CS & IT ENGINEERING

2025

Computer Network

IPv4 Addressing

Lecture No. - 04

By - Abhishek Sir

Topic — Subnetting

Topic — Subnet Mask

Topic Subnetting

Topic Subnet Mask

ABOUT ME

Hello, I'm **Abhishek**

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→ Dividing (logically) a network into smaller manageable sub-networks

→ Sub-network (subnet) : Clustering of hosts inside a network

→ Clustering of hosts based on some bits of host identifier (HostId) field
  [In practice, most significant bits of host identifier]

→ Before subnetting, IP address having two sections :

1. Network Identifier (Net ID)   : x - bits

2. Host Identifier   (Host ID) : y - bits

→ Size of IP address field = (x + y) bits

→ After subnetting, IP address having three sections :

    1. Network Identifier   (Net ID)   : x - bits

    2. Sub-network Identifier (Subnet ID) : y_1 - bits

    3. Host Identifier   (Host ID)   : y_2 - bits

y bit
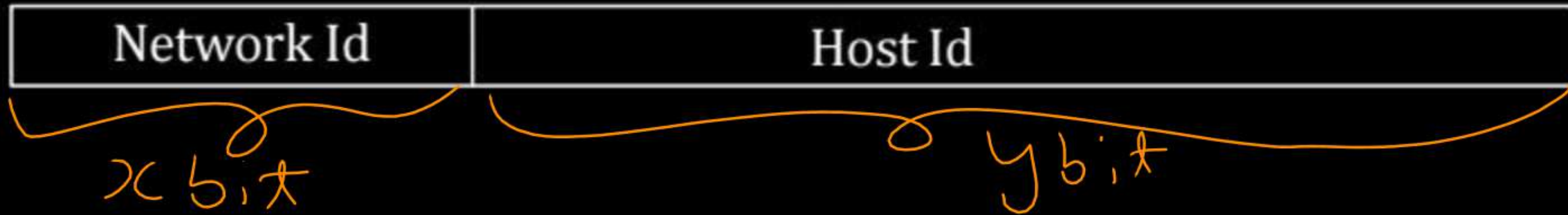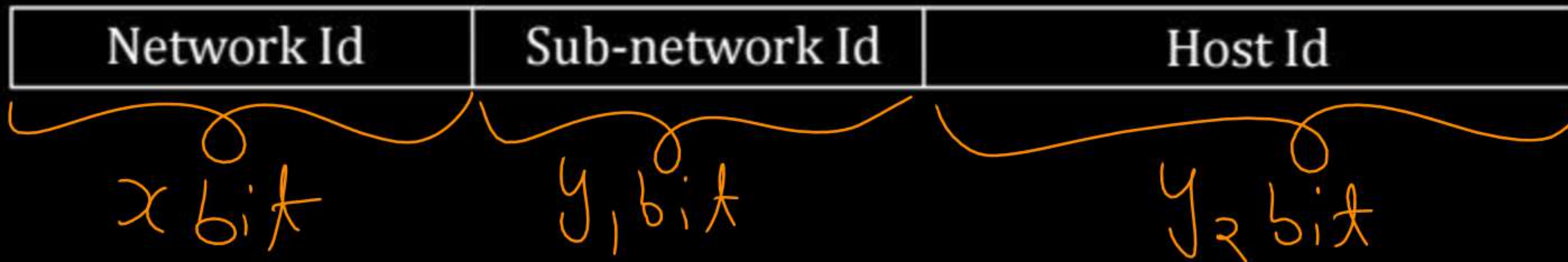
→ Size of IP address field = $(x + y_1 + y_2)$ bits

$[\, y = y_1 + y_2 \,]$

Before Subnetting

Network Id	Host Id

x bit y bit

After Subnetting

Network Id	Sub-network Id	Host Id

x bit y_1 bit y_2 bit

→ Special IP address (32-bits)

