Ch. 12 IP addressing

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* Addressing :-

Address is required whenever one computer wants to communicate with another computer.

In TCP/IP model, four levels of addresses are used by computer:

Addresses

- Physical address
- Logical addresse
- Port address
- Specific address

- Association of these addresses with layers of ~~App~~ TCP/IP model :-

Application layer	→	Specific address
Transport layer	→	Port address
Network OR Internet layer	→	Logical address
Data link layer Physical layer	→	Physical address

fig: Relation between TCP/IP structure and addresses

Physical Address :-

- Physical address is associated with Physical layer & data link layer.
- It is also known as MAC (Media Access Control) address
- A MAC address is a local address. It is unique locally but need not unique globally.
- LAN uses a 48-bit (6-byte) physical address which is imprinted on network interface card (NIC).

Logical address:-
- Logical address is required to allow smooth communications ~~over~~ worldwide.
- It is also known as IP address
- At network level, the hosts and routers are recognized by their IP addresses or logical addresses.
- It is 32-bit address.

Port address:-
- It is address of a specific process on a particular host or machine.
- Port address is a label assigned to a process.
- It is a 16 bit address.

Specific address:-
- Specific addresses are used at application level.
- Email addresses or URL are examples of specific addresses.

* IPv4 Addresses:-
- Each machine like computer, routers etc in internet has unique IP address.
- IPv4 is current version.
- It is 32-bit address.
- Uniqueness: The IP address is unique & universal. It means each IP address defines only one connection to the internet.

- address space :-

Address space is total number of addresses used by the protocol.

- If Address space is 2^N if N number of bits ~~is~~ used in address.
- Therefore address space of IPv4 is 2^{32} or 4,294,967,296.

- Notation

IPv4 addresses can be shown using three different notation

i) Binary notation (base 2)
ii) Dotted decimal notation (base 256)
iii) Hexadecimal notation (base 16)

- Binary notation :

This format uses binary 1 & 0 bytes separated by dot ('.').

e.g.

10010001 . 00001010 . 00100010 . 00000011

8 bit or 1 byte | 8 bit or 1 byte | 8 bit or 1 byte | 8 bit or 1 byte

- Dotted decimal notation :

This is most commonly used notation. It is easy to remember.

e.g.

172 . 17 . 3 . 240

Decimal number ~~can be~~ from 0 to 255 is used & is separated by dot ('.').

- IP address assignment :-

IP address cosist of network identifier and host identifier. within a subnet, all host have same network identifier. But each has separate host identifier.

The internet assigned numbers authority (IANA) assigns network identifiers.

- IPv4 address format

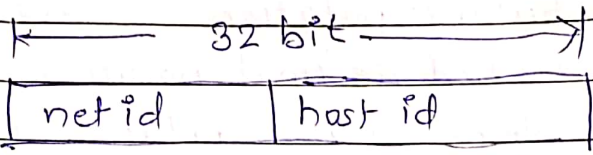

fig.: IPv4 address format.

IPv4 address consist of net id and host id. They are variable in length depending upon class of address.

* Classful addressing :-

Previously IP addressing technique uses the concept of classes. In this, IPv4 address range is divided into various groups known as class. This scheme is known as classful addressing.

IPv4 address classes

Class A Class B Class C Class D Class E

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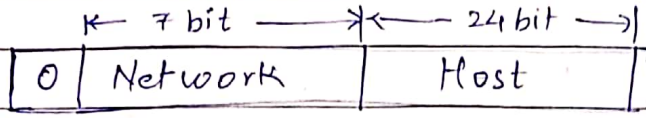
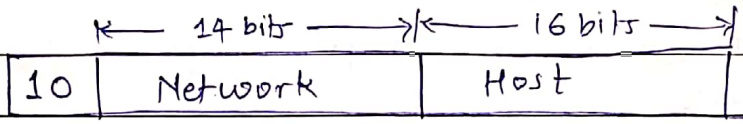
Class A format



