UNIT - II

IPV4 ADDRESSING ARCHITECTURE

IPV4 ADDRESSES:- 848

*) The identifier used in the IP layer of TCP/IP protocol suite to identify the connection of each device to the internet is called the Internet address or IP address.

*) An IPv4 is a 32-bit address that uniquely identifies the connection of a host or router to the internet.

ADDRESS SPACE:-

An address space is the total number of addresses used by the protocol.
For example, if a protocol uses b bits to define an address, then the address space is 2^b.

IPv4 uses 32 bit address, which means that,

$$\text{Address space of IPv4} = 2^{32}$$
$$= 4,294,967,296$$
$$\simeq 4 \text{ Billion.}$$

NOTATION:-

There are Three Common notations to show an IPV4 address.

i) Binary notation (base 2)

ii) Dotted-decimal notation (base 256)

iii) Hexa-decimal notation (base 16).

Binary: 10000000 00001011 00000011 00011111

Dotted Decimal: 128 . 11 . 3 . 31

Hexa Decimal: 80 0B 03 1F

HIERARCHY IN ADDRESSING:-

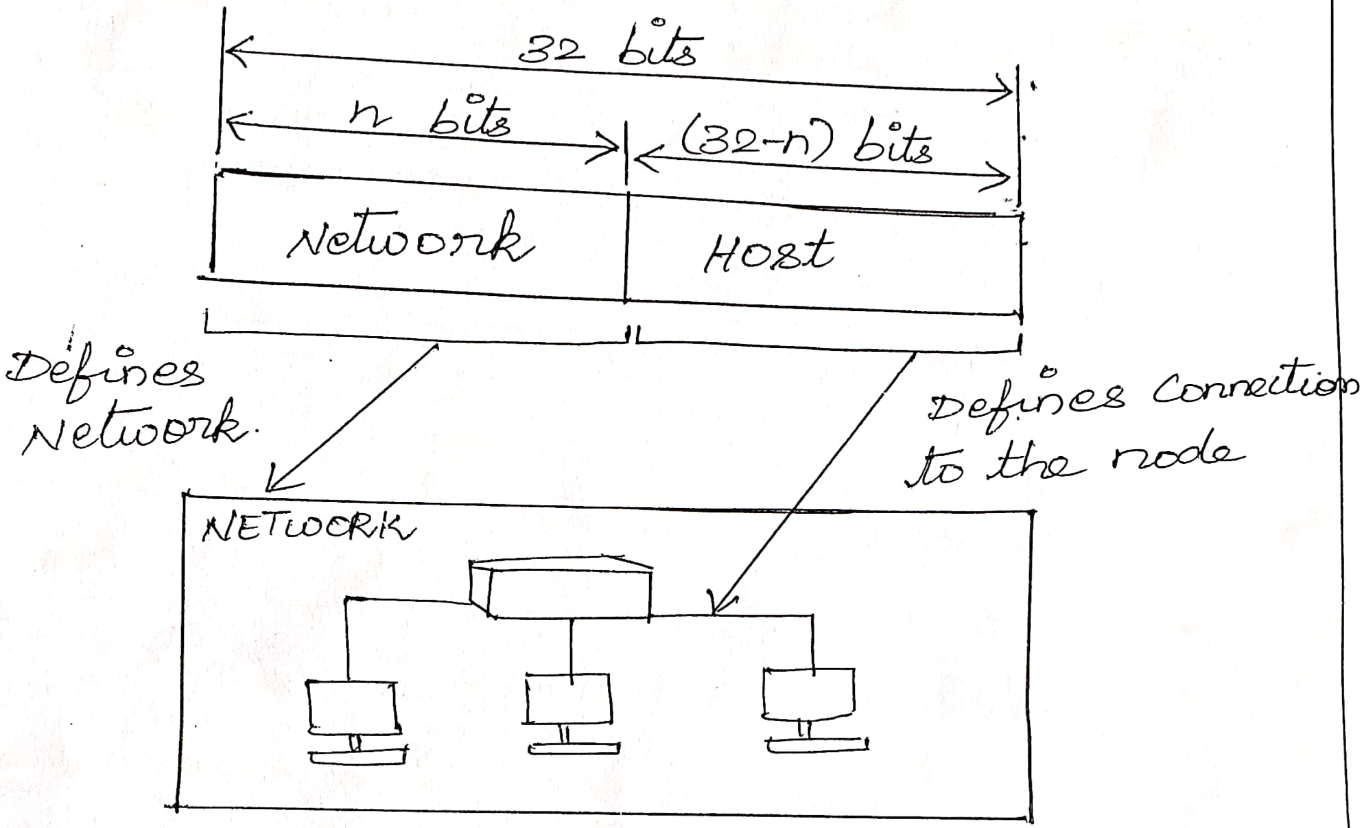
The 32-bit IPV4 address is hierarchial which is divided into two parts.

(1) prefix or Network address

(2) Suffix or Host address.

The network address = n bits

The host address = 32 − n bits



CLASSFUL ADDRESSING:-

*) The IPv4 was initially designed with fixed-length Network address.

*) Three fixed-length Network addresses were designed to accomodate small and large networks. (n=8, n=16, n=24).

*) The whole address space was divided into five classes (class A, B, C, D and E).

*) This scheme is referred to as "classful addressing."

	8 bits	8 bits	8 bits	8 bits
CLASS A	0 NETWORK ADDRESS	HOST ADDRESS		
CLASS B	10 NETWORK ADDRESS		HOST ADDRESS	
CLASS C	110 NETWORK ADDRESS			HOST ADDRESS
CLASS D	1110 MULTICAST ADDRESS			
CLASS E	1111 RESERVED FOR FUTURE USE			

*) In class A, The network length is 8 bits, but since the first bit is 0, we have only seven bits as the network identifier.

