→ Loop Back Address :

The IP address with the first Byte equals to 127 is used for the Loop Back address which is an address used to test Software on a device. when This address is used, the a packet ~~never~~ does not leave The device, It simply returns to the protocol software.

$\boxed{127.X.Y.Z}$

→ Address for Privat Networks :

Class	Net id	Blocks
A	10	1
B	172.16 to 172.31	16
C	192.168.0 To 192.168.255	256

→ Unicast Communication : one to one
Multicast Communication : one to Many
Broadcast Communication : one to All

- No Broadcasting is allowed at The global Level. A device Can NOT send a message to all hosts in The internet.

* ## Class Less Addressing :-

In classless addressing variable length blocks are assigned that belong to No class, we can have a block of 2 addresses, 4 addresses, 128 addresses and so on.

- In this architecture, the entire address space (2^{32} addresses) is divided into blocks of different sizes.

Rules :-

Rule 1 :- The number of addresses in a block must be a ~~per~~ Power of 2 (2, 4, 8, 16 - -)

Rule 2 : The first address must be evenly divisible by the number of addresses.
For example, if a block contains 4 addresses the first address must be divisible by 4. If the block contains 16 addresses, the first address must be divisible by 16.

Examples :

1. which of the follow address of a block

205 . 16 . 37 . 32

Sl :- Convert every

10/4

205 . 16 . 37 .

256^3 256^2 256

check $(256)^0$

Here $\frac{32}{16}$

2. 190 . 16 . 42 . 44

$\frac{44}{16}$ - X

3. 17 . 17 . 30 . 80

$\frac{80}{16}$ =

4. 123 . 45 . 24 . 52

$\frac{52}{16}$ =

5. 205 . 16 . 37

$\frac{32}{256}$ = X ,

Examples :

1. which of the following address can be the beginning address of a block that contains 16 addresses.

205 . 16 . 37 . 32

Sl : convert everything into decimal & divide by 16.

10/4

or

/16

205 . 16 . 37 . 32

256^3 256^2 256^1 256^0

check $(256)^0$ divided by addresses.

Here $\frac{32}{16}$ is divisible. so this First Address.

Yes.

2. 190 . 16 . 42 . 44 , /16

$\frac{44}{16}$ - X , NO

3. 17 . 17 . 30 . 80 , /16

$\frac{80}{16} = 5$ ✓ , YES

4. 123 . 45 . 24 . 52 /16

$\frac{52}{16}$ = X , NO

5. 205 . 16 . 37 . 32 /256

$\frac{32}{256}$ = X , for 256 it should ending with 0.

NO

6. 190.16.42.0

$\frac{0}{256}$ - ✓ - YES, 0's is in 256^{0} unit place

7. 17.17.32.0 - YES

8. 123.45.24.52 - NO

9. 205.16.37.32

/1024 address.

↓

4 x 256

check 4,256 divisible

$\frac{32}{256}$ - X NO

10. 190.16.42.0 /1024

↓

4 x256

$\frac{0}{256}$ - ✓

190.16.42 (even Though not an IP Jst for mathematicas)

$\frac{42}{4}$ = X

So NO. 256 - 1.0 in decimal

11. $\frac{205.16.37.32}{1.0}$

$\frac{32}{256}$ = X NO

But for math it can be written as

- 205.16.37, 32

12. $\frac{17.17.32.0}{1.0}$ /1024

$\frac{0}{256}$ - ✓, $\frac{32}{4}$ = ✓ YES.

-
b
- T
of
ac
-
iden
The
- The
comm
(simil

13. 123 . 49 . 24 . 52 - $\frac{52}{256}$ - x No.

* Format of Classless addressing address :

$\boxed{x.y.z.t/n}$

- In Classful addressing, when an address is given we can first find the class of the address then we can apply the mask to find the beginning address and the range of addresses.

- In Classless addressing, when an address is given, the block address belongs to, cannot be found unless we have the mask.

- The n after the slash defines the number of bits that are the same in every address in the block.

- If n = 20, the 20 left most bits are identical in each address with 12 bits not the same.

- The prefix is another name for the common part of the address range. (similar to NetID).

- The Suffix is the varying part (similar to Host ID). The Suffix length is 32 - n.
- Classful addressing is a special case of classless addressing.
- We can "AND" the mask & the address to find the first address.

