Internet Protocol : IPv4
Tuesday 2 June 2020 10:00 PM

If is the network layer protocol

Design was based on following assumptions:-
① IP should provide an unreliable connectionless service
② must have fixed 32 bit size address
③ IP hosts should be able to exchange variable length packets

Address assignment
Appropriate network layer address allocation is key to the efficiency & scalability of internet.

// Note
A naive allocation scheme would be to provide an IPv4 address to each host when the host is attached to internet on first come, first served basis. With this solution a host in Belgium could have 2.3.4.5 as IP while another in India would use 2.3.4.6.

This would force all routers to maintain a specific route towards all ≈1 billion hosts on internet. Not scalable

Subnetting
One aim is that routers should only maintain routes towards "blocks of addresses" & not towards individual hosts. For this blocks of IP addresses are assigned to ISPs. The ISPs assign sub block of the assigned address space in a hierarchical manner. These sub-blocks are called "Subnets".

A typical subnet groups all the hosts that are part of some enterprise. An enterprise network is usually composed of several LAN's interconnected by routers. A small block of IP addresses from the enterprise block is usually assigned to a LAN.

// IP address has 2 parts
1000 101 000 11 000 0000 11 01 0000 0001
Subnet id | Host ID

Address classes
When a router needs to send a packet it must know the subnet of the dest address to be able to consult its routing table to forward the packet.
It was proposed to use the high order bits of address to encode the length of subnet identification.

We have 5 classes → A, B, C, D, E

In class A, the first bit is always 0
In class A, we have 2^{32} IP address, from 1st bit is fixed
In class A first 8 bit octet represent network ID. The rest of the bits represent host.
No. of network ID in class A is 2^8
First address in network address & last address i.e. X.255.255.255 is broadcast address.

→ Default mask of class A → 255.0.0.0
Helps in deciding the network address for class A by doing bitwise mask.

Class B
first 2 bits are set as 1,0
(2^16 - 2^8) (2^8 - 2^0) (2^8 - 2^0)
128 0000 0000 | 1111 1111 | 1111 1111
network | host
Range → 128 - 191 for first octet
No. of total IP addresses → 2^{32}
No. of networks → first 8 octet tell about network & rest about host
Total network IP address = $2^7 \times 2^8 = 64 \times 256 = 16384$
No. of hosts = $2^{16} - 2 = 65536$
Default Mask → 255.255.0.0

Class C
The first 3 prefix are fixed as 1,1,0
Range → 192 - 223
Total IP addresses → 2^{32} (due to first 3 octets)
No. of networks → 2^{21}
Total no. of hosts → 2^8
Default mask → 255.255.255.0

Class D
Default mask → 255.255.0.0
The first four IP no. are 1,1,1,0
Range → 224-239
No. of IP address → 2^{32} → multicasting
No network or host bits: reserved for specific purpose

Class E
First four bits are 1,1,1,1
These are reserved for multicasting purpose.
Range → 240 - 255

Disadvantages of classful IP address.
→ Wastage of IP address.
→ Maintenance and time consuming.
→ More prone to errors.

Classless Addressing
→ No class
→ Only blocks
Notation
X.Y.Z.W/n

mask / no. of bits to represent block
Eg 200.10.20.40/28
No. of Hosts = 2^{32-n}
How to calculate Mask → 28 ones
11111111.11111111.11111111.11110000
255.255.255.240
Network →
200.10.20.40
200.10.20.00101000
200.10.20.32/28
network address
OR
AND with the Mask

Rules
① addresses should be continuous
② No of addresses in a block must be a power of 2
③ First address or network address should be divisible with size of block

Subnetting in Classful addressing
→ Divide by network to small subnets
→ No effect should be done on network id

Eg 200.10.20.128/25
Subnet mask 255.255.255.128
200.10.20.128 - 200.10.20.255
200.10.20.0 - 200.10.20.127
Subnet
Network id
Host id
Broadcast
200.10.20.128/26
200.10.20.128 - 200.10.20.191
200.10.20.192 - 200.10.20.255
200.10.20.0/26
200.10.20.0 - 200.10.20.63
200.10.20.64 - 200.10.20.127
200.10.20.128/25
200.10.20.128 - 200.10.20.255
200.10.20.0/25
200.10.20.0 - 200.10.20.127
200.10.20.128/26
200.10.20.128 - 200.10.20.191
200.10.20.192/26
200.10.20.192 - 200.10.20.255
Block
Subnet
Broadcast
Network id
Host id
Broadcast

If we fix the first x bits from host octet then we divide it into 2^x subnet
To calculate subnet mask we just for x reserved places

Variable length Subnet Mask (VLSM)
To provide flexibility in dividing non equal subnets

200.10.20.0/24
200.10.20.0 - 200.10.20.127
200.10.20.128 - 200.10.20.255
200.10.20.0/25
200.10.20.0 - 200.10.20.127
200.10.20.128/26
200.10.20.128 - 200.10.20.191
200.10.20.192/26
200.10.20.192 - 200.10.20.255
Subnet mask
200.10.20.192
or
200.10.20.11000000
for 26 bits

Subnetting in classless interdomain routing (CIDR)
Same as above, just calculate network ID using CIDR principle & use set rest of host bits by using x MSB
For the 'n' values until the updates
$n! = n \times x$

Same for VLSM