$2^7 = 128$ Networks can have CLASS A address.

*) In class B, The network length is 16 bits, but since first two bits are used to define the class, we have only 14 bits as the network identifier.

$2^{14} = 16,384$ Networks can have CLASS B address

*) In class C, The network length is 24 bits, but since first three bits are used to define the class, we have only 21 bits as Network identifier.

$2^{21} = 2,097,152$ Networks can have CLASS C address.

CLASS	NETWORK ADDRESS	FIRST BYTE
A	n = 8 bits	0 to 127
B	n = 16 bits	128 to 191
C	n = 24 bits	192 to 223
D	Not Applicable	224 to 239
E	Not Applicable	240 to 255

ADDRESS DEPLETION :-

*) The reason for classful addressing has become obsolete (No more in use) because of address depletion.

*) Since the addresses were not distributed properly, the Internet was faced with the problem of the addresses being rapidly used up, resulting in no more addresses available for organization and individuals.

SUBNETTING & SUPERNETTING :-

*) To overcome address depletion problem, two strategies were proposed,

1. Subnetting
2. Supernetting

*) In subnetting, a class A or class B block is divided into several subnets.

*) Each subnet has a larger prefix length than the original network.

*) For example, if class A is divided into four subnets, each subnet has prefix or network address as $n_{sub} = 10$.

*) At the sametime, if all of the addresses in a network are not used, subnetting allows the addresses to be divided among several organizations.

*) Supernetting was designed to combine several class C blocks into a large block to organizations that need more than 256 addresses.

* This idea did not work because it makes the routing of packets more difficult.

ADVANTAGE:-

*) Given an address, The class of the address can be found easily, since ~~each~~ The network address of each class is fixed.

*) No extra information is needed to find the network address and host address.

CLASSLESS ADDRESSING :-

*) In 1996, The internet authorities announced a new architecture called classless addressing.

*) In classless addressing, variable-length blocks are used that belong to no classes. we can have a block of 1 address, 2 addresses, 4 addresses, 128 addresses and so on.

*) The prefix in an address defines the block (Network); The suffix defines the node (device).

*) The prefix length in classless addressing is variable.

PREFIX LENGTH : SLASH NOTATION

*) The prefix length is not inherent in the address, we need to seperately give the length of the prefix.

*) In classless addressing, the prefix length n, is added to the address, seperated by a slash.

*) The notation is informally referred to as slash notation and formally known as "classless interdomain routing" or CIDR strategy.

byte	.	byte	.	byte	.	byte	/	n

→ prefix length.

Examples:

12.24.76.8/8

23.14.67.92/12

220.8.24.255/25.

EXTRACTING INFORMATION FROM AN ADDRESS:-

Given a classless addressing with slash notation, the following information can be extracted.

1) The number of addresses in the block,

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

2) To find the first address, we keep the n leftmost bits and set the (32-n) right most bits all to 0's.

3) To find last address, we keep n leftmost bits and set (32-n) rightmost bits all to 1's.

Example:-

167.199.170.82/27.

The no. of addresses in the network

$= 2^{32-n}$

$= 2^{(32-27)}$

$= 2^5$

= 32 addresses.

To find first address,

167.199.170.82/27

↳ Convert to binary form

10100111 11000111 10101010 01010010

↳ first address got by changing (32-n) rightmost bits to 0's.

(32-n) = 5 bits

∴ 5 rightmost bits changed to 0's.

↳ 10100111 11000111 10101010 010$\underline{10010}$

↓

10100111 11000111 10101010 010 00000

↓

167.199.170.64/27.

To find last address,

167.199.170.82 /27

↳ convert to binary form

10100111 11000111 10101010 01010010

↳ last address got by changing (32−n) rightmost bits to 1's.

∴ 5 rightmost bits must be changed to 1's

10100111 11000111 10101010 010 <u>10010</u>

↓

10100111 11000111 10101010 010 <u>11111</u>

↓

167.199.170.95

<u>ADDRESS MASK:-</u>

*) Address mask is used to find the first and last addresses of a address block.

*) The address mask is a 32-bit number in which n leftmost bits are set to 1's and the rest of the bits (32−n) are set to 0's.

*) A Computer can easily find the address mask because it is the complement of $(2^{(32-n)}-1)$.

1. The number of addresses in block N,

$= NOT(mask) + 1$

2. The first address in the block

$= (\text{Any address in block}) \text{ AND } (\text{mask})$

3. The last address in the block

$= (\text{Any address in block}) \text{ OR } [NOT(\text{mask})]$

Example:-

167.199.170.82/27. → Address Block

256.256.256.224 → mask.

Convert Address Block and mask into Binary form.

167.199.170.82/27 =

10100111 11000111 10101010 1010010 10110110

256.256.256.224 =

11111111 11111111 11111111 11100000.

To find Number of addresses in Block N,

$N = NOT(mask) + 1$

= NOT (11111111 11111111 11111111 11100000) + 1

= (00000000 00000000 00000000 00011111) + 1

= (0 . 0 . 0 . 31) + 1

= 0 . 0 . 0 . 32

= 32 addresses.

ii) To find First address,

128/32/160

FIRST = (address) AND (mask).

= (10100111 11000111 10101010 10110110)

01010010

AND

(11111111 11111111 11111111 11100000)

~~= 0010~~

= 10100111 11000111 10101010 10100000

= 167 . 199 . 170 . 82

First address =

iii) To find Last address,

LAST = (address) OR [NOT(mask)]

= 10100111 11000111 10101010 10110110

OR

00000000 00000000 00000000 00011111

10100111 11000111 10101010 11111111

10100111 11000111 10101010 11111111

= 167.199.170.255.

