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# Network Layer

## (4.1) IPV4 Addressing :

IP address which is of 32 bit uniquely identifies a machine in a network and for represent$^n$ it is divided into 4 equal parts each of 8 bits.
With 8 bits, one can represent $2^8$ values i.e. 256 (0 – 255)

### IP Address Representation :-

**Decimal (Dotted Decimal)**

Eg:- 114. 20. 200. 10

**Binary**

Eg:- 10101010 01010101 11001011 01101100

Q.1) Convert following decimal into binary.

(1) 114. 20. 200. 10

I) Converting into Binary

| | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|
| 114 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| 20 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 200 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |

II) Binary Representation :-

01110010 00010100 11001000 00000010

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(2) 237.148.89.230

| | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|
| 237 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 148 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 89 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| 230 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |

Binary Representation:-
11101101 10010100 01011001 11100110

Convert binary into decimal:-

(1) 10101010 01010101 11001011 01101100

I) Converting into decimal

| | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|
| 170 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 85 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 203 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| 108 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |

II) Decimal Representation:
170.85.203.108

(2) 11110111 10101111 11011101 01101110

I) Converting into decimal:-

| | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|
| 247 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 175 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| 221 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| 111 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |

II) Decimal Representation:-
247.175.221.111

Find Errors if any :-

(1) 1.2.3.4.5

IP address is of 32 bit which is divided into 4 equal parts of 8 bits. Since there is an extra part in this IP, there is an error.

(2) 1.00101110.3.4

IP address can entirely made of Dec, Bin or Hex only. Since IP is a combinat$^{n}$ of Dec and Bin, there is an error.

(3) 1.2.200.300

Each part of IP address should strictly range from (0-255). Since 300 is out of range, there is an error.

(4) $(A1)_H$.2.3.$(B2)_H$

IP address can entirely made up of Dec, Bin or Hex only. Since this IP is a combinat$^{n}$ of Hex and Dec, there is an error

(5) 1.2.3.4

No error

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## Classful addressing / IP classes :

IP address are defined using following classes

| Class | Range | Detailed Range | Description |
|---|---|---|---|
| A | 0-127 | 0.0.0.0 to 127.255.255.255 | used for large size network |
| B | 128-191 | 128.0.0.0 to 191.255.255.255 | used for medium size network |
| C | 192-223 | 192.0.0.0 to 223.255.255.255 | used for small size network |
| D | 224-239 | 224.0.0.0 to 239.255.255.255 | Reserved |
| E | 240-255 | 240.0.0.0 to 255.255.255.255 | Reserved |

How to identify the given IP belongs to which class?
Generally the IP is of the form a.b.c.d

(1) If $0 \leq a \leq 127$, IP is of class A
Eg:- 1.2.3.4

(2) If $128 \leq a \leq 191$, IP is of class B
Eg:- 129.3.4.5

(3) If $192 \leq a \leq 223$, IP is of class C
Eg:- 198.15.230.16

(4) If $224 \leq a \leq 239$, IP is of class D
Eg:- 230.160.60.10

(5) If $240 \leq a \leq 255$, IP is of class E
Eg:- 245.60.180.30

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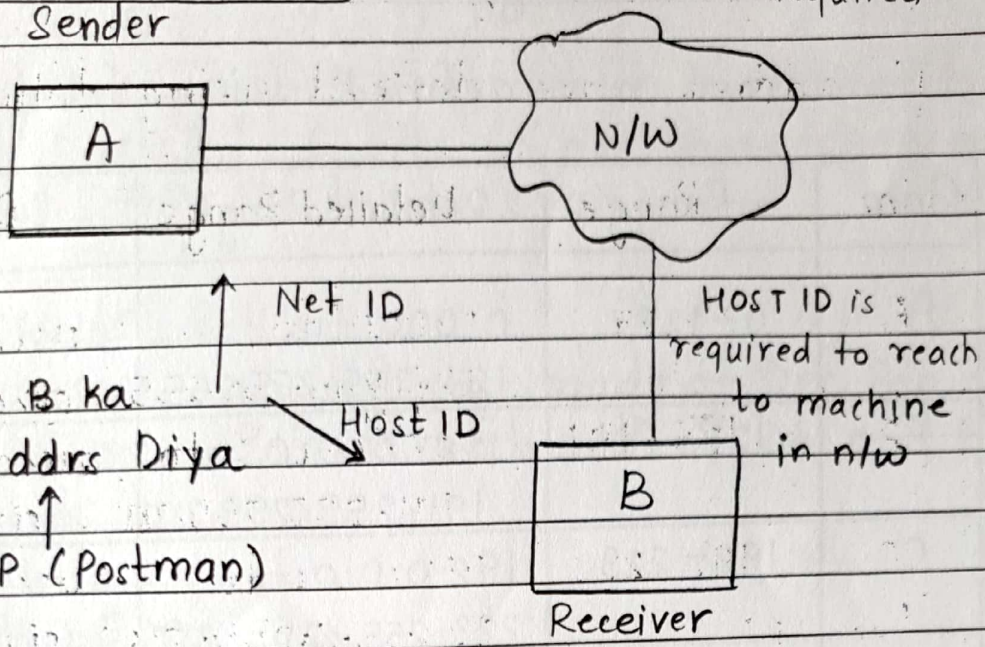
**Net ID and Host ID :-** To reach till n/w NET ID is required




