Module - 5

Network Layer

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Logical Addressing

IPv4 Addressing

- It is an 32-bit address that uniquely and universally defines the connection of device to the Internet.
- Address Space = 2^{32} OR 4,294,967,296

Representation:

128.11.3.3

10000000 00001011 00000011 00011111

Classful Addressing

	First Byte	Second Byte	Third Byte	Fourth Bit
Class A	0 0-127			
Class B	10 128-191			
Class C	110 192-223			
Class D	1110 224-239			
Class E	1111 240-255			

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Class	Net ID	Host ID	Application
A	8	24	Unicast
B	16	16	Unicast
C	24	8	Unicast
D	32	0	Multicast
E	32	0	Multicast

⇒ No. of Blocks in each class = 2^n

n = No. of Net ID bits - reserved bits in class for net ID

⇒ First IP address in each class is reserved for network address and last IP address of each class except D and E are reserved for broadcasting.

⇒ Loopback Address : 127.0.0.1

⇒ In classful IP addressing, a large part of the available addresses were wasted.

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Default Mask in classful addressing

Class	Binary	Decimal	CIDR
A	11111111 00000000 00000000 00000000	255.0.0.0	/8
B	11111111 11111111 00000000 00000000	255.255.0.0	/16
C	11111111 11111111 11111111 00000000	255.255.255.0	/24

⇒ First address of a block can be found by setting rightmost $32-n$ bits into 0's, where n is the no. of 1's present in the default mask i.e. CIDR in the given IP address.

⇒ Last address of a block can be found by setting rightmost $32-n$ bits into 1's.

⇒ No. of addresses in a block $= 2^{32-n}$

⇒ CIDR in Subnetting

For 32 IP addresses in a subnet,

$32 = 2^5 \Rightarrow 32-5 = 27 \Rightarrow /27$

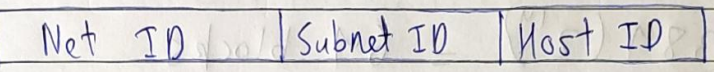
⇒ $n-s$, where n is no. of IP addresses in a subnet in the power of 2 substracted by the power of 2 of the no. of IP addresses count.

128 64 32 16 8 4 2 1
1 0 1 1 0 __/__/____

Beginning address + Address in the block → AND ← Mask

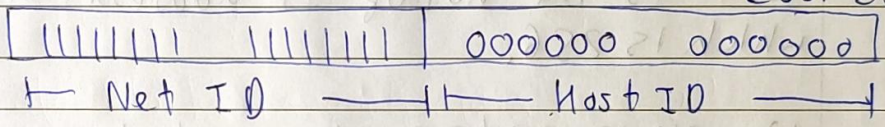
Subnet Addresses

⇒ Host ID can be divided into two parts subnet ID and host ID.



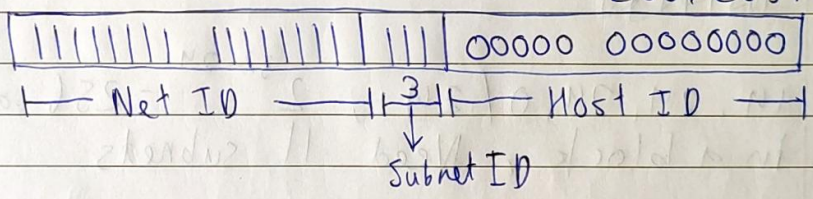
Default Mask

255. 255. 0. 0



Subnet Mask

255. 255. 224. 0



⇒ 3 Subnet ID bits = 2^3 = 8 subnets

⇒ No. of Subnets in subnet ID = 2^n, where n is no. of subnet bits.

⇒ No. of IP addresses in each subnet :

2^k, k → No. of bits in host ID − no. of bits used in subnet ID.

Example 141.14.0.0

S_1 : 141.14.0.0 – 141.14.63.255
S_2 : 141.14.64.0 – 141.14.127.255
S_3 : 141.14.128.0 – 141.14.191.255
S_4 : 141.14.192.0 – 141.14.255.255

⇒ $\frac{16384\ (2^{14})}{256} = 64$ blocks

⇒ 256 is the no. of IP addresses in a block (0-255) which is 256.