SUBNETTING:-

*) In subnetting an address block is divided into several subnets.

*) More levels of hierarchy can be created using subnetting.

*) An organisation (or an ISP) that is granted a range of addresses may divide the range into several subranges and assign each subrange to a subnetwork.

*) A subnetwork can again be divided into several sub-subnetworks and so on.

DESIGNING SUBNETS:-

*) The subnetworks in a network should be carefully designed to enable the routing of packets.

*) We assume the total number of addresses granted to the organization as N.

Number of addresses to organization = N

The prefix length (Network address = n

The assigned number of addresses to each subnetwork } = N_{sub}

The prefix length of each subnet = n_{sub}

*) The following steps need to be carefully followed to guarantee the proper operation of subnetworks.

→ The number of addresses in each subnetwork should be a power of 2.

→ The prefix length of each subnetwork

$$n_{sub} = 32 - \log_2 N_{sub}$$

→ The starting address in each subnetwork should be divisible by the number of addresses in that subnetworks.

Example:-

An organization is granted a block of addresses with the beginning address 14.24.74.0/24. The organization needs to have 3 subblocks of addresses to use in its 3 subnets: one subblock of 10 addresses one sub-block of 60 addresses and one sub-block of 120 addresses. Design the subnets.

Solution :-

(1) Given address block = 14.24.74.0/24.

The prefix length = 24.

The subnet requirements are,

subnet 1 = 10 addresses

subnet 2 = 60 addresses.

subnet 3 = 120 addresses.

(2) Arrange the subnet requirements in descending order.

Subnet	Requirement
3	120
2	60
1	10

(3) The Total number of addresses available in the given block is found by the formula,

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

Here, prefix length, $n = 24$

$$N = 2^{(32-24)}$$

$$N = 2^{8}$$

$N = 256$ addresses.

$$\boxed{N = 256}$$

(4) First address = 14.24.74.0 /24

Last address = 14.24.74.255 /24.

(5) The first block requires 120 addresses. But the subnetwork address must be a power of 2.

So we allocate 128 addresses to first subnet.

The subnet mask for this subnet is found by, $n_{sub} = 32 - \log_2 N_{sub}$.

$$n_1 = 32 - \log_2 128$$

$$= 32 - 7$$

$$\boxed{n_1 = 25}$$

First address in this Block = 14.24.74.0 /25

Last address in this Block = 14.24.74.127 /25

(6) The second sub-block requires 60 addresses, which is also not a power of 2. So we allocate ~~ad~~ 64 addresses. The subnet mask can be found as

$$n_{sub} = 32 - \log_2 N_{sub}$$

$$n_2 = 32 - \log_2 64$$

$$n_2 = 32 - 6$$

$$\boxed{n_2 = 26}$$

128
64
192

First address = 14.24.74.128 /26

Last address = 14.24.74.191 /26.

(7) The Third sub-block requires 10 addresses, which is also not a power of 2. So we allocate 16 addresses. The subnet mask can be found as

192
16
208

$$n_{sub} = 32 - \log_2 N_{sub}$$

$$n_3 = 32 - \log_2 16$$

$$n_3 = 32 - 4$$

$$\boxed{n_3 = 28}$$

First address = 14.24.74.192 / 28

Last address = 14.24.74.207 / 28.

(8) Total no. of addresses available in this block of address } = 256

Total no. of addresses allocated to subnets } = 208

Remaining addresses = 256 − 208

= ~~4~~ 48 addresses

VLSM :-

- Variable length Subnet Mask.
- It extends classic subnetting.
- VLSM is a process of breaking down subnets into smaller subnets, according to need of individual networks.

Steps:-

1) Find the largest segment i.e) The segment which needs the largest no. of hosts.

2) Do subnetting to fulfill the requirement of largest segment.

3) Assign the appropriate subnet mask for the largest segment.

4) For second largest segments, take one of these newly created subnets and apply a different more appropriate subnet mask to it

5) Assign appropriate subnet mask for second largest segment.

6) Repeat this process until the last network.

Ex/.

Admin 192.168.1.0 /24

↳ no. of bits used for n/w address

departments

Sales	100
purchase	50
Accounts	25
Management	5

Step 1:-

Make a list of subnets possible.

Subnet Mask	Hosts / subnet.
255.255.255.0	254
255.255.255.128	126
255.255.255.192	62
255.255.255.224	30
255.255.255.240	14
255.255.255.248	6
255.255.255.252	2

Step 2:-

Sort the requirements of Ips in descending order.

1) Sales 100
2) purchase 50
3) Accounts 25
4) Management 5

192.168.1.0/24.

4 departments:

Sales	100
Purchase	50
Accounts	25
Management	5

prefix length = 24.

(1) Total number of addresses available in the given block is found by the formula

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

$$N = 2^{(32-24)}$$

$$N = 2^{8}$$

$$N = 256 \text{ addresses.}$$

(2) First address = 192.168.1.0/24

Last address = 192.168.1.255/24.

(3) The first block requires 100 addresses. But the subnetwork address must be a power of 2. So we allocate 128 addresses to first subnet.

The subnet mask for this subnet is found by

$$n_{sub} = 32 - \log_2 N_{sub}$$

$$= 32 - \log_2 \cancel{N_{sub}}\ 128$$

$$= 32 - 7$$

$$n_1 = 25$$

First address in this Block = ~~14.24~~
192.168.1.0/25

Last address in this Block =
192.168.1.127/25

The subnet mask is 255.255.255.128

(4) The ~~firs~~ second block requires 50 addresses. But the subnetwork address must be a power of 2. So we allocate 64 addresses to second subnet.

