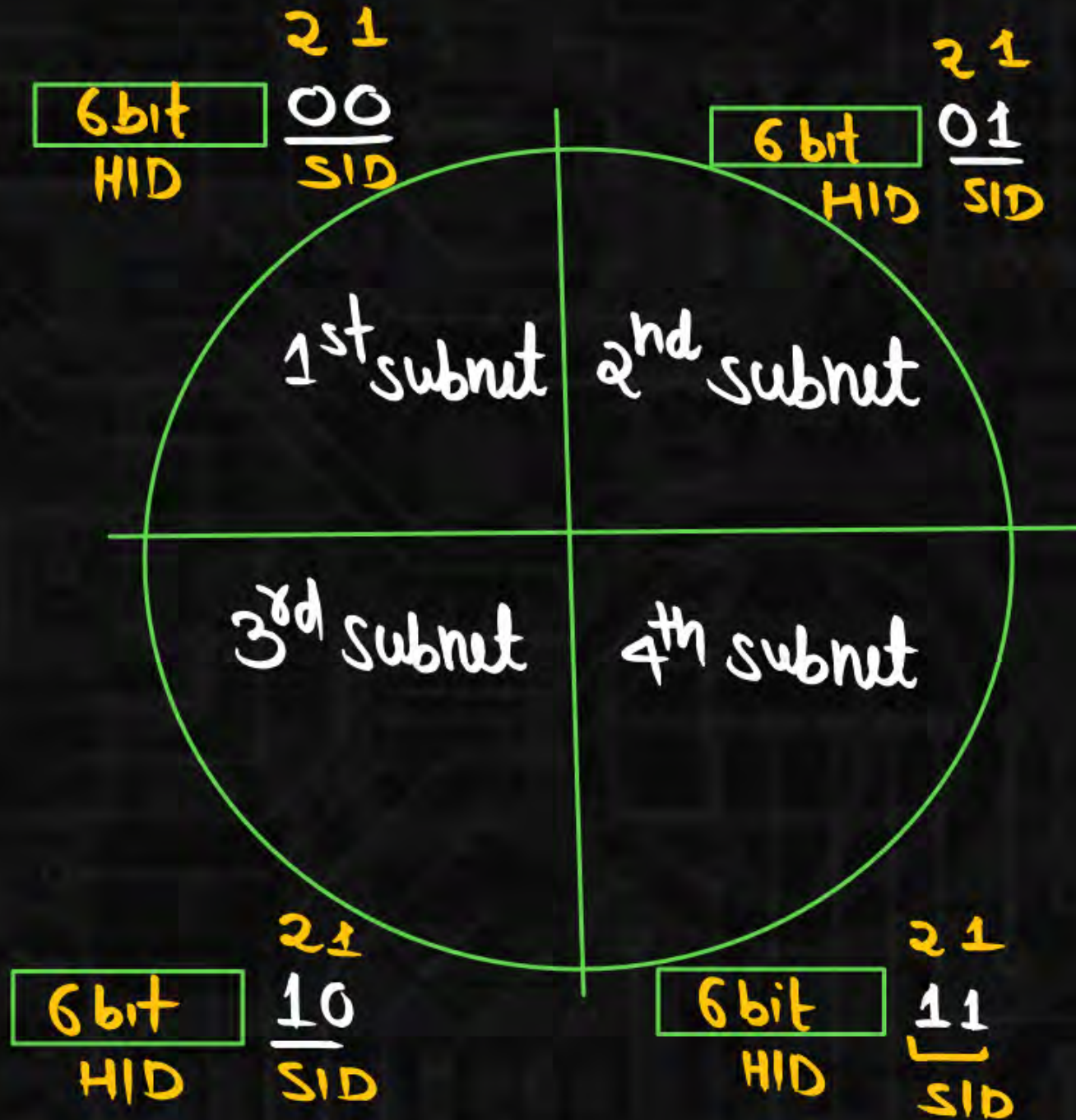157.157.0110 11 11.11111111 → 157.157.111.255 ] DBA

# Q.4
ISRO

$$\overset{NID}{\overline{200 \cdot 200 \cdot 200 \cdot}} \overset{HID}{\overline{0}}$$