Q 130.34.12.64/26, four subnets

Q 14.24.74.0/24, $2^{32-24} = 256$ addresses in a block, Need 11 subnets

(a) two subnets, each with 64 addresses

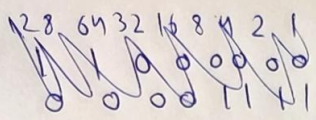
$64 = 2^6 = 2^{32-n}$ ⇒ $6 = 32-n$
⇒ $n = 32-6 = 26$

Range: 14.24.74.0 – 14.24.74.63/26
14.24.74.64 – 14.24.74.127/26

(b) two subnets with, each having 32 addresses

⇒ $2^5 = 32 = 2^{32-n}$ ⇒ $n = 27$

Range: 14.24.74.128 – 14.24.74.159/27
14.24.74.160 – 14.24.74.191/27



3 D11000000 4

4 _/_/___

(c) 3 subnets with each having 16 addresses

Ans $32 - 4 = /28$

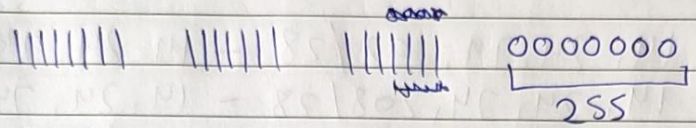
Range = 14.24.74.192/28 – 14.24.74.207/28
14.24.74.208/28 – 14.24.74.223/28
14.24.74.224/28 – 14.24.74.239/28

(d) 4 subnets with each having 4 addresses

1010 __/__/____

Q 159.50.10.60/24

Ans First address 159.50.10.0



=> 159 . 50 . 10 . 0

Q

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Address Allocation

a) It is the responsibility of ICANN i.e. Internet Corporation for Assigned Names and Network.

Q 190.100.0.0/16 (65,536 addresses)

(a) 64 customers, each need 256 addresses

a) $2^8 = 256 \Rightarrow 32 - 8 = 24$

a) C1: 190.100.0.0/24 – 190.100.0.255/24
C2: 190.100.1.0/24 – 190.100.1.255/24
⋮
C64: 190.100.63.0/24 – 190.100.63.255/24

(b) 128 customers, each need 128 addresses

a) $2^7 = 128 \Rightarrow 32 - 7 = 25$

a) C65: 190.100.64.0/25 – 190.100.64.127/25
C66: 190.100.64.128/25 – 190.100.64.255/25
⋮
C128: 190.100.127.128/25 – 190.100.127.255/25

(c) 128 customers, each need 64 addresses

a) $2^6 = 64 \Rightarrow 32 - 6 = 26$

a) C129: 190.100.128.0/26 – 190.100.128.63/26
C130: 190.100.128.64/26 – 190.100.128.127/26
⋮
C256: 190.100

Q 159.100.10.59/20

(i) 64 customers, 256 IP
(ii) 32 customers, 512 IP
(iii) 128 customers, 128 IP

First IP address = 11111111 11111111 00010100 00111011

⇒ 255.255.0.0 = 11111111 11111111 00000000 00000000

⇒ 159.100.0.0/20

(i) 2^8 = 256 IP ⇒ 32-8 = 24

⇒ 1: 159.100.0.0/24 - 159.100.0.255/24
2: 159.100.1.0/24 - 159.100.1.255/24
⋮
64: 159.100.63.0/24 - 159.100.63.255/24

(ii) 2^9 = 512 IP ⇒ 32-9 = 23

⇒ 65: 159.100.64.0/23 - 159.100.65.255/23
64: 159.100.66.0/23 - 159.100.67.255/23
⋮
86: 159.100.126.0/23 - 159.100.127.255/23

(iii)