The subnet mask for this subnet is found by,

$$n_{sub} = 32 - \log_2 N_{sub}$$

$$= 32 - \log_2 64$$

$$= 32 - 6$$

$$n_2 = 26$$

The subnet mask for this subnet is

255.255.255.192/26

First address in this Block =

192.168.1.128/26

Last address in this Block =

192.168.1.191/26.

(5) The Third block requires 25 addresses. But the subnetwork address must be a power of 2. So we allocate 32 addresses to third subnet.

The prefix is found by,

$$n_{sub} = 32 - \log_2 N_{sub}$$

$$= 32 - \log_2 32$$

$$= 32 - 5$$

$$= 27$$

$$n_3 = 27$$

The subnet mask for this subnet is

255.255.255.224/27

First address in this Block =

192.168.1.192/27

Last address in this Block =

192.168.1.223/27.

(6) The fourth block requires 5 addresses. But the subnetwork address must be a power of 2. So we allocate 8 addresses to this host.

The prefix is found by.

$$n_{sub} = 32 - \log_2 N_{sub}$$
$$= 32 - \log_2 8$$
$$= 32 - 3$$
$$n_4 = 29$$

The subnet mask for this subnet is

255.255.255.232/29

First address in this Block =

192.168.1.224/29

Last address in this Block =

192.168.1.232/29.

IPv4 addressing

Identifier used in IP layer of the TCP/IP protocol suite to identify the connection of each device to the internet is called internet address or IP address.

1) IP address is a 32 bit address uniquely and universally defines the connection of a host or a router to the internet

2) One and only one connection to the internet

3) Address space — Total no of addresses used by the protocol.

If a protocol uses b bits to define an address, address space is 2^b —

IPV4 — 32 bit addresses — 2^{32} or 4,294,967,296

4 billion devices could be connected to the internet.

Notation

3 common notations, 1) (base 2)

2) dotted decimal notation (base 256)

3) hexadecimal (base 16).

In binary — displayed as 32 bits.

Address more readable — one or more space is inserted between each octet (8 bits)

Each octet is called bits.

Dotted decimal notation

Written in dotted decimal form with a decimal point seperating the bytes. 8 bits - 0 to 255.

Binary 10000000 00001011 00000011 00011111

Dotted decimal 128 . 11 . 3 . 31

Hexadecimal 80 0B 03 1F

Hierarchy in addressing

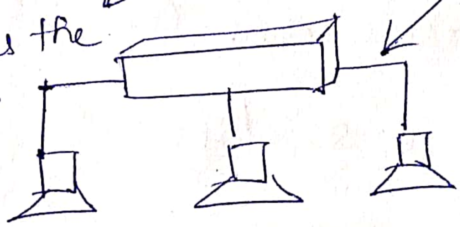
32 bits

n bits | (32-n) bits

Prefix | Suffix.

Defines the N/W.

Defines connection to the node.



Prefix can be fixed or variable length.

N/W identifier designed as fixed length prefix.

Classful addressing

Address space.

A	B	C	D	E
50	25	12.5%	6.25	6.25%

	8	8	8	8
Class A	0 Prefix	Suffix		
Class B	10 Prefix		Suffix	
/9 C	110 Prefix			Suffix
/17 D	1110 Multicast address			
/25 E	Reserved for future			

Class	Prefixes	First byte
A	$n=8$	0 to 127
B	$n=16$	128 to 191
C	$n=24$	192 to 223
D	Not applicable	224 to 239
E	Not applicable	240 to 255

/10 ① A classless address is given as 167.199.170.82/27.

/18 2 Given a classless addressing with slash.

26 2 1) The no of addresses in the block.

$N = 2^{32-n}$

4:

2) To find the first address, keep the n leftmost bits and set the (32−n) rightmost bits all to 0's.

3) To find the last address keep n leftmost bit set (32−n) rightmost bits to 1's.

1) No of addresses in the n/w.

$= 2^{32-n}$

$= 2^{32-27} = 2^5 = 32$ addresses.

2) To find first address.

167.199.170.82/27

14.20. ...

SRM INSTITUTE OF SCIENCE & TECHNOLOGY (Deemed to be University u/s 3 of UGC Act, 1956)

Step 1 convert to binary form

10100111 11000111 10101010 01010010

Step 2 First address is got by changing (32-n) rightmost to 0's.

10100111 11000111 10101010 01010010

↓

01000000

167 . 199. 170.64/27

Step 3 Find last address

167 . 199 . 170 . 82/27

convert to binary form.

10100111 11000111 10101010 01010010.

last address got by changing (32-n) righmost bit to 1's

∴ 5 righmost bit changed to 1s

10100111 11000111 10101010 01010010

↓

10100111 11000111 10101010 01011111

167 . 199 . 170 . 095

Ex 18.2 Address mask is used to find first and last addresses of address block.

1) Address mask is a 32 bit no in which n leftmost bits are set to 1s and rest of bits 32−n are set to 0's

2) Computer can find the address mask because it's complement of $(2^{32-n} - 1)$

1) The no of address in block N = NOT (Mask) +1
2) The first address in the block = (Any address in block) AND (Mask)
3) The last address in the block = (Any address in block) OR (NOT (Mask))

eg 167.199.170.82/27 Address block.

256.256.256.224

$$\begin{array}{r} 256 \\ 32 \\ \hline 224 \end{array}$$

167.199.170.82/27

10100111. 11000111 10101010 10110110.

256.256.256.224

11111111 11111111 11111111 1110000

To find the mask address in block N.

N = NOT (mask) +1

= NOT (11111111. 11111111 11111111 111000000) +1

= (00000000 00000000 00000000 00011111) +1
= (0.0.0.31) +1 = 32 addresses.

Scanned by CamScanner

SRM INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

In a classless addressing, address 230.8.24.56 can belong to many blocks.