When sender sends any packet to receiver, it specifies IP address of receiver and IP (Internet Protocol) divides IP address into 2 parts.

(1) Net ID :
It uniquely identifies network among other networks.

(2) Host ID :
It uniquely identifies machine among other machine in same network.

Net ID and Host ID for IP classes :-

(1) Class A

a . b . c . d → $2^{24}$ devices (1,67,77,216)
NET ID (8 bit) | HOST ID (24 bits)

1 . 2 . 3 . 4
(Net id) (Host id)

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(2) class B

a . b . c . d ⟶ $2^{16}$ device (65536)

Net ID (16 bits) Host ID (16 bits)

Eg: 144.3.200.1

(3) class C

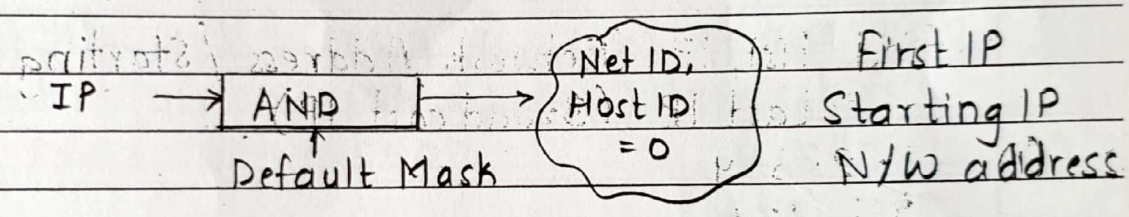
a . b . c . d ⟶ $2^8$ devices (256)

Net ID (24 bit) Host ID (8 bit)

Eg:- 192.168.2.1

Masking :-

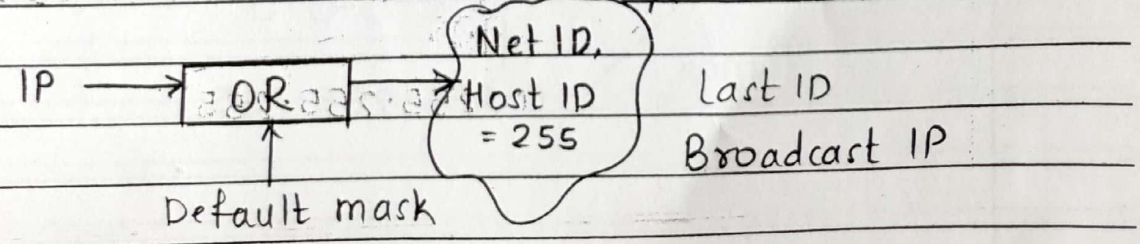
The process of retaining the Net ID and setting the Host ID to zero is known as masking.




| I/P | AND | O/P |
|---|---|---|
| 0 yaa l | 1 | 0 yaa l |
| 0 yaa l | 0 | 0 |

| Class | Default Mask |
|---|---|
| A | 255.0.0.0 |
| B | 255.255.0.0 |
| C | 255.255.255.0 |

| I/P | OR | O/P |
|---|---|---|
| 0 yaa l | 1 | 1 |
| 0 yaa l | 0 | 0 yaa l |



How many IP address can be alloted in class A, B and C?

→ class A

$2^{24} - 2$

→ class B

$2^{16} - 2$

→ class C

$2^{8} - 2$

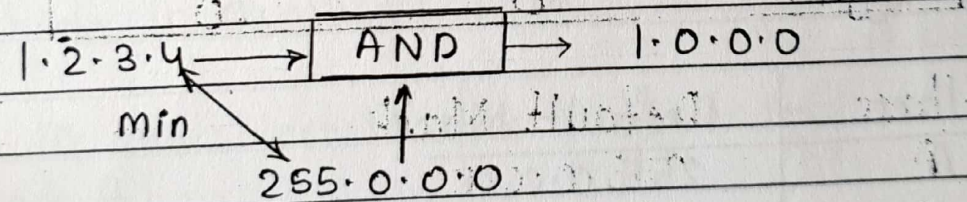
Since, .0 represents this network and .255 represent Broadcast IP

Find Fist IP (Network Address / Starting IP)
Last IP (Broad cast IP).