→ Used to represent a sub-network

NetID field   =   As Assigned

Subnet ID   =   Anything

HostID field   =   All Zero Bits

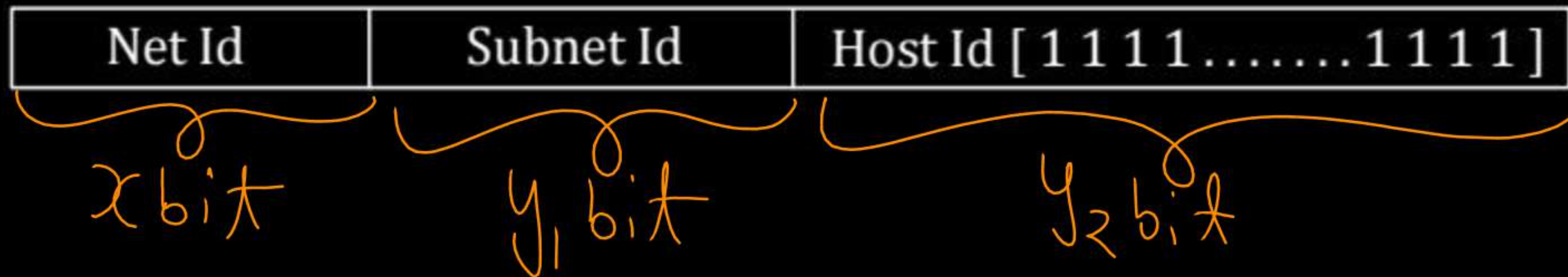| Net Id	Subnet Id	Host Id [0 0 0 0 ..... 0 0 0 0]

x bit y_1 bit y_2 bits

→ Special IP address (32-bits)

→ Used to broadcast a packet to all hosts belongs to a sub-network

NetID field	=	As Assigned
Subnet ID	=	Anything
HostID field	=	All One Bits

Net Id	Subnet Id	Host Id [1 1 1 1 .... 1 1 1 1]
x bit	y_1 bit	y_2 bit

→ Host IP address (32-bits)

→ Used to identify a host uniquely world wide

NetID field   (x - bits)   =   As Assigned

Subnet ID field (y_1 - bits)   =   [Anything]

HostID field   (y_2 - bits) =   [Any thing]

[Except all zero and all one bits]

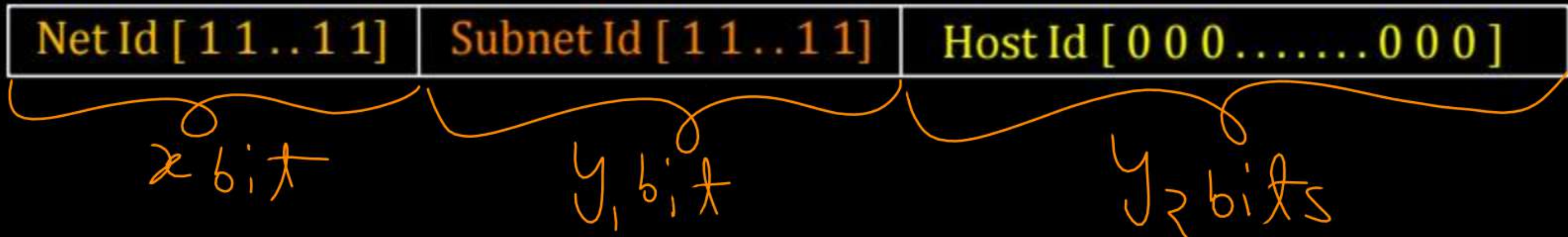| Net Id	Subnet Id	Host Id

→ Sub-network Mask (Subnet mask) [32-bits]

NetID field	=	All One Bits
Subnet ID field	=	All One Bits
HostID field	=	All Zero Bits

→ Used to generate subnet address from a given IP address

Net Id [1 1 .. 1 1]	Subnet Id [1 1 .. 1 1]	Host Id [0 0 0 .... 0 0 0]

x bit y_1 bit y_2 bits

Class C network (Network Address : 200 . 200 . 200 . 0), with 3-bit subnetting.