## Class-C

$$\underset{NID}{24} \quad \underset{HID}{8}$$

4 Subnet

$$\underset{NID}{24} \quad \underset{HID}{6} \quad \underset{SID}{2}$$

$2^2 = 4 \text{ subnet}$

$2^6 \text{ IP Add/subnet}$

$2^6 - 2 = 62 \text{ Host/Sub}$

6bit HID $\overset{21}{\underset{SID}{00}}$

6bit HID $\overset{21}{\underset{SID}{01}}$

1st subnet 2nd subnet

3rd subnet 4th subnet

6bit HID $\overset{21}{\underset{SID}{10}}$

6bit HID $\overset{21}{\underset{SID}{11}}$

# 1ˢᵗ subnet

200·200·200 $\underbrace{------}_{HID}$ $\underset{SID}{\underline{00}}$

200·200·200· 000000 $\underline{00}$ → 200·200·200·0 ] SID

200·200·200· 000001 $\underline{00}$ → 200·200·200·4

200·200·200· 000010 $\underline{00}$ → 200·200·200·8

200·200·200· 000011 $\underline{00}$ → 200·200·200·12

⋮

200·200·200· 111110 $\underline{00}$ → 200·200·200·248

200·200·200· 111111 $\underline{00}$ → 200·200·200·252 ] DBA

# shortcut

1st subnet
$\begin{cases} \text{SID} & 200.200.200.0 \\ \text{DBA} & 200.200.200.252 \end{cases}$

2nd subnet
$\begin{cases} \text{SID} & 200.200.200.1 \\ \text{DBA} & 200.200.200.253 \end{cases}$

3rd subnet
$\begin{cases} \text{SID} & 200.200.200.2 \\ \text{DBA} & 200.200.200.254 \end{cases}$

4th subnet
$\begin{cases} \text{SID} & 200.200.200.3 \\ \text{DBA} & 200.200.200.255 \end{cases}$

SID = 2 bit

00 X
01 ⎫
10 ⎭ Valid subnet
11 X

According to RFC No-950

No. of subnet = $2^2 - 2 = 2$

---

SID = 3 bit

000 X
001 ⎫
010 ⎪
011 ⎬ Valid subnet
100 ⎪
101 ⎪
110 ⎭
111 X

No. of subnet = $2^3 - 2 = 6$

---

According to RFC - 950

If SID = $n$ bit

No. of subnet = $2^n - 2$

According to latest RCF No (1812)

If SID = $n$ bit
No. of subnet = $2^n$

## Note:

In the past, there were limitations to the use of a subnet 0 (all subnet bits are set to zero) and all ones subnet (all subnet bits set to one). Some devices would not allow the use of these subnets.

## Problems with Subnet Zero and the All-Ones Subnet:

Traditionally, it was strongly recommended that subnet zero and the all-ones subnet not be used for addressing. This means the values of all zeros and all ones in the subnet field should not be assigned to actual (physical) subnets." This is the reason why network engineers required to calculate the number of subnets obtained by borrowing three bits would calculate $2^3 - 2(6)$ and not 2^3 (8). The -2 takes into account that subnet zero and the all-ones subnet are not used traditionally

" Today, the use of subnet zero and the all-ones subnet is generally accepted and most vendors support their use. However, on certain networks, particularly the ones using legacy software, the use of subnet zero and the all-ones subnet can lead to problems".

Subnetting Category-2

## Subnet Mask

It is a 32 bit number used to indicate number of bits borrowed from host –id and there positions based on the following rules:

**Rule1:** Number of 1's in the subnet mask indicate NID + SID

**Rule2:** Number of 0's in the subnet mask indicate HID part

## Default subnet Mask

For class-A : 255.0.0.0

For class-B : 255.255.0.0

For class-C : 255.255.255.0

## Class-A

255.0.0.0

11111111.00000000.00000000.00000000

No. of 1's = 8 , No. of 0's = 24

NID + SID = 8 | HID = 24

8 + SID = 8

SID = 0 bit

**Q.** If NID = 200.200.200.0 and the subnet Mask = $\rightarrow$ class-c , NID=24 bit, HID=8 bit

255.255.255.192 then identify:

**I.** Number of bit borrowed from Host-id.

Ans: 2

**II.** Number of subnet possible and their subnet id's.

Ans: 4

**III.** Number of Host/subnet. Ans: 62

Soln: SM: 255.255.255.192

11111111 . 11111111 . 11111111 . 11000000
        NID                      SID    HID

No. of 1's = 26 , No. of 0's = 6

NID+SID=26        HID=6 bit
24+SID=26
SID=2 bit         No. of Host/subnet = $2^6-2=62$
No. of subnet=$2^2=4$