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Q 50.80.0.0/16

(i) 200, each 128 IP

$2^7 \Rightarrow 128 \Rightarrow 32-7 = 25$

1: 50.80.0.0/25 - 50.80.0.127/25

⋮

200: 50.80.99.128/25 - 50.80.99.255/25

(ii) 400, each 16 addresses

$2^4 = 16 \Rightarrow 32-4 = 28$

1: 50.80.100.0/28 - 50.80.100.16/28

⋮

400: 50.80.124.240/28 - 50.80.124.255/28

(iii) 2000, 4 addresses each

$2^2 = 4 \Rightarrow 32-2 = 30$

1: 50.80.125.0/30 - 50.80.125.3/30

⋮

2000: 50.80.156.60/30 - 50.80.156.63/30

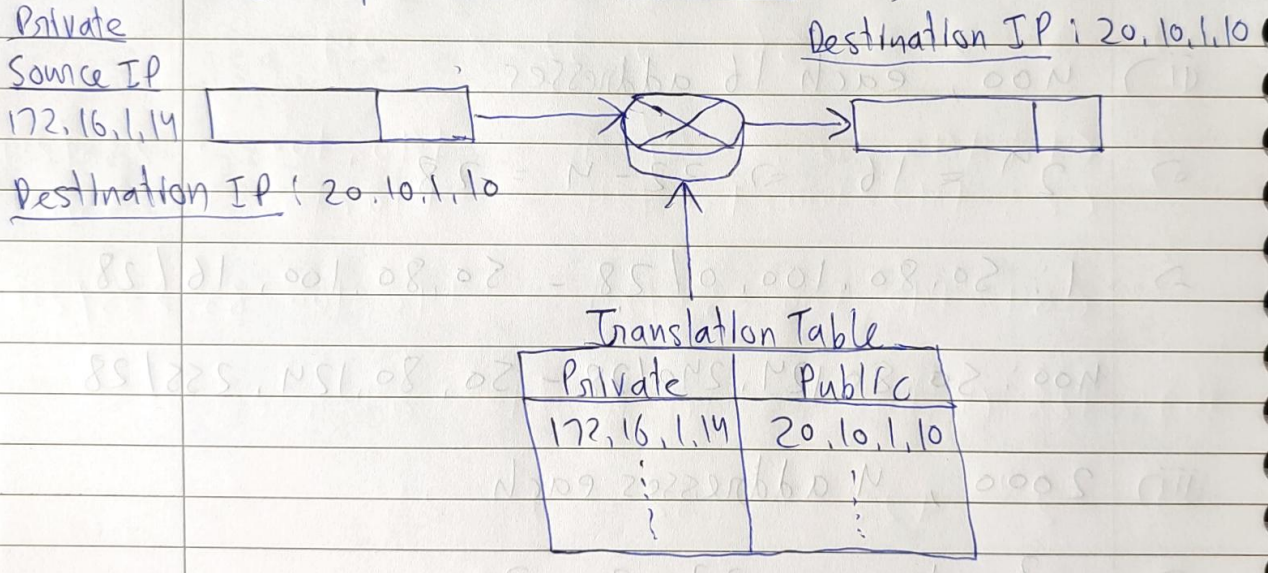
Note: 1 block can serve $= \frac{256}{4} = 64$ customers

$\Rightarrow$ Blocks needed to serve 2000 $= \frac{2000}{64} = 31.25$

Addresses for Private Networks

Range			Total
10.0.0.0	to	10.255.255.255	2^{24}
172.16.0.0	to	172.31.255.255	2^{20}
192.168.0.0	to	192.168.255.255	2^{16}

Network Address Translation (NAT)



IPv6 Addressing

- Because of the shortage of no. of IP addresses available in the IPv4 addressing, IPv6 addresses were developed.
- IPv6 addresses are 128 bits long.
- No. of Addresses :- 2^{128}

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Abbreviated IPv6 addresses

Original

FDEC : 0074 : 0000 : 0000 : 0000 : B0FF : 0000 : C0BB

Abbreviated

FDEC : __74 : ___0 : ___0 : ___0 : B0FF : ___0 : C0BB