→ Prefix Length:

/n	Mask (A)	/n	Mask (B)	/n	Mask (C)	/n	Mask (D)
1	128.0.0.0	9	255.128.0.0	17	255.255.128.0	25	255.255.255.128
2	192.0.0.0	10	255.192.0.0		255.255.192.0		255.255.255.192
3	224.0.0.0						
4	240.0.0.0						
5	248.0.0.0						
6	252.0.0.0						
7	254.0.0.0						
8	255.0.0.0	16	255.255.0.0	24	255.255.255.0	32	255.255.255.255

10/09

1) What is the first address - 16[illegible]

$/27 - 24 + 3$

$82 - \boxed{010}10010$

01000000

A - 167.199.170.64/[illegible]

2) 140.120.84.24/20 ?

$/20 - 16 + [illegible]$

$84 - \boxed{010[illegible]}$

140.120[illegible]

3. Find the no. of [illegible] addresses is [illegible]

Formula

The T[illegible]

4. Ho[illegible]

10/06

→ what is the first address - 167.199.170.82/27 ?

A) /27 - 24 + 3

82 - $\boxed{010}$10010

01000000 - 64

A - 167.199.170.64/27

2. 140.120.84.24/20 ? first address

/20 - 16 + 4

84 - $\boxed{0101}$0100

0101 0000 - 80

140.120.80.0/20 //

3. Find the no. of addresses in the block if one of the addresses is 140.120.84.24/20

$2^{32-n} = 2^{32-20} = 2^{12} = 4096.$

Formula

The Total No. of Address in the Block is 2^{32-n}.

4. How to find last address in the block

Method 1: The Number of address - 1 to the first address.

Method 2

we add first address to the compliment of the mask.

eg: /29

① $2^{32-n} = 2^{32-29} = 2^{3} = 8-1 = 7$

② $111 = 7$

eg8: Using Method ①, find last address of

140.120.84.24/20.

$120 = 2^{32-20} = 2^{12} = 4096 - 1$

$= 4095$.

Convert 4095 to 256 decimal

$4096 - 16 \cdot 0$ (256^1, 256^0)

$4095 = 4096 - 1$

$$\begin{array}{r} 16\cdot 0 \\ - \quad 1 \\ \hline 15\cdot 255 \end{array}$$

~~140.120.~~

Now change given address to first address & Then add 15.255

$$\begin{array}{r} 140.120.80.0 \\ 15.255 \\ \hline 140.120.95.255/20 \end{array}$$

egs:1 using Method (2)

12 ans is 00-0.1111 11111111

15 . 255

FA - 140.120.80.0

15.255

140.120.95.255/20

egg: Find The Block, if one of addrs 190.87.140.202/29

A. so for find Block, we need FA & LA.

190.87.140.202/29

FA:

/29 - 24+5

202 - 11001010

$\boxed{11001}010$

11001000 - 200

FA - $\boxed{190.87.140.200/29}$

LA. 111 - 7

LA - $\boxed{190.87.140.207/29}$

→ In class less addressing, The last address in The block does not necessarly end in 255.

→ In CIDR Notation, The block granted is defined by The first address & The prefix length.

$\boxed{CIDR}$ - classless Inter Domain Router.

* Subnet in Classless Addressing:

If the number of subnets is S, the number of extra 1s in the prefix length is

$\log_2 S$.

$S = 2^x$

x – number of extra 1's

ex:

1. Block 130.34.12.16/26, we need 4 subnets
   prefix length – ?

   $\log_2 4 = 2$ – extra 1's

   $26 + 2 = 28$

   ~~130.34.~~

2. what are subnet address & range of each subnet?

   Block – 130.34.12.~~1~~64/26

   No. of address – $2^6 = 64$.

   How many subnets – 4

   How many address per subnet – $\frac{64}{4} = 16$.

   FA of 1st subnet – 130.34.12.64/28

   How many address – 2^4 – 16 addr

   $64 + 16 - 1$

   LA – 130.34.12.79/28

2^{nd} - 130.34.12.80/28 - FA
130.34.12.95/28 - LA

2^{nd} - 130.34.12.96/28
130.34.12.111/28

4^{th} - 130.34.12.112/28
130.34.12.127/28

CA - 130.34.12.64/26
00111111 - 63 - 130.34.12.127/27

10/11

3. 14.24.74.0/24 , 2 SN with 64 address

2	32
3	16
4	4

2.64 = 128
2.32 = 64
3.16 = 48
4.4 = 16
256

log 64 = 6 - /26
log 32 = 5 - /27
log 16 = 4 - /28
log 4 = 2 - 30

14.24.74.0/24

1^{st} 14.24.74.0/26
14.24.74.63/26

2^{nd} 14.24.74.64/26
14.24.74.127/26

64

3^{rd} 14.24.74.128/27
14.24.74.159/27

4^{th} 14.24.74.160/27
14.24.74.191/27

32

5^{th} 14.24.74.192/28
14.24.74.207/28

6^{th} 14.24.74.208/28
14.24.74.223/28

7^{th} 14.24.74.224/28
14.24.74.238/28

16

8th 14.24.74.240/30
14.24.74.243/30

9th 14.24.74.244/30
14.24.74.247/30

10th 14.24.74.248/30
14.24.74.251/30

11th 14.24.74.252/30
14.24.74.255/30

* We can also design subnets having Variable-length Masks.