Host ID 8 bit

[0 0 0 0 0 0 0 0]

Network Address   : 200 . 200 . 200 . 0 ✓

Broadcast Address : 200 . 200 . 200 . 255

[1 1 1 1 1 1 1 1]

(Network Directed)

Network Mask   : 255 . 255 . 255 . 0
[Default]

Before Subnetting :-

First Host IP Address : 200 . 200 . 200 . 1

[0 0 0 0 0 0 0 1]

Last Host IP Address : 200 . 200 . 200 . 254

[1 1 1 1 1 1 1 0]

Network Size $= [2^8 - 2] = 254$ hosts in the network

After 3-bit Subnetting :-

$$\underbrace{\text{Net ID}}_{24 \text{ bit}} \quad \underbrace{\text{Subnet ID } 3\text{bit}}_{} \quad \underbrace{\text{Host ID}}_{5 \text{ bit}}$$

Sub-network Address : 200 . 200 . 200 . _ _ _ 0 0 0 0 0

    First Host IP Address : 200 . 200 . 200 . _ _ _ 0 0 0 0 1

    Last Host IP Address : 200 . 200 . 200 . _ _ _ 1 1 1 1 0

Subnet Broadcast Address : 200 . 200 . 200 . _ _ _ 1 1 1 1 1
(Sub-network Directed)

First Sub-network Address : 200 . 200 . 200 . 0   [0 0 0 0 0 0 0 0]

    First Host IP Address : 200 . 200 . 200 . 1   [0 0 0 0 0 0 0 1]

    Last Host IP Address : 200 . 200 . 200 . 30   [0 0 0 1 1 1 1 0]

First Subnet Broadcast Address : 200 . 200 . 200 . 31   [0 0 0 1 1 1 1 1]
(Sub-network Directed)

Second Sub-network Address : 200 . 200 . 200 . 32   [0 0 1 0 0 0 0 0]

    First Host IP Address : 200 . 200 . 200 . 33   [0 0 1 0 0 0 0 1]

    Last Host IP Address : 200 . 200 . 200 . 62   [0 0 1 1 1 1 1 0]

Second Subnet Broadcast Address : 200 . 200 . 200 . 63   [0 0 1 1 1 1 1 1]
(Sub-network Directed)

Last Sub-network Address : 200 . 200 . 200 . 224 $[11100000]$

First Host IP Address : 200 . 200 . 200 . 225 $[11100001]$

Last Host IP Address : 200 . 200 . 200 . 254 $[11111110]$

Last Subnet Broadcast Address : 200 . 200 . 200 . 255 $[11111111]$
(Sub-network Directed)

Sub-network Mask : $\overset{255 . 255 . 255 . 11100000}{255 . 255 . 255 . 224}$

Sub-network Size $= (2^5 - 2)$ hosts per subnet

Network Size $= 2^3 * (2^5 - 2) = 240$ hosts in the network

Limited Broadcast Add.
$= 255.255.255.255$

→ Sub-network Size : Maximum possible number of hosts can be in a sub-network

For IP address (32-bits)

NetID field   (x - bits)

Subnet ID field $(y_1$ - bits)

HostID field $(y_2$ - bits)

Sub-network Size = $[2^{y_2} - 2]$ hosts per subnet

For IP address (32-bits)

NetID field   (x - bits)

Subnet ID field (y_1 - bits) }

HostID field   (y_2 - bits)

Number of subnets = $[2^{y_1}]$ subnets per network

old time
No of subnets
$= \{2^{y_1} - 2\}$

→ Network Size : Maximum possible number of hosts can be in a network

For Host IP address (32-bits)

NetID field (x - bits)

Subnet ID field (y_1 - bits)

HostID field (y_2 - bits)