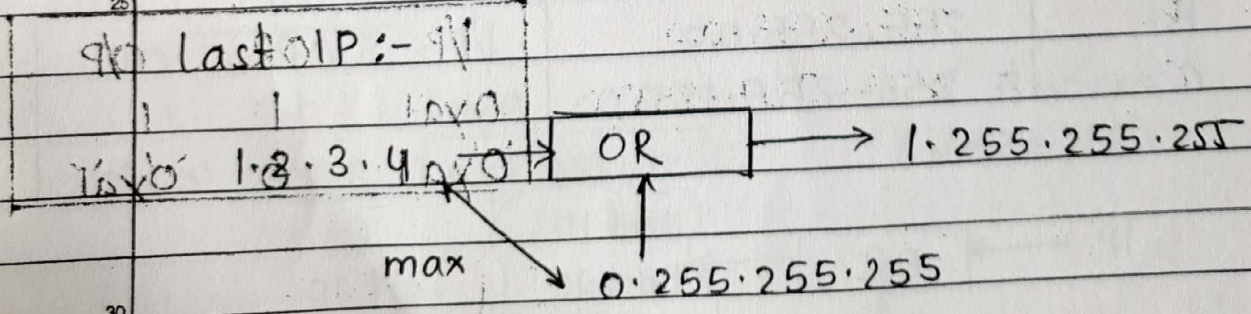
(1) 1.2.3.4

1st IP :-

Since IP is of class A Default mask is 255.0.0.0




Last IP :-

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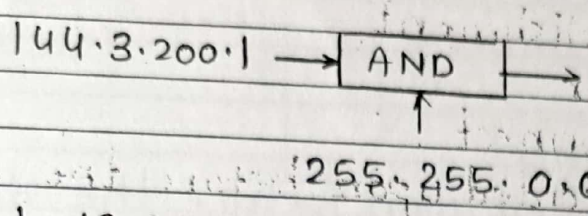
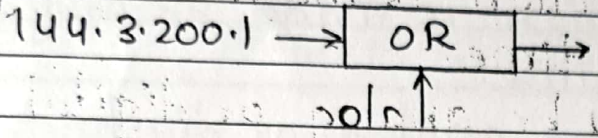
(2) 144.3.200.1

1st IP:

Since IP is of class B default mask is 255.255.0.0



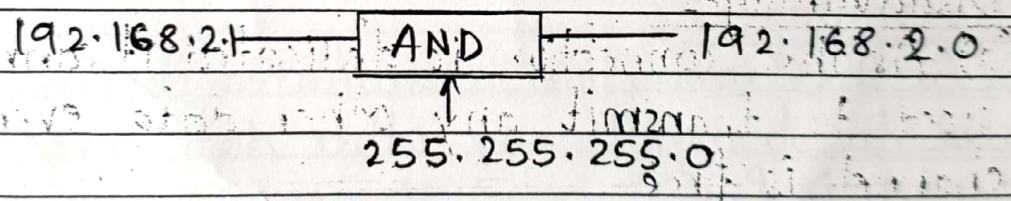

Last IP:



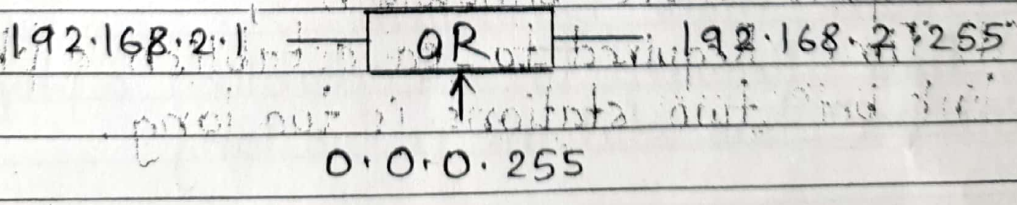

(3) 192.168.2.1

1st IP:

Since IP is of class C default mask is 255.255.255.0




Last IP

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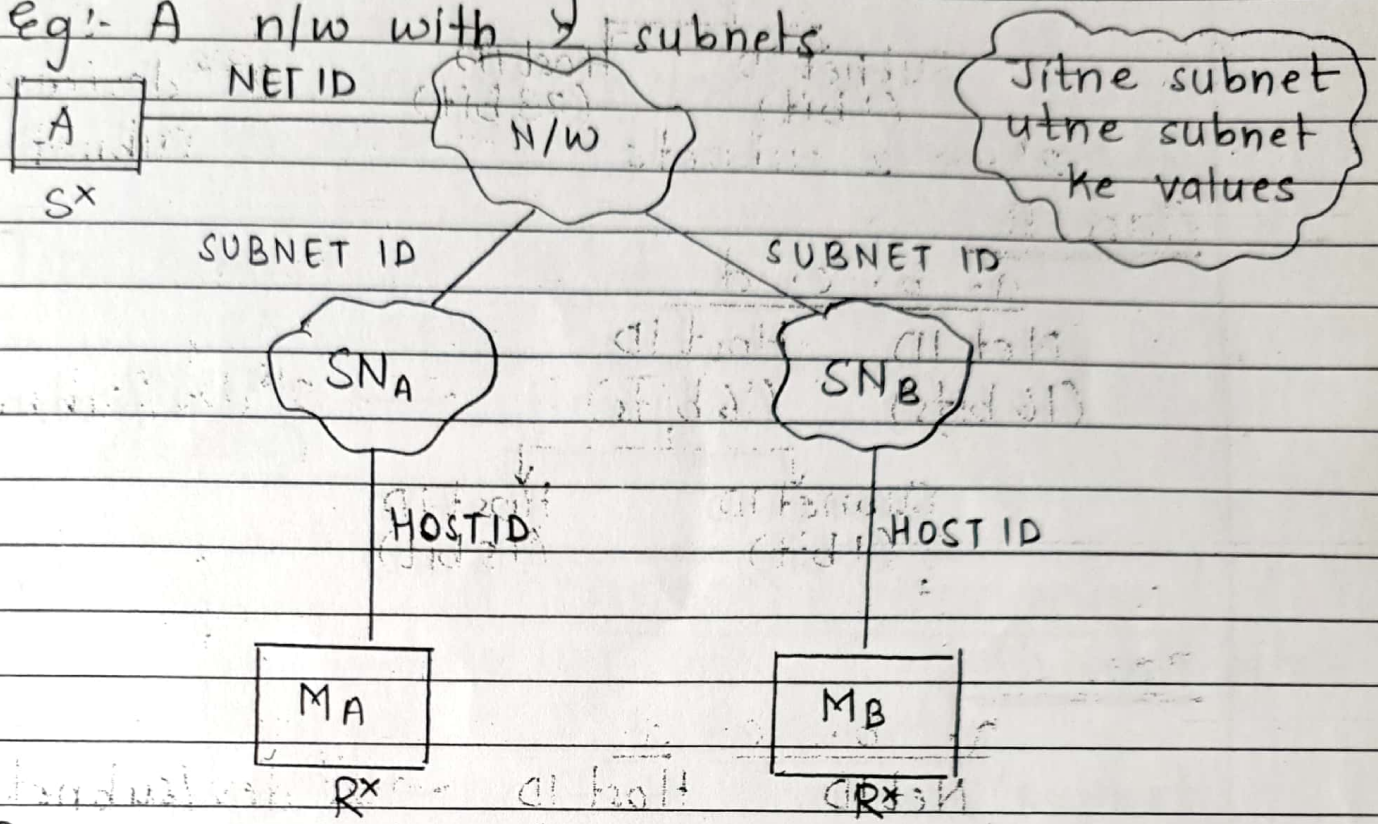
## Subneting :-

The process of dividing a network into multiple sub network logically for better management is known as subneting.

Eg:- A n/w with 2 subnets




- Regardless whether the n/w is subnetted or not, NET ID would remain same and hence subnet is derived from host id.
- The IP address for delivery of packet is divided into 3 parts :
  (1) NET ID - It uniquely identifies n/w among other n/w's
  (2) SUBNET ID - It uniquely identifies subnet among other subnets from same n/w
  (3) HOST ID - It uniquely identifies machine among other machines in the same subnet.

## Deriving Subnet ID :

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## Class A

a . b . c . d
Net ID (8 bits) | Host ID (24 bits)

Subnet ID (1 bit) | Host ID (23 bit)

$2^1$ → 2 subnets

$2^{23}$ devices/subnet

## Class B

a . b . c . d
Net ID (16 bits) | Host ID (16 bits) → $2^{15}$ dev/subnet

Subnet ID (1 bit) | Host ID (15 bit)

## Class C

a . b . c . d
Net ID (24 bits) | Host ID (8 bits) → $2^7$ dev/subnet

Subnet ID (1 bit) | Host ID (7 bit)