3) An ISP has requested a block of 1000 addresses.
Since 1000 is not a power of 2. 1024 addresses are granted
Prefix length $n = 32 - \log_2 1024 = 22$.
An available block 18.14.12.0/22.

4) An organisation, with beginning address 14.24.74.0/24
organisation needs to have 3 subblocks of addresses to
use in 3 subnets -

one block of 10 address
one subblock of 60 address
one subblock of 120 address.

a) largest subblock requires 120 addresses, power of 2.

$2^7 = 128$ addresses. $n_1 = 32 - \log_2 128$
$= 32 - 7 \log_2 2$
$= 25$

First address 14.24.74.0/25
last address 14.24.74.127/25

b) largest subblock requires 60 addresses. power of 2

$2^6 = 64$ address $n_2 = 32 - \log_2 64$
$= 32 - 6 \log_2 2$
$= 26$

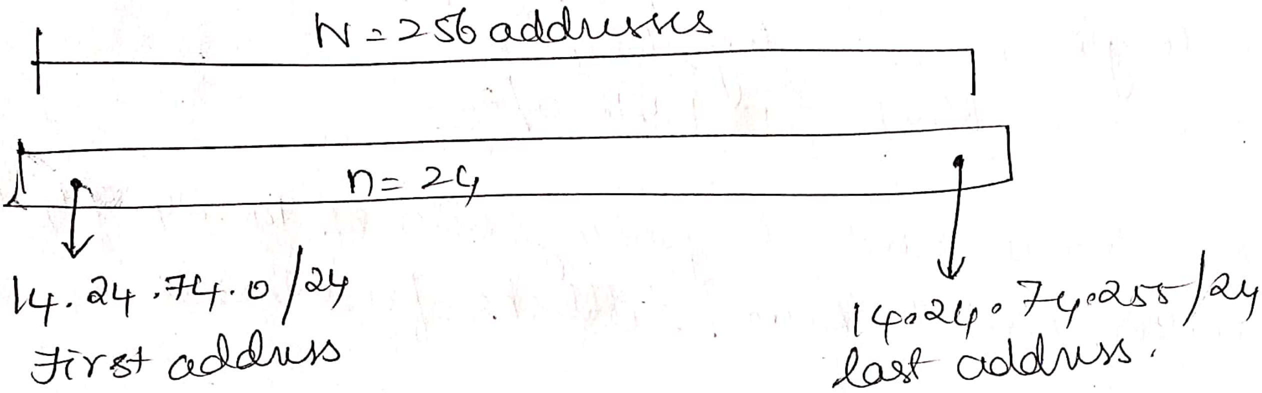
128
64
192

First address 14.24.74.128/26
last address 14.24.74.191/26

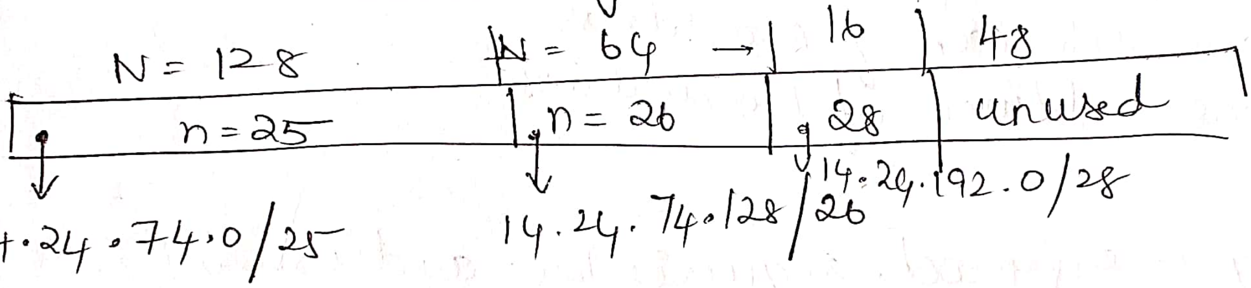
c) Smallest block 10 address

192
16
208

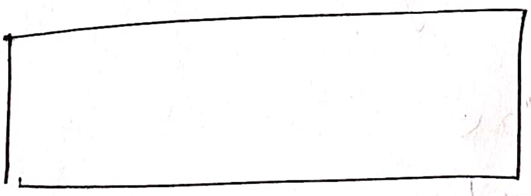
$2^4 = 16$ address $n_3 = 32 - \log_2 2^4 = 32 - 4 = 28$
First address 14.24.74.192/28
14.24.74.207/28



(a) Original block



Subblock.



Basics of subnetting

Class A Subnet Mask : 255.0.0.0/8 11111111.00000000.00000000.00000000

B Subnet Mask : 255.255.0.0/16.

C Subnet Mask : 255.255.255.0/25.

/9 255.128.0.0. 11111111.10000000.00000000.00000000

/17 255.255.128.0 11111111.11111111.10000000.00000000

/25 255.255.255.128 11111111.11111111.11111111.10000000.

/10 255.192.0.0 11111111.11000000.00000000.00000000

/18 255.255.192.0 11111111.11111111.11000000.00000000.

→ 2^{14} = 65536 Host IP ie 2^{16} subnet bits is Host is reduced to 2_{24}

/26 255.255.255.192 11111111.11111111.11111111.11000000.

→ 4 subnets

16 host ip address.

2^{16} = 65535 host ip

is reduced to

2^{14} = 16,384 per subnets

4 seperate subnets having 16,384.