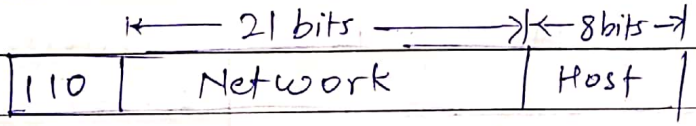
- first bit of address is 0
- Next 7 bits defines network
- last 24 bits defines host addresses
- First 8 bit (00000000 to 01111111) ranges from 1 to 126.
- Total 2^{31} addresses are available in class A.
- host numbers ranges from 0.0.0.0 to 127.255.255.255

Class B format



- first two bits of address is 10
- Next 14 bits defines network
- last 16 bits defines host addresses
- Total 2^{30} addresses are available in class B
- host numbers ranges from 128.0.0.0 to 191.255.255.255

Class C format



- first three bits of address are 110
- Next 21 bits defines network.
- last 8 bits defines host.
- total 2^{29} addresses are available in class C
- host address ranges from 192.0.0.0 to 223.255.255.255

Class D. format

1110	Multicast address

- first 4 bits are 1110
- 2^{28} addresses are available in class D.
- Host addresses ranges from 224.0.0.0 to 239.255.255.255

Class E. format

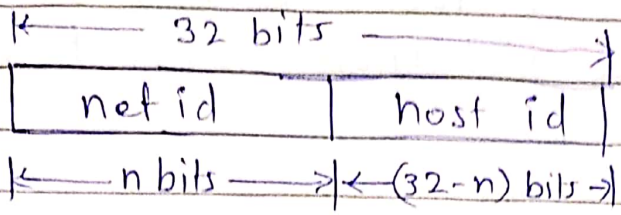
11110	Reserved for future use

- first five bits are 11110
- 2^{28} addresses are available in class E
- Host addresses ranges from 225.0.0.0 to 255.255.255.255

In Abstract

Class	First Default Bits	No. of addresses	No. of bits (Network)	No. of Bits (Host)	Address range
A	0	2^{31}	7	24	1.0.0.0 to 127.255.255.255
B	10	2^{30}	14	16	128.0.0.0 to 191.255.255.255
C	110	2^{29}	21	8	192.0.0.0 to 223.255.255.255
D	1110	2^{28}			224.0.0.0 to 239.255.255.255
E	11110	2^{28}			240.0.0.0 to 255.255.255.255

* Two level Addressing



*Note: n bits also includes first default bits
e.g. 'n' of class A is 8 (Not 7)
'n' of class B is 16 (Not 14)
'n' of class C is 24 (Not 21)

*Extracting information in a Block

To extract information from given IPv4 address first identify 'to which class it belongs to'. This can be done through either by 'first default bits' or address range.

→ If IPv4 address given in
- Binary format ← use first default bits to identfy class (A/B or C)
- Dotted decimal format ← use address range to identify class
  * Refer table on previous page.

Information can be
i) Total number of addresses in block
ii) first address of block
iii) Last address of block
iv) Network address

i) Total number of address in block

$N = 2^{(32-n)}$

value of n is depends on class identified.

ii) first address of block.
- keep leftmost n bits as it is
- change rightmost 32-n bits to '0'

iii) last address of block
- keep leftmost n bits as it is.
- change rightmost 32-n bits to 1

iv) Network address (* same as 1st address)
- keep leftmost n bits as it is
- change rightmost 32-n bits to 0

Example : Extract information from address
132.7.21.84

Step 1 Identify class : (*IP address is in dotted decimal format)
132 is between 128 to 191
∴ It is in class B
∴ n = 16

