Logical Addressing

For host-to-host communication (NW layer) we need a global addressing scheme.

→ We use IP Address to do so.

(The identifier used in NW Layer of the TCP/IP Protocol suite to identify each device connected to the internet, is known as Internet Address or IP Address)

→ It is a 32 bit address.

→ It uniquely & universally defines the connection of a device.

IP Addressing
- → IPv4
- → IPv6

Address space – It is the total no. of addresses used by the protocol. If a protocol uses N bits to define an address, then address space is 2^N (each bit can have two values 0 & 1 so N bits can have 2^N values)

eg. IPv4 (2^{32})

IPv6 (2^{128})

Notations – Binary Notation

10000000 00001011 00000011 00011111

Dotted Decimal

128 . 11 . 3 . 31

* Since each byte (octet) is 8 bits each no in dotted-decimal notation is a decimal value ranging from 0 to 255.

Addressing

Classful Classless

Classful Addressing

An IP add here consists of

Classtype	Netid	Hostid

Here address space is divided in 5 classes - A, B, C, D, E

	Byte 1	Byte 2	Byte 3	Byte 4
class A	0...			
class B	10..			
class C	110..			
class D	1110			
class E	1111			

	Byte 1	Byte 2	Byte 3	Byte 4
class A	0–127			
class B	128–191			
class C	192–223			
class D	224–239			
class E	240–255			

→ **Netid & Hostid**

An IP address in Class A, B, C is divided into netid & hostid.

Class A : One Byte Netid & Three Bytes hostid
B : Two Bytes " & Two bytes "
C : Three bytes " & One Bytes "

* Total Diagram of IP Addressing :

Unicast

	Byte 1	Byte 2	Byte 3	Byte 4	
Class A	0 ←Netid→	← Hostid →			0.0.0.0 to 127.255.255.255
Class B	10 ← Netid	→	← Hostid →		128.0.0.0 to 191.255.255.255
Class C	110 ← Netid		→	← Hostid	192.0.0.0 to 223.255.255.255
Class D	1110 ← Multicast Add →				224.0.0.0 to 239.255.255.255
Class E	1111 ← Reserved for future use →				240.0.0.0 to 255.255.255.255

Unicast → from one source to one destination.
A host need to have at least unicast address to be able to send or received packets

Multicast → from one source to a group of destinations.
If a host belongs to a group or groups, it may have one or more multicast address.
A multicast address can be used as a destination address never as a source "

Subnetting

→ IP Addresses are designed with 2 level hierarchy ie

Class type	Netid	Hostid

→ A portion of 32 Bit address indicates the Network (Netid) and a portion indicates the host (hostid) on the N/W.

So, to reach a host on the internet we must first reach the N/W by using Netid & then reach the host by using hostid.

→ An organisation needs to assemble the hosts into groups; the N/W needs to be subdivided into several subnetworks called subnets.

→ Each subnet has its own subnet address.

Supernetting & Address Depletion

→ Time came when class A and class B addresses were depleted; however there was a huge demand for midsize blocks

→ The size of a class C block with a maximum no of 256 addresses did not satisfy needs of organisations.

One solution to the above two scenario is Supernetting where an organization can combine several class C blocks to create a larger range of addresses.

Mask

Why to use ?

When a router receives a packet with destination address, it needs to route the packet.

The ~~routing~~ router outside the organisation, routes the packet based on N/W Address.

The router ~~out~~ inside the organisation, routes the packet based on subnetwork address.

→ A N/W Admin. knows the N/W Address & Subnet address, but a router doesn't.

→ A 32 bit no, called key or mask.

Mask

Default Mask (Router outside the org. uses it)

Subnet Mask (Router inside the org. use it)

Default Mask

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

Subnet Mask

The no of 1's in the subnet mask is more the no of 1's in the default mask.

Default Mask (255.255.0.0)

11111111	11111111	00000000	00000000

Subnet Mask 255.255.224.0

11111111	11111111	11100000	00000000

★ The extra 1's in subnet mask, is determined by the no. of subnets.

if No of Subnets is N
then, the no of Extra 1's are $\log_2 N$

if No of Extra 1's are n
then the no of subnets is 2^n.

Classless Addressing

* Address Depletion

Although no. of devices on the Internet is much less than the 2^{32} address space, we have run out of class A and B addresses and a class C block is too small for most of the midsize organisations.

As a result of this address depletion Classless Addressing introduced.

Address Blocks

In classless addressing, when an entity, small or large needs to be connected to the internet, it is given a block / range of addresses. The size of the block varies depending upon the nature & size of the entity.

e.g. A household may be given only two addresses.
A large company may be a thousand of u.

* Restriction / Rules

1. The addresses in a block must be contiguous
2. The no of addresses in a block must be a power of 2 ($2^0, 2^1, 2^2, 2^3, \ldots$)
3. The first address must be evenly divisible by the no. of addresses.

e.g. A block of 16 addresses granted to a small org.

Block

	Block	
First →	205.16.37.32	11001101 00010000 00100101 00100000
	205.16.37.33	
	⋮	⋮
last →	205.16.37.47	00101111

explaination of restrictions

1 The addresses are contigous
2 The no of addresses is power of 2 ($16 = 2^4$)
3 The first address is divisible 16.
(3440387360) / 16 = 215024210

Mask

A better way to define a block of addresses is to select any address in the block & the mask.

A mask is a 32 bit number in which the n leftmost bits are 1s and 32−n rightmost bits are 0s.

In IPv4 addressing,
A block of addresses can be defined as

$$\underbrace{x.y.z.t}_{\text{One of the addresses}} / \underbrace{n}_{\text{defined the mask.}}$$

First address
The first address in the block can be found by setting the 32−n right most bits in the binary notation of the address to 0s.

Last address
The last address in the block can be found by setting the 32−n right most bits in the binary notation of address to 1s.

No of addresses
The no of addresses in a block = Difference b/w last & first address
$= 2^{32-n}$

Prob: A block of addresses is granted to an org. One of the addresses is 205.16.37.39/28.
- First address & last address
- No of addresses

Sol: Binary form of the given address is

11001101 00010000 00100101 00100111

Set 32-28 right most bits to 0.

11001101 | 0001000 | 00100101 | 00100000

first → 205 16 37 32

Set 32-28 right most bits to 1

11001101 | 0001000 | 00100101 | 00101111

last → 205 16 37 47

No of addresses $= 2^{32-28} = 16$

Another Approach

Represent the mask as a 32 bit binary

28 can be represented as

Mask: 11111111 11111111 11111111 11110000

* First address can be found as —
(Both Bit 1 = 1, = 0 o/w) AND ing bit by bit with the mask

Address: 11001101 00010000 00100101 00100111

First address: 11001101 00010000 00100101 00100000

Last address can be found by ~~ORing~~ -

ORing the given addresses with the complement of mask.

Address :	11001101	00010000	00100101	00100111
Mask complement :	00000000	00000000	00000000	00001111
Last add :	11001101	00010000	00100101	00101111

(Both Bit 0s = 0
= 1 o.w.)

No of addresses

Complementing the mask, interpreting it as a decimal no & adding 1 to it.

Mask complement :

00000000 00000000 00000000 00001111

No of addresses = 15+1
= 16

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