/26. 255.255.255.192

1111 1111. 1111 1111. 1111 1111. 11 00 0000

Class B

65536	32768	16384	8192	4096	2048	1024	512		256	128	64	32	16	8	4	2	← subnet/network
2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}		2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	
0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	
2^{1}	2^{2}	2^{2}	2^{3}	2^{4}	2^{5}	2^{6}	2^{7}		2^{9}	2^{10}	2^{11}	2^{12}	2^{13}	2^{14}	2^{15}	2^{16}	
2	4	8	16	32	64	128	256		512	1024	2048	4096	8192	16384	32768	65536	→ host/subnet

Class B

If u borrow 4 from octet 3.

16 subnets – each having 4096 hostip address

If u borrow 5 from octet 3.

32 subnets – each having 2048 hostip address

Class C

If u borrow 4 ~~bits~~ bits from octet 3.

256	128	64	32	16	8	4	2
2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1
0	0	0	0	0	0	0	0
2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8
2	4	8	16	32	64	128	256

16 subnets – 16 host ip addresses.

If u borrow 5 bits from octet 5.

32 subnets ~~from~~ 8 host Ip addresses.

eg

(1) Given the IP address and subnet mask of 172.16.134.48 255.255.255.224. which of the following describe this address

a) this is a usable host address?

b) this is a broadcast address

c) this is a n/w address

d) This is not a valid address.

$$\begin{array}{l} \ \ \ \ 64 \\ 0\ 1\ 1\ 1\ \ 0\ 0\ 0\ 0 \\ \ 128\ 32\ 16\ 8\ 4\ 2 \end{array}$$

224

128
64
32

224

32
16

48

5 bits are taken There are 32 ~~host in~~ each subnet

48 is between .32 and .64 subnet. => this usable h
ad

(2) Possible host which subnetwork does this address resi

172.16.134.56.

1) 172.16.134.0

2) 172.0.0.0

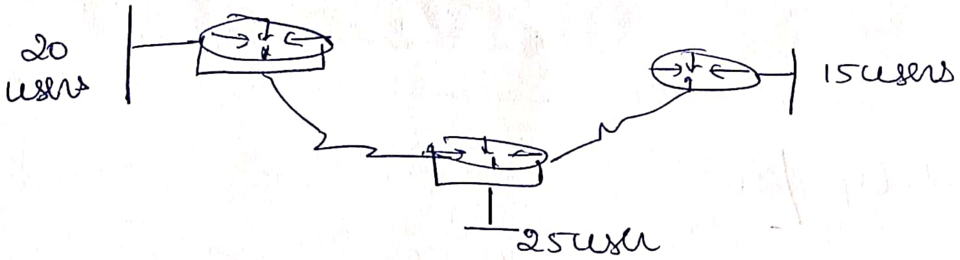
✓ 3) 172.16.134.32

4) 172.16.134.48

5) 172.16.134.47

6) 172.16.134.63

.56 lies between .32 and .64



The company n/w shown in the drawing has to be subnetted. The company has leased one Class C ip address 200.1.2.0 which of the following n/w address and masks would be appropriate for one of the n/ws.

1) 200.1.2.96. 255.255.255.192
2) 200.1.2.160 255.255.255.224
3) 200.1.2.80 255.255.255.224
4) 200.1.2.32 255.255.255.240.

64 16

240 1111 0000 ⇒ 16 host.

128 32

192 1100 0000 ⇒ 64 hosts

Required is 32 hosts. why. 15+25+20.
60.

1110 0000 ⇒ 224

128
64
32

bec.

80 ÷ 32 X.

6.

(2) 192.168.2.64 /26.

/26 subnet mask ⇒ 26's 1's rest 0's.

Subnet mask	1111 1111	1111 1111	1111 1111	11 00 0000
IP address	1100 0000	1010 1000	0000 0010	01 00 0000
	"	"	"	000000 ← n/w id
				111111 ← broadcast

(i) no of hosts

(ii) Network address

(iii) Broad cast address.

Network address = 192.168.2.64

Broadcast address = 192.168.2.127

← hosts

hosts = 192.168.2.65

⇕

192.168.2.126.

7

Find number of subnets and no of valid hosts per subnet

Subnets = 2^# of subnet bits

Valid hosts = 2^# of host bits − 2 [netid & broadcast add].

= ip address to allocate

eg (1) 192.168.1.0 /28.

11110000.

192.168.1.0 ⟹ 255.255.255.240.

11111111. 11111111. 11111111. 11110000

1) Class C.

2) Subnets = 2^{32-28} = 2^4 = 16. addresses.

$2^7 = 128$
$2^6 = 64$
$2^5 = 32$
$2^4 = 16$

(3) Hosts = 2^4 = 16 − 2 = 14

eg (2) 150.150.0.0 /30.

(1) Class B. 255.255.0.0.

$\underbrace{11111111 . 11111111}_{\text{Network}}$. 11111111.11111100

(2) Subnets = ~~2^{32-30}~~ = ~~2^2~~ = ~~4 address~~.

= 2^{14} = 16,384

(3) Hosts = 2^2 = 4 − 2 = 2 valid hosts.

Scanned by CamScanner

168.173.70.134/29.

128 192 224 240 248 252 254 255

128 64 32 16 8 4 2 1

00000000.00000000.00000000.00000000 = 32 bit.

8 16 24

.11111000
10000110
10000000

168.173.70.134/29.

1) Check for /29. = 32 − 29 = 3.

2) 2^3 = 8

1111 1000.

1) Subnet mask = 255.255.255.248.

2) Network id = ~~255.255.255.128.~~ 168.170.70.128

3) First ip = ~~255.255.255.129~~ 168.170.70.129

4) Last ip = ~~255.255.255.134.~~ 168.170.70.134

5) Broadcast ip = ~~255.2~~ 168.170.70.135

168.173.70.0

168.173.70.8

.16

.24

.32

.40

.48

.56

.64

.72

0000 0111
.1111 1000
1000 0000
1111 0000

1000 0110

Scanned by CamScanner

9

153.34.173.242 / 17.