Step 2 Extract information
i) Total number of addresses
$N = 2^{32-n} = 2^{32-16} = 2^{16}$

ii) first address : Make 32-16=16 Rightmost bits = 0
∴ 132.7.0.0

iii) last address : Make 32-16=16 Rightmost bits to 1
∴ last address = 132.7.255.255

iv) Network address
132.7.0.0

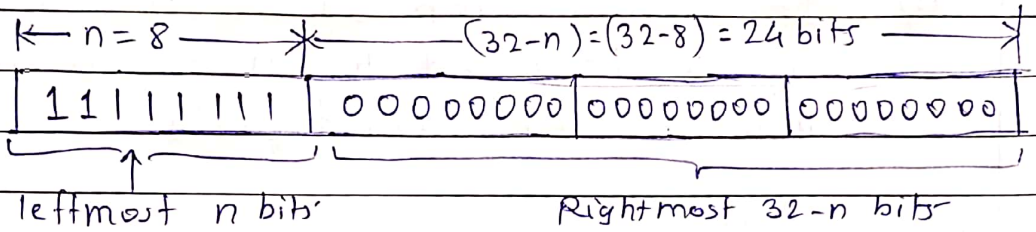
* Network Mask or Default Mask

Network address of any IPv4 address can be extracted by using network mask.

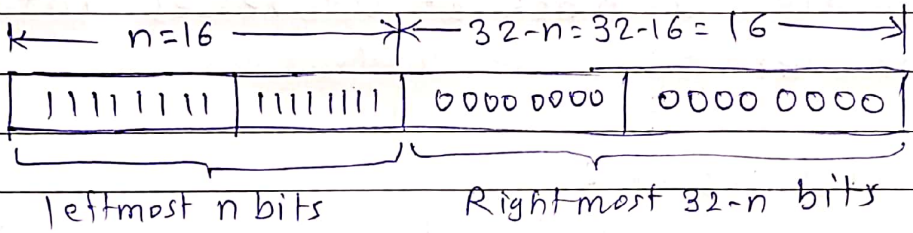
A network mask or default mask in classful addressing is defined as a 32-bit number obtained by setting all the "n" leftmost bits to 1 and all (32-n) rightmost bits to 0.

"n" varies from one class to another.

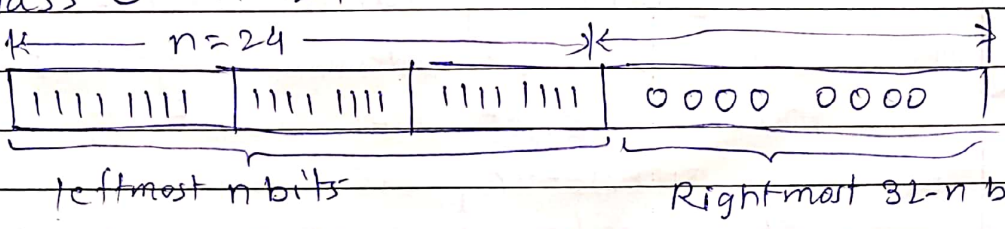
Class A : n = 8



Class B: n = 16



Class C : n = 24



In decimal

Class	Default Mask
A	255.0.0.0
B	255.255.0.0
C	255.255.255.0

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* Three levels addressing OR subnetting

Two level addressing uses Net id and Host id. Each class (A, B or C) has their own format and fixed number of networks and hosts within the network.

Three level addressing comes into reality because-

i) Requirement of small sub-networks for improve management and security.

ii) If organisation is allotted class A and B they need to divide those into smaller subnetworks.

* Subnetting:

Subnetting is a technique of splitting a block of addresses into smaller block of addresses.

Subnet mask:

Each class has their default or network mask.

Subnetting further divides the available block of address. Depends upon how much subnet user want to create, bits for subnetting are used.

e.g. To create 4 subnetworks ($2^2=4$), 2 bits are enough

To create 8 subnetworks ($2^3=8$), 3 bits are required

and so on.

Consider following example of class B

Default mask of class B

11111111	11111111	00000000	00000000

Subnet mask in class B (Example)

1111 1111	1111 1111	111	00000	0000 0000

Extra 3 bits set to '1'

∴ Number of subnetworks = $2^3 = 8$ can be created

(*) Supernetting:

Class A and class B address are almost depleted. But class C are still available.

But in class C, maximum number of hosts can be 256 which does not satisfy needs of most of the organisations.

The solution to this situation is supernetting.

Supernetting combines severed blocks in class C and creates a large range of addresses.

Therefore organization can get multiple number of blocks of class C and by supernetting them requirement can be fulfilled.