eg 4

70.12.100.128/26. — 64 Block add

32 — central —
16 — East
16 — West

log 32 = 5 — /27

FA 70.12.100.128/27
31
LAST 70.12.100.159/27 } central

FA 70.12.100.160/28 log 16 = 4 /28
15
70.12.100.175/28 } east

70.12.100.176
15
70.12.100.191/28 } west

eg 16 190.100.0.0./16. - 65,536 - 2^{16}

(a) 64. custom - 256 each - 16 384 - 14.
(b) 128 - 128 each - 16,384 - 14
(c) 128 - 64 each + 8192 - 13

40 960

(a) ~~190.100.0.0/18~~ $\log_2 16384 - 14$

FA - 190.100.0.0. /16   32 - 14

CA - 190.100.255.255 /16   = 18

so

(a) 190.100.0.0
190.100.63.255

(b) 190.100.64.0
190.100.127.255

(c) 190.100.128.0
190.100.159.255

left 190.100.160.254
190.100.255.255

→ IP is a connectionless protocol.

→ In a Connectionless service, the network layer protocol treats each packet independently. The decision about the route of a packet is made individually by each router.

* Delivery of a packet
  - Direct
  - Indirect.

1. <u>Direct Delivery:</u>

Direct delivery occurs when the source and destination of the packet are located in the same physical network or if the delivery is between the last router and the destination device.

2. <u>Indirect Delivery:</u>

In an indirect delivery the packets go from router to router until it reaches the one connected to the same physical network as its final destination.

The Last delivery is always a direct delivery.

* Forwarding Techniques:

1. Next Hop Method:

In This Technique The routing Table holds only the address of the next hop instead of information aboute The complete route.

10/13

2. Network Specific Method:

Instead of having an entry for every destination host connected to a physical Network, we have one entry that defines The address of The destination network itself.

3. Default Method:

Router R_1 routes the packets to hosts Connected to network N2. For the rest of the internet router R_2 is used. Instead of using all networks in the entire internet host A can Just have one entry called The Default.

* Forwarding with classful addressing :

Each routing Table has 3 columns.

1. The Network address of the destination network tells us where the destination Host is located.

2. The Next-Hop address tells us to which router the packet must be delivered for an indirect delivery. This Column is empty for a Direct delivery.

3. The Interface number defines the outgoing interface from ~~to~~ which the packet is sent out. A router is usually connected to several Networks. Each Connection has a different interface.

→ The Forwarding Module follows these steps:

1. The destination of the packet is extracted.
2. The destination address is used to find the class of the address. This is done by Shifting the address 28 bits to the right. The Result is a 4-bit number between 0 and 15.

0 - 7 - Class A

8 - 11 class B

12 - 13 class C

14 class D

15 class E.

3. Find the Network address. This is done by masking.

4. The class of the address & the Network address are used to find the Next-Hop address and the interface number.

5. The ARP Module uses the Next-Hop address & the interface number to find the physical address of the next router. Then the Data link layer delivers the packet to the Next-Hop.

10/18

* ~~Sub~~ Simplified forwarding Module in classfull address with subnetting :

-> Subnetting happens inside the organization.

1. The Module extracts the destination address.
2. The destination address and the mask are used to find the subnet address.

3. The routing Table is searched to find the Next-hop address and the interface number.

4. The Next-hop address and the interface number are given to ARP.

~~Destination address~~

-> In CF address, the routing table has 3 colomns.

-> In classless address, the routing Table has 4 Columns

* <u>Simplified forwarding module in ClassLess addressing:</u>

we need to include the mask (/n) in the routing table.

-> In Classless addressing we need at least 4 columns.

10/20

* <u>Address Aggregation:</u>

To reduce the size of the routing Table the idea of address aggregation was introduced.

→ Address Aggregation:

Blocks of addresses for many organizations are aggregated into one larger group.

→ Longest Mask Matching:

Routing in classless addressing uses longest mask matching. The Routing Table is sorted from the longest mask to the shortest mask.

→ Hierarchical routing with ISP's:

To solve the problem of gigantic routing tables, we can create ~~route~~ ~~a~~ a sense of hierarchy in the routing tables.

→ Routing Tables Searching Algorithms:

- classful addressing
- classless addressing

→ - Static Routing Table
- Dynamic Routing Table.

→ common fields in a table

- Mask, Network address, Next hop address, Interface, Flags, Reference count, Use