## Subnet id's

$$200 \cdot 200 \cdot 200 \cdot \underset{\text{SID}}{\underset{\uparrow}{\square\square}} \overset{128\,64}{} \underset{\text{HID}}{\underline{------}}$$

$200 \cdot 200 \cdot 200 \cdot \underline{00}\,000000 \rightarrow 200 \cdot 200 \cdot 200 \cdot 0$ ⎫

$200 \cdot 200 \cdot 200 \cdot \underline{01}\,000000 \rightarrow 200 \cdot 200 \cdot 200 \cdot 64$ ⎪ Subnet id's

$200 \cdot 200 \cdot 200 \cdot \underline{10}\,000000 \rightarrow 200 \cdot 200 \cdot 200 \cdot 128$ ⎬

$200 \cdot 200 \cdot 200 \cdot \underline{11}\,000000 \rightarrow 200 \cdot 200 \cdot 200 \cdot 192$ ⎭

## Subnet id's (AD Rule)

$$\overset{128\;64}{\underline{\phantom{xx}}}$$

$0 \; 0 \rightarrow 0$

$0 \; 1 \rightarrow 64$  ⎫ Subnet id's

$1 \; 0 \rightarrow 128$ ⎬

$1 \; 1 \rightarrow 192$ ⎭

**Q.** If NID = 200.200.200.0 and the subnet Mask = 255.255.255.224 then identify:

$\Gamma^{\circ}$ Class-C, NID=24bit, HID=8bit

I. Number of bit borrowed from Host-id.

II. Number of Subnet possible and their subnet id's.

III. Number of Host/Subnet.

Soln: SM. 255.255.255.224

11111111 . 11111111 . 11111111 . 111 00000

NID      SID   HID

SID=3bit

No. of Subnet = $2^3$ = 8

HID=5bit

No. of Host/Subnet = $2^5 - 2 = 30$

SID = 3bit (AD Rule)

128 64 32

0 0 0 → 0

0 0 1 → 32

0 1 0 → 64

0 1 1 → 96

1 0 0 → 128

1 0 1 → 160

1 1 0 → 192

1 1 1 → 224

**Q.** If NID = 200.200.200.0 and the subnet Mask = 255.255.255.44 then identify

**I.** Number of bit borrowed from Host-id

**II.** Number of subnet possible and their subnet id's

**III.** Number of Host/subnet

$SM: \underbrace{||||''|||.||||||||.|||||||}_{NID}.\overset{32\quad 84}{00\underset{HH}{1}\underset{SH}{0}\underset{S}{1}\underset{S}{1}\underset{HH}{00}}$

$SID = 3bit$

$No\cdot of\ subnet = 2^3 = 8$

$HID = 5bit$

$No\cdot of\ Host/subnet = 2^5 - 2 = 30$

SID = 3 bit (AD Rule)

$$32 \quad 8 \quad 4$$

$$0 \quad 0 \quad 0 \rightarrow 0$$
$$0 \quad 0 \quad 1 \rightarrow 4$$
$$0 \quad 1 \quad 0 \rightarrow 8$$
$$0 \quad 1 \quad 1 \rightarrow 12$$
$$1 \quad 0 \quad 0 \rightarrow 32$$
$$1 \quad 0 \quad 1 \rightarrow 36$$
$$1 \quad 1 \quad 0 \rightarrow 40$$
$$1 \quad 1 \quad 1 \rightarrow 44$$

**Q.**

If NID = 200.200.200.0 and the subnet Mask = 255.255.255.200 then identify

**I.** Number of bit borrowed from Host-id

**II.** Number of subnet possible and their subnet id's

**III.** Number of Host/subnet

**Q.** → Class-B, NID=16, HID=16

If NID = 173.173.0.0 and the subnet Mask = 255.255.128.128 then identify

I. Number of bit borrowed from Host-id

II. Number of subnet possible and their subnet id's

III. Number of Host/subnet

Sol$^n$: SM 255·255·128·128

$$\underbrace{11111111 \cdot 11111111}_{NID} \cdot \underset{S}{-}\underbrace{10000000}_{HID} \cdot \underset{S}{-}\underbrace{10000000}_{HID}$$