Network Size = Number of Subnets per network * Sub-network size

$$= [2^{y_1}] * [2^{y_2} - 2] \text{ hosts per network}$$

Topic : Reduction in networks size

$$[y = y_1 + y_2]$$

Network Size (before subnetting)

$$S_1 = [2^{(y_1+y_2)} - 2] \text{ hosts per network} = [2^y - 2]$$

Network Size (after subnetting) $[y_1 \text{ bit subnetting}]$

$$S_2 = [2^{y_1}] * [2^{y_2} - 2] \text{ hosts per network}$$

$$= [2^{(y_1+y_2)} - 2^{(y_1+1)}] \text{ hosts per network}$$

$$\boxed{S_1 > S_2}$$

Reduction in Network Size (after subnetting)

$$S_1 - S_2 = [2^{(y_1+1)} - 2] \text{ hosts per network} = [2*2^{y_1} - 2]$$

#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

Ans: D

Class B :-
Net ID ⟹ 16 bit

No. of subnets = 64

No. of bits for subnet ID
$$= \lceil \log_2 (\text{No. of subnet}) \rceil \text{ bits}$$
$$= \lceil \log_2 (64) \rceil \text{ bits}$$
$$= 6 \text{ bit}$$

6-bit subnetting

Subnet Mask =
255.255.11111100.
           00000000
255.255.252.0

#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?

[GATE-2008]

(A) 1022

(B) 1023

(C) 2046

(D) 2047

Ans : C

Class B :-
NetID ⟹ 16 bit

Subnet Mask = 255.255.248.0

255.255.11111000.00000000

NetID   5 bit   11 bit
16 bit   SubnetID   HostID

Subnet Size = $[2^{11} - 2]$ hosts per subnet
= 2046 hosts —//—

#Q. The address of a class B host is to be split into subnets with a 6-bit subnet number. What is the maximum number of subnets and the maximum number of hosts in each subnet?

[GATE-2007]

(A) 62 subnets and 262142 hosts.

(B) 64 subnets and 262142 hosts.

(C) 62 subnets and 1022 hosts.

(D) 64 subnets and 1024 hosts

Ans: C

Class B:-

Net ID $\Rightarrow$ 16 bit

Subnet ID $\Rightarrow$ 6 bit

max^m no. of subnets = 2^6 subnets

$= (2^6 - 2)$ subnet

Host ID $= (16 - 6) = 10$ bit

Subnet Size $= (2^{10} - 2)$ hosts per subnet

$= 1022$ hosts $-//-$

#Q. A subnetted Class B network has the following broadcast address :

144 . 16 . 95 . 255. Its subnet mask

(A) is necessarily 255 . 255 . 224 . 0   H.W.

(B) is necessarily 255 . 255 . 240 . 0

(C) is necessarily 255 . 255 . 248 . 0

(D) could be any one of 255 . 255 . 224 . 0, 255 . 255 . 240 . 0, 255 . 255 . 248 . 0

Classless network (Network Address : 40 . 50 . 64 . 0 / 19), with 4-bit subnetting.

Network Address   : 40 . 50 . 64 . 0 / 19

Broadcast Address   : 40 . 50 . 95 . 255 / 19
(Network Directed)

40 . 50 . 01000000 . 00000000
NetID (19bit)   HostID (13bit)

40 . 50 . 010 11111 . 11111111

Before Subnetting :-

First Host IP Address : 40 . 50 . 64 . 1 / 19

Last Host IP Address : 40 . 50 . 95 . 254 / 19

Network Size = $[2^{13} - 2]$ hosts in the network

40 . 50 . 010 ____ . _____
19bit   4bit   9bit HostID
NetID   Subnet ID

After 4-bit Subnetting :-

Sub-network Address : 40.50.010 _ _ _ _ 0.00000000/23

First Host IP Address : 40.50.010 _ _ _ _ 0.00000001/23

Last Host IP Address : 40.50.010 _ _ _ _ 1.11111110/23

Subnet Broadcast Address : 40.50.010 _ _ _ _ 1.11111111/23
(Sub-network Directed)

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THANK - YOU