1) Class B

2) $/17 = 2^{32-17} = 2^{15}$

1111 1111 . 11111111 . 1000 0000 . 0000.

Mask is 255 . 255 . 128 . 0 .

3) No of

173 1010 1101
1000 0000

153.34.0.0
153.34.128.0
153.34.256.0

70 => 0010 0110.
1000 0000

N/w id => 153.34.128.0

4) First address = 153.34.128.1

5) Last address = 153.34.255.254

6) Broad cast = 153.34.255.255

Scanned by CamScanner

172.10.60.16/29

/29

1111 1111 . 1111 1111 . 1111 1000 . 0000 0000

255 . 255 . 248 . 0 .

N/w id   60 ⟹ 0011 1100
    mask   1111 1000
    0011 1000 .

N/w id 172 . 10 . 56 . 0 .

First id 172 . 10 . 56 . 1

Last id   172 . 10 . 0011 1100 .
    Not mask ⟹   0000 0111   1111 1111
    0011 1111

Broad cast 172 . 10 . 63 . 255

Last 172 . 10 . 63 . 254

192.168.60.55/20.

Mask $\Rightarrow$ 2^{32-20}.

/20 11111111 1111 1111 1111 0000 00000000

255.255.240.0

<u>Net Id</u>

192.168. 1111 0000

$\Rightarrow$ 60 0011 1100

0011 0000

$\Rightarrow$ 48.

192.168.48.0.

First add 192.168.48.1

Last add 192.168. 1111 0000.

$\Rightarrow$ 60. 0011 1100

Not mask 0000 1111

63 $\Rightarrow$ 0011 1111.

192.168.63.254

192.168.63.255.

Broadcast

1
48
16
64

172.10.85.60 /22.

Class B

22 ⟹ 1111 1111.1111 1111 . 1111 1100.00000000

Mask 255.255.252.0 .

First address 172.10.85.60 .

⇓

85 01010101

Mask 11111100

01010100

Net id ⟹ 172.10.84.0

First add 172.10.84.1

Last add 01010101

00000011

01010111

Broadcast 172.10.87.255.

Last add 172.10.87.254

13

172.10.60.16/29

Mask 1111 1111 . 1111 1111 . 1111 1111 . 1111 1000

255.255.255.248.

Netid ⇒ 00010000.

Mask 11111000

00010000

172.10.60.16.

172.10.60.17.

Broadcast 0001 0000.

Not mask 0000 0111

00010111

172.10.60.23

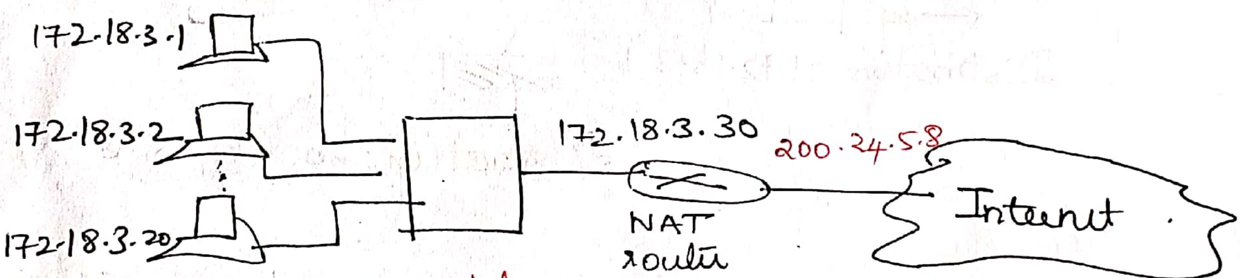
Last add 172.10.60.22.

Network Address Translation [NAT]

* If an ISP has granted a small range of addresses to a small buisness or a household
* If buisness grows or household needs a large range,
* ISP may not be able to grant the demand because the addresses before and after the range may have been allocated to other networks.
* In most situations, only a portion of computers in a small network need access to the Internet simultaneously.
* ie the number of allocated addresses does not have to match the number of computers in the n/w.

Network Address Translation [NAT]

* The mapping between private and universal addresses, and support virtual private n/w.