SID = 2 bit

No. of subnet = $2^2$ = 4

HID = 14 bit

No. of Host/subnet = $2^{14}$ - 2

# Subnet id's

173.173.$\boxed{\phantom{0}}$ — — — — — · $\boxed{\phantom{0}}$ — — — — —
       NID    SID    HID          SID    HID

(128 above first SID box, 128 above second SID box)

173.173. $\underline{0}$ 0000000. $\underline{0}$ 0000000 → 173.173.0.0

.$\underline{0}$ 0000000. $\underline{1}$ 0000000 → 173.173.0.128

.$\underline{1}$ 0000000. $\underline{0}$ 0000000 → 173.173.128.0

.$\underline{1}$ 0000000. $\underline{1}$ 0000000 → 173.173.128.128

## AD Rule

128  128

$\boxed{\phantom{0}}$ · $\boxed{\phantom{0}}$

0 · 0 → 0.0

0 · 1 → 0.128

1 · 0 → 128.0

1 · 1 → 128.128

**Q.**

If NID = 173.173.0.0 and the subnet Mask = 255.255.255.0 then identify

I. Number of bit borrowed from Host-id

II. Number of subnet possible and their subnet id's

III. Number of Host/subnet

Problem Solving

**Q.** Which of the following is the default mask for the address 198.0.46.201? (Assuming Classful addressing scheme is followed)

(A.) 255.0.0.0

(B.) 255.255.255.0

(C.) 255.255.0

(D.) 255.255.255.255

*Class-C [192-223]*

↓

*default mask*

*255·255·255·0*

**Q.** If a class B network on the Internet has a subnet mask of 255.255.248.0. What is the maximum number of hosts per subnet? (Assuming Classful addressing scheme is followed)

GATE 2008

A. 1022

B. 1023

C. 2046

D. 2047

11111111 . 11111111 . 11111000 . 00000000

$\underbrace{\qquad\qquad\qquad\qquad}_{HID}$

HID = 11 bit

No. OF Host/Subnet = $2^{11} - 2$

$= 2 * 2^{10} - 2$

$= 2048 - 2 = 2046$

**Q.** A subnet has assigned a subnet mask of 255.255.255.192. What is the maximum number of hosts that can belong to this subnet?

A. 14

B. 30

C. 62

D. 126

$$\underbrace{||||||| \cdot |||||| \cdot |||||| \cdot || \underbrace{000000}_{HID}}$$

$$HID = 6 \text{ bit}$$

$$No. \text{ OF Host} | \text{ subnet } = 2^6 - 2 = 62$$

**Q.** In a class B network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts per subnet? (Assuming Classful addressing scheme is followed)

(A.) 4096

(B.) 4094 ✓

(C.) 4092

(D.) 4090

**Q.** An organization has a class B network and wishes to form subnets for 64 departments. The subnet mask would be:

A. 255.255.0.0

B. 255.255.64.0

C. 255.255.128.0

D. 255.255.252.0

class-B

$$\frac{NID}{16} \quad \frac{HID}{16}$$

64 subnet

$$\frac{16}{NID} \quad \frac{6}{SID} \quad \frac{10}{HID}$$

No. of 1's in the subnet mask = NID + SID = 16 + 6 = 22

No. of 0's in the subnet mask = HID = 10

11111111. 11111111. 11111100. 00000000 → 255.255.252.0

**Q.** Consider default subnet mask for a network is 255.255.255.0. →class-c

How many number of hosts per subnet possible if 'm' bits are borrowed from Host ID (HID)

A. $2^{HID-m} - 2$

B. $2^{HID}$

C. $2^{HID} - m$

D. $2^m$

class-c

$\underline{NID \quad HID}$

$\frac{M}{SID} \quad \frac{HID-M}{HID}$

No. of Host/subnet $= 2^{HID-M} - 2$

**Q.** A university has LANs with 100 hosts in each LAN. If it uses class B then the subnet mask in Dotted Decimal Notation is _____.

Class-B

$\dfrac{\text{NID}}{16}$  $\dfrac{\text{HID}}{16}$

$\boxed{\text{100 Host in each LAN}}$

$\dfrac{\text{NID}}{16}$  $\dfrac{\text{SID}}{9}$  $\dfrac{\text{HID}}{7}$

No. of 1's in the S.M = NID + SID = 16 + 9 = 25

No. of 0's " " " = HID = 7

11111111 · 11111111 · 11111111 · 10000000

255·255·255·128

A university has 150 LANs. Use Class B address and then the subnet mask in Doted Decimal notation is _____