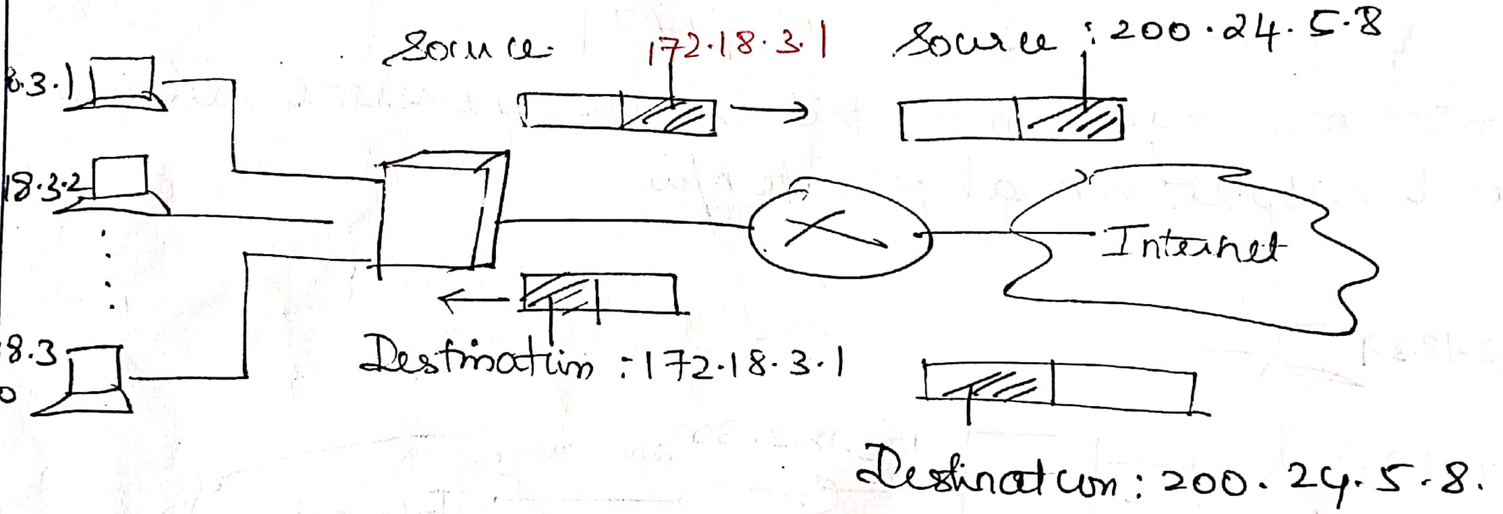


Site using private addresses.

* private n/w uses private addresses
* Router that connects the n/w to the global address uses one private address and one global address.
* private n/w is invisible to the rest of the internet; the rest of the internet sees only NAT router with address 200.24.5.8

Address Translation

* All of the outgoing packets go through the NAT router which replaces the source address in the packet with global NAT address.
* All incoming packets also pass through the NAT router, which replaces the destination address in the packet (NAT router which replaces the destination address in the packet (NAT router global address) with appropriate private address.



Translation table

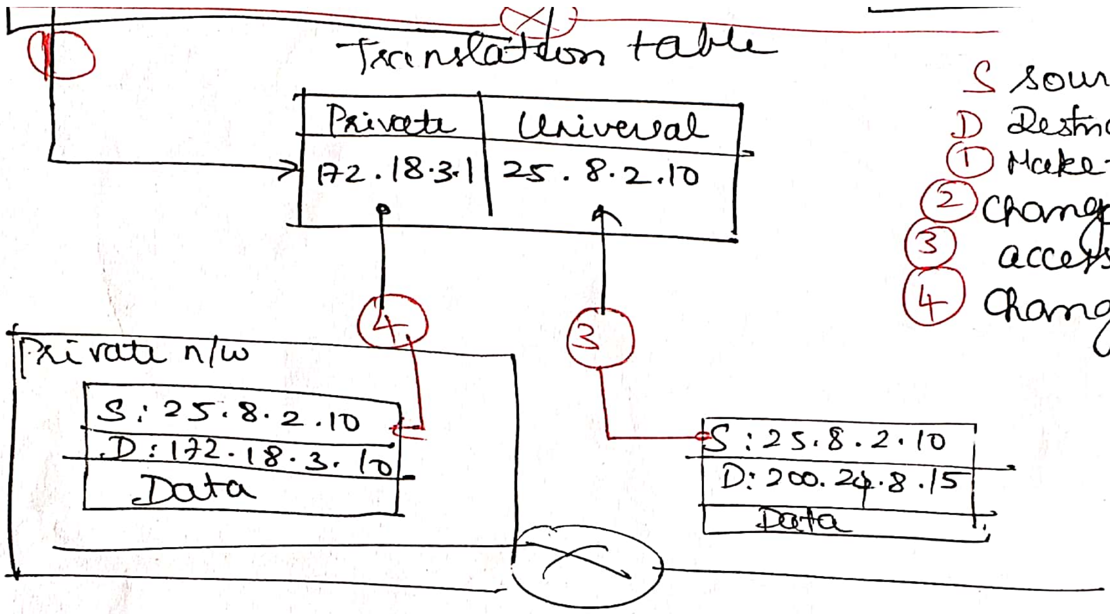
Translating the source address for a outgoing packet is straightforward. For translating tens or hundreds of private IP addresses, NAT router has a translation table.

* Using one IP address

Translation has only 2 columns

* private address
* external address

When router translates the source address of outgoing packet, it makes note of destination address where the packet is go...



S source add
D Destination add
1 Make table entry
2 Change source addr
3 access table
4 Change destination addr.

1) Initiated by the private n/w
2) NAT mechanism requires private n/w start the commn.
3) ISP assign a single address to a customer.

- Using pool of IP addresses
- Using Both IP addresses and Port Addresses

Private Address	Private Port	External Address	External Port	Transport Protocol

Subnetting

1) More levels of hierarchy can be created using subnetting.

2) An organisation that is granted a range of addresses may divide the range into several subranges and assign each subrange to a subnetwork (or subnet).

3) A subnetwork is divided into several sub-networks. A sub-subnetwork can be divided into several sub-sub-subnetworks and so-on.

Supernetting was devised to combine several class C blocks into a larger block to be attractive for organisations that needed more than 256 addresses available in class C block.

Special Addresses

5 special addresses used for special purposes.

This-host address

- only address in the block 0.0.0.0/32.
- whenever a host needs to send an IP datagram
- does not know its own address to use source address.

Limited-broadcast address

- The only address in block 255.255.255.255/32
- It is used whenever a router or a host needs to send a datagram to all devices in a network.
- The routers in the n/w, block the packet having this address as a destination. Hence the packet cannot travel outside the network.

Loop back address

* The block 127.0.0.0/8 is called loop back block
* A packet with one of the addresses in this as the destination address never leaves the host - it will remain in the host.
* used to test a piece of software in the machine
eg * client and a server program in one of the addresses is used as server address.

Private address

4 blocks are assigned - 10.0.0.0/8
172.16.0.0/12
192.168.0.0/16.
169.254.0.0/16.

Multicast addresses

Block 224.0.0.0/24 is reserved